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English

Operating manual

UVB Radiometer

LPUVB02

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1 INTRODUCTION

The LPUVB02 radiometer measures the global irradiance in the UVB spectral range on a flat surface (W/m^2). In particular, the instrument spectral sensitivity is centred at 304 nm with a 5 nm bandwidth (FWHM - Full Width at Half Maximum).

The global irradiance is the sum of the direct solar irradiance and the sky diffuse irradiance on a surface parallel to the ground. Unlike the visible spectrum, where the direct component prevails over the diffuse component, in the UVB spectral region the light is strongly diffused by atmosphere and thus the two components are equivalent; therefore it is of primary importance to measure both the components accurately.

The probe is typically used in the following fields:

- **Monitoring the ozone layer.** The radiation around 295…315 nm 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 UV radiation reaching the ground.
- **Effects of UVB radiation** (the most harmful to human health) on living beings.
- **UVB radiation measurement in workplaces**.

The radiometer requires external power supply.

The radiometer is manufactured to operate for long periods without maintenance (if powered correctly). This characteristic makes it suitable for use in meteorological stations.

A Pt100 temperature sensor is placed inside the radiometer in order to control its temperature. Internal temperature must remain within the specified operating range, otherwise measurements could be affected by systematic errors higher than those stated. Exposure to temperature higher than +60 °C can alter the interferential filters spectral characteristics.

2 WORKING PRINCIPLE

The LPUVB02 radiometer is based on a solid state photodiode whose spectral response was adapted to that desired by using special interferential filters. In particular, the used photodiode and filters have exceptional stability characteristics, both in temperature and over 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 pass-band of interest. The solar energy within the 302 nm – 308 nm spectral band is only 0.01% of the total energy from the sun reaching Earth's surface.

The relative spectral response curve is shown in Fig. 2.1 (in linear scale) and Fig. 2.2 (in logarithmic scale).

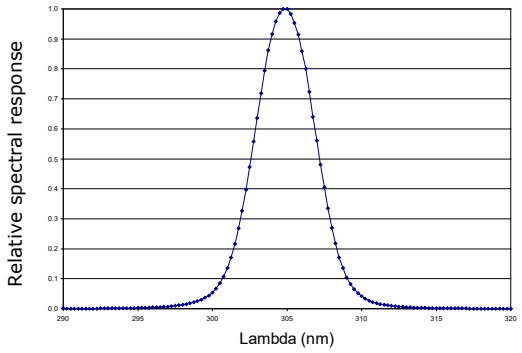


Fig. 2.1

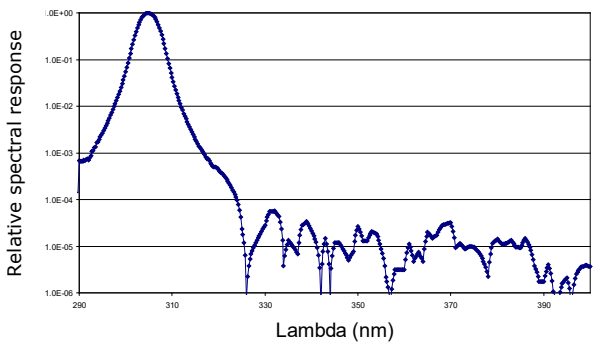


Fig. 2.2

The LPUVB02 is provided with a 50 mm external diameter dome in order to supply a suitable protection of the sensor to the weather agents. Quartz was chosen due to its optimum 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 deviation between the theoretical response and the measured one is shown in the Fig. 2.3.

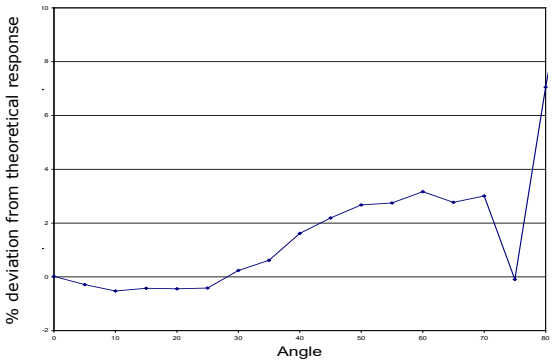


Fig. 2.3

The excellent relation between the response of the radiometer and the cosine law allows using the instrument also when the sun has a very low raising (the UVB diffuse radiation increases as the sun moves away from the zenith, therefore the error on the direct radiation, due to the imperfect response according to the cosine law, becomes negligible on the measurement of the global radiation).

3 INSTALLATION

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 drier 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 is properly positioned and undamaged.
7. Screw the cartridge to the radiometer body using a coin.
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.

The following picture shows the operations necessary to fill the cartridge with the silica-gel crystals.

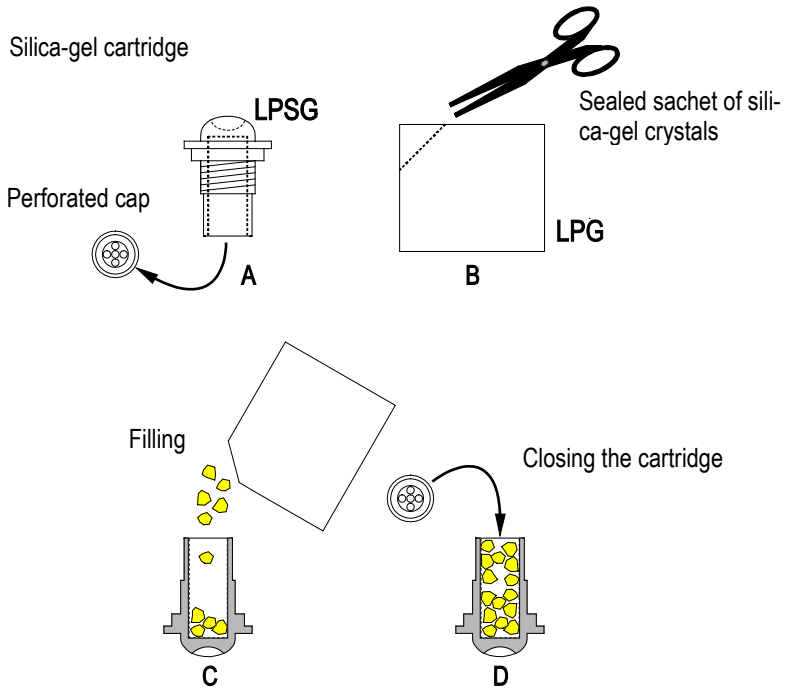


Fig. 3.1: filling the silica-gel cartridge

- The radiometer must be mounted in an easy-to-reach location in order to clean the dome regularly and carry out maintenance. At the same time, make sure that no buildings, constructions, trees or obstructions exceed the horizontal plane where the radiometer lies. If this is not possible, select a site where obstructions in the path of the sun from sunrise to sunset do not exceed 5 degrees of elevation.
- The radiometer must be located far from any kind of obstruction, which might reflect sunlight (or sun shadow) onto the radiometer itself.
- For fixing, use the holes on the radiometer body (remove the shade disk to access the holes and reposition it after mounting) or the suitable accessories (see the figures below). In order to allow an accurate horizontal positioning, the radiometer is equipped with a levelling device: the adjustment is made by means of the two levelling screws that allow adjusting the radiometer inclination. The mast height does not exceed the radiometer plane to avoid measurement errors caused by any reflection or shadow of the mast itself.
- It is preferably to thermally insulate the radiometer from its mounting bracket ensuring, at the same time, a good electrical contact to ground.

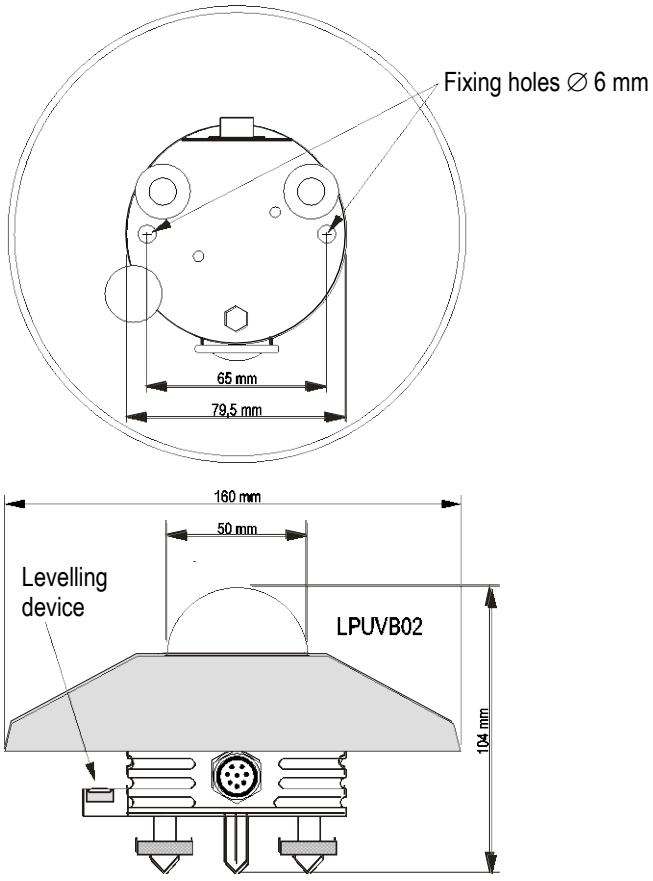
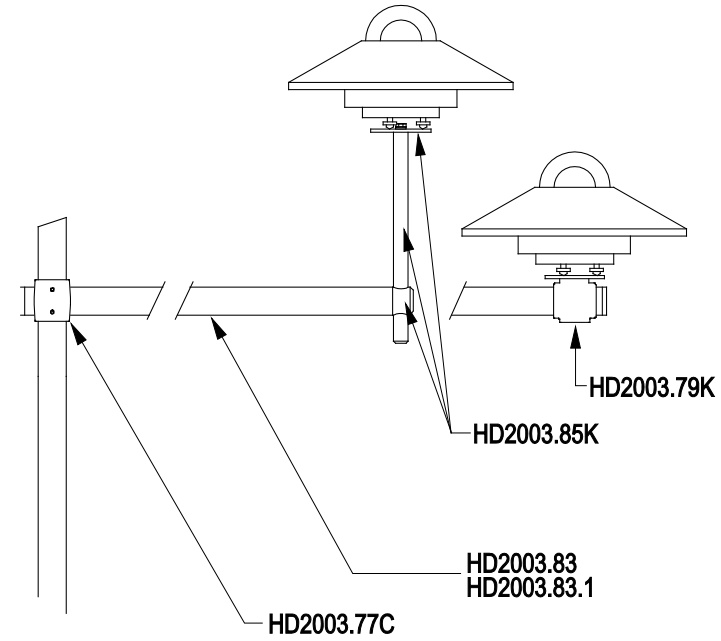


Fig. 3.2: fixing holes and levelling device



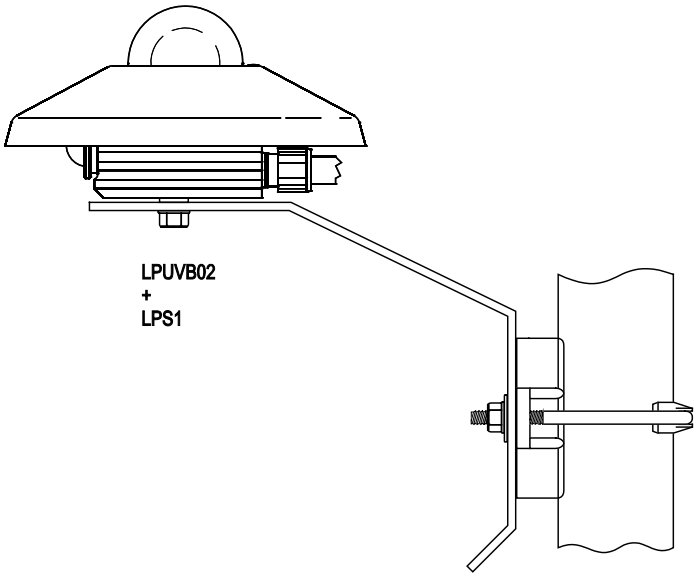


Fig. 3.3: fixing accessories

4 ELECTRICAL CONNECTIONS

LPUVB02 has a 8-pole connector and uses the **CPM12AA8U... optional** cables.

The metallic housing of the radiometer should preferably be grounded (⏚) locally. In this case, do not connect the wire of the cable corresponding to the housing to prevent ground loops.

Only if it is not possible to ground locally the metallic case of the radiometer, connect the wire of the cable corresponding to the housing to ground.

The radiometer has two analog outputs: one for temperature, **normalized 0...1 V** corresponding to -40…+60 °C, and one for UV irradiance, **not normalized** corresponding to **S** V/(Wm^{-2}), where S is the radiometer sensitivity.

The radiometer has to be connected to a power supply (7…30 Vdc) and instruments with voltage input as shown in fig. 4.1. The load resistance of the instrument reading the signal must be **≥ 10 kΩ**.

Connector	Function	Color
1	Analog outputs ground (SGND)	Red
2	+Vout UV	Blue
3	Not connected	
4	Cable shield (SH)	Shield
5	Power supply negative (GND)	Brown
6	+Vout Temperature	White
7	Housing (C)	Black
8	Power supply positive (+Vdc)	Green

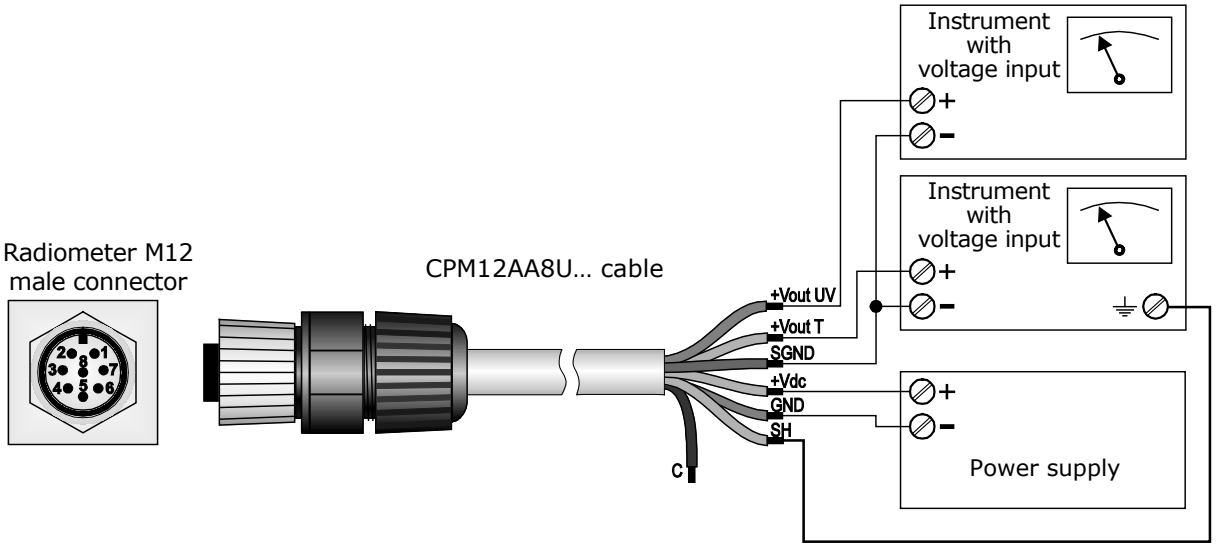


Fig. 4.1: LPUVB02 connections

5 MEASUREMENT

Each radiometer is distinguished by its own sensitivity (or calibration factor) ***S*** expressed in V/(Wm^{-2}) and shown in the label on the radiometer (and in the calibration report).

The irradiance E_e is obtained by measuring with a multimeter the output voltage **Vout UV** (difference of potential between +Vout UV and SGND) and applying the following formula:

$$E_e = \text{Vout UV} / S$$

where:

E_e is the irradiance expressed in W/m^2;

Vout UV is the difference of potential expressed in V measured by the multimeter;

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

It is possible that an offset of some tenths of millivolts (0.3 - 0.4 mV) be present on the output signal. In this case it is recommended that the data be acquired also at night and subtract the night-measurement offset from the performed measurements.

In the presence of a possible offset OFS (in Volt), the previous formula becomes:

$$E_e = (\text{Vout UV} - \text{OFS}) / S$$

Typically, the radiometer output signal, when exposed to the sun, does not exceed 1 V. In order to fully exploit the radiometer features, the readout instrument should have 0.1 mV resolution.

The temperature ***T*** in °C is obtained by measuring with a multimeter the output voltage **Vout Temp** (difference of potential between +Vout Temp and SGND) and applying the following formula:

$$T = (100 \times \text{Vout Temp}) - 40$$

For example, supposing to read a voltage Vout Temp = 0.532 V, from the previous formula we obtain that the radiometer internal temperature is:

$$T = (100 \times 0.532) - 40 = 13.2\ °C$$

Notes on the radiometer calibration:

The calibration factor of the radiometer is factory-determined by measuring the output signal when the radiometer is hit by a parallel and homogeneous beam of light over the entire surface of the diffuser. Calibration is performed with monochromatic light at 304 nm.

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. 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: https://nvlpubs.nist.gov/nistpubs/jres/106/4/j64lar.pdf).

6 MAINTENANCE

In order to grant measurements high accuracy, it is important to keep the glass dome clean. Consequently, the more the dome will be kept clean, the more measurements will be accurate.

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

Because of the high temperature changes between day and night, some condensation might appear on the radiometer dome. In this case the performed reading is highly over-estimated. To minimize the condensation, the radiometer is provided with a cartridge containing dessicant material (silica-gel). The efficiency of the silica-gel crystals decreases over time while absorbing humidity. Silica-gel crystals are efficient when their color is **yellow**, while they turn **white/translucent** as soon as they lose their efficiency. Read instructions at chapter 3 about how to replace the silica-gel crystals. Silica-gel typical lifetime goes from 2 to 6 months depending on the environment where the radiometer works.

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

7 TECHNICAL SPECIFICATIONS

UV MEASUREMENT	
Typical sensitivity	0.5 – 1.5 V/(W/m^2)
Response time	<0.5 sec (95%)
Min. load impedance	10 KΩ
Measurement range	0 - 2 W/m^2
Viewing range	2π sr
Spectral range	304 nm Peak ± 1 nm 302.5 nm…307.5 nm (1/2) 301 nm…309 nm (1/10) 297.5 nm…311.75 nm (1/100) 292.5 nm…316.255 nm (1/1000)
Working temperature	-40 °C…+60 °C
Response according to the cosine law:	< 8 % (between 0° and 80°)
Long term instability (1 year)	<|±3| %
Non linearity	<|1| %
Response according to temperature	< 0.01%/°C
TEMPERATURE MEASUREMENT	
Measurement range	-40 °C…+60 °C
Accuracy	±0.2 °C
Min. load impedance	10 KΩ
POWER SUPPLY	
V+	7…30 Vdc
Typical consumption	3 mA
Weight	0.90 Kg

8 SAFETY INSTRUCTIONS

General safety instructions

The instrument has been manufactured and tested in accordance with the safety standard EN61010-1:2010 "Safety requirements for electrical equipment for measurement, control and laboratory use" and has left the factory in perfect safety technical conditions.

The instrument proper operation and operating safety can be ensured only if all standard safety measures as well as the specific measures described in this manual are followed.

The instrument proper operation and operating safety can be ensured only in the climatic conditions specified in this manual.

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:

- EEC directives on workplace safety.
- National law regulations on workplace safety.
- Accident prevention regulations.

9 ACCESSORIES ORDERING CODES

LPUVB02 Amplified radiometric probe for outdoor use for measuring IRRADIANCE in the UVB spectral range. Supplied with shade disk, sylica-gel cartridge, 2 spare sachets, bubble level, 8-pole M12 connector and Calibration Report.

Accessories

CPM12AA8U... 8-pole cable. 8-pole M12 connector on one end, open wires on the other end. Available length 2 m (CPM12AA8U.2), 5 m (CPM12AA8U.5) or 10 m (CPM12AA8U.10).

LPS1 Only attachment bracket, suitable for mast with diameter 40…50 mm. Installation on horizontal or vertical mast.

LPSP1 Spare shade disk.

LPSG Cartridge to contain desiccant silica-gel crystals, complete with O-ring and cap. Spare part.

LPG Pack of 5 sachets of silica-gel crystals. Spare part.

LPS6 Kit for the installation of the radiometer. The kit includes: 750 mm mast, base fitting, graduated support plate, bracket for radiometer.

LPRING02 Base with levelling device and adjustable holder for mounting the radiometer in an inclined position.

DELTA OHM metrology laboratories LAT N° 124 are ISO/IEC 17025 accredited by ACCREDIA for Temperature, Humidity, Pressure, Photometry / Radiometry, Acoustics and Air Velocity. They can supply calibration certificates for the accredited quantities.

NOTE

NOTES

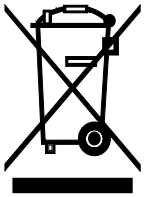
WARRANTY

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 reserves 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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