SIAP+MICROS
Environmental Monitoring Solutions
Since 1925

# T057 TSD

## Sunshine duration sensor

User Manual and maintenance

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# Sommario

# *1* INTRODUCTION

The T057 TSD heliofanometer measures the state and duration of insolation. The WMO (World Meteorological Organisation) defines the duration of insolation as the time during which direct radiation is greater than 120 W/m.

The irradiance measurement is carried out with a series of photodiodes arranged according to a special geometry that allows for an accurate measurement under all conditions. This solution avoids the use of mechanical moving parts and guarantees great reliability over time.

The T057 TSD is equipped with a separately powered and galvanically insulated heating element, which prevents the formation of condensation on the glass surface onto which the sensitive elements face.

The instrument is available with output RS485 MODBUS-RTU and Potential-free contact (closed ⇒ SRD ≥ 120 W/m , open ⇒ SRD < 120 W/m$^{2)}$

The instrument does not require positioning adjustments during the year and can be fixed to a pole or placed on a flat base using optional fixing accessories.

The fields of application are many: from agronomy for studying crop trends, to photovoltaic systems to check their yield, to 'building automation' for the automatic opening/closing of roller shutters, blinds and in general to all those sectors where it is necessary to monitor the presence of sunlight.

# 2 OPERATING PRINCIPLE

The T057 TSD heliofanometer is based on the use of 16 sensors arranged in such a way that when the sun is present at least one of the photodetectors receives light directly from the sun (in addition to the diffused component).

The sensors that are not directly illuminated by the sun are used for the measurement of diffuse light, which is subtracted from the measurement of the sensor that directly sees the sun in order to obtain the direct radiation.

The cylindrical glass protects the sensors and the internal circuitry of the instrument from the weather, while at the same time providing excellent transparency to sunlight.

To prevent the formation of condensation inside the instrument, the T057 TSD is equipped, in addition to the heating element, with a cartridge that must be filled with colloidal silica dehydrating material (Silica-gel).

# 3 INSTALLATIONS

**Before installing the heliofanometer, the cartridge containing the silica-gel crystals must be loaded.**

When loading the silica-gel crystals, avoid getting them wet or touching them with your hands. The operations to be performed in a dry place (as far as possible) are:

1. Unscrew the silica-gel cartridge with a coin.
2. Remove the perforated cartridge cap.
3. Open the bag (supplied with the heliofanometer) containing the silica-gel.
4. Fill the cartridge with the silica-gel crystals.
5. Close the cartridge with its cap, ensuring that the O-ring seal is correctly positioned.
6. Screw the cartridge onto the heliospherometer body with a coin.
7. Make sure that the cartridge is screwed in tightly (otherwise the service life of the silica-gel crystals will be reduced).

The following figure shows the steps required to load the cartridge with silica gel crystals.

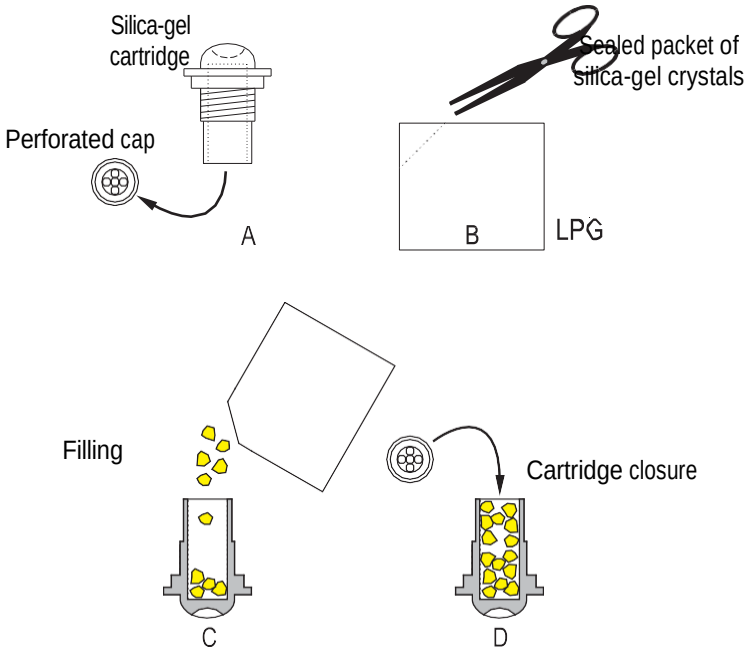



Fig. 3.1: Filling the silica-gel holder cartridge

The heliofanometer should be installed in an easily accessible location for periodic glass cleaning and maintenance. At the same time it must be avoided that buildings, trees or obstacles of any kind overstep the horizontal plane on which the heliospherometer lies. It is acceptable to choose a position where obstacles in the path of the sun from sunrise to sunset are less than 5° from the horizontal plane of the heliofanometer. It should also be checked that there are no reflective elements present that could alter the measurement.

The T057 TSD does not require orientation adjustments during the course of the year.

Various installation modes are available, with adjustable supports to adapt the sensor to the position of the sun at the latitude of the installation site:

- Installation on a plane using the support with adjustable inclination (without scale). The bracket must be requested when ordering the sensor, as it must be assembled at the factory.

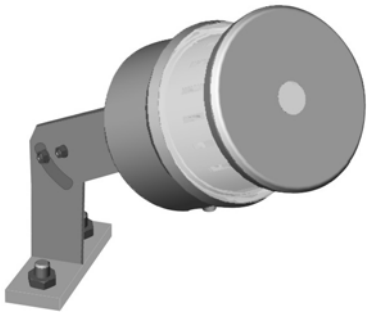


Fig. 3.2: bracket

- Installation on the base The base allows the sensor to be tilted up to 80° (with scale) from the vertical. Two adjustable feet and one fixed foot allow the sensor to be placed horizontally.

Fig. 3.3: stand

- Installation on a Ø 40 mm vertical pole using the bracket. The bracket allows the sensor to be tilted up to 80° (with scale) from the vertical and the sensor to be rotated in the horizontal plane.

Fig. 3.4: bracket

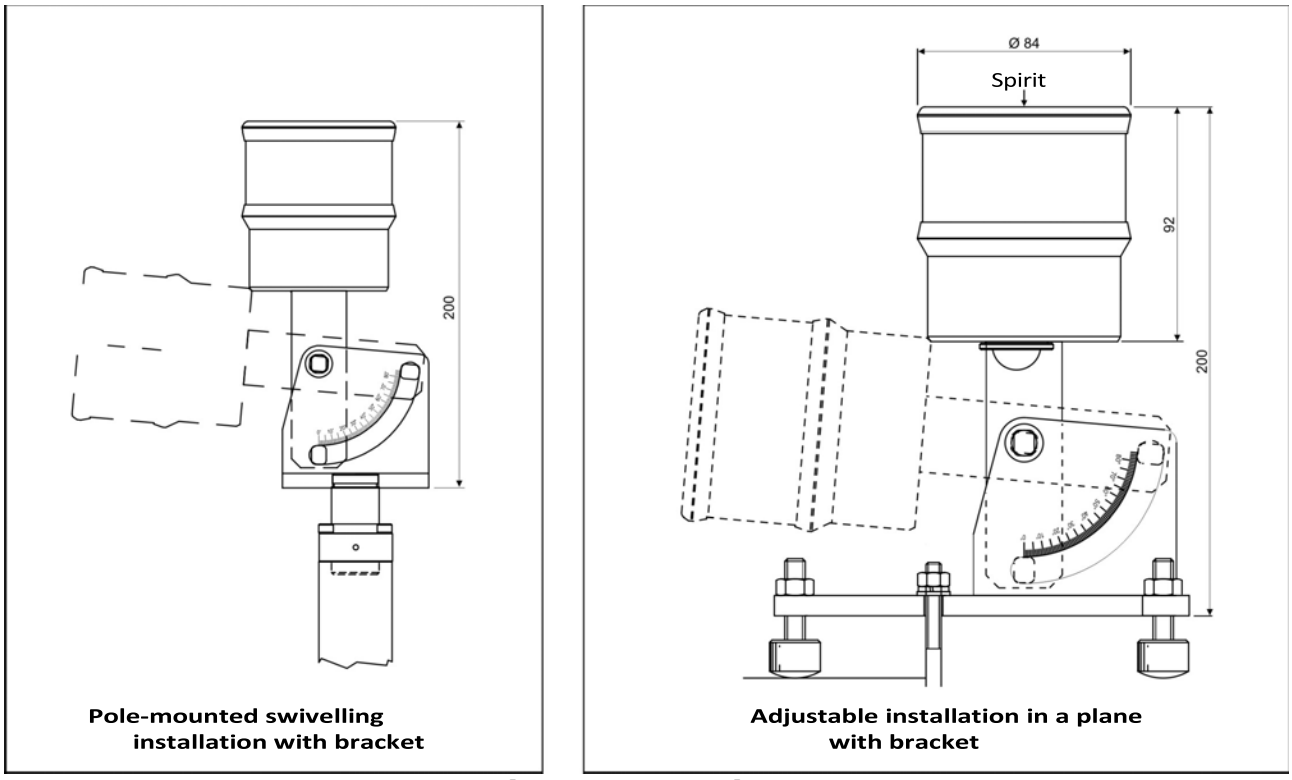



**Fig. 3.5: Brackets**

Before swivelling the heliospherometer to its final position, place it vertically and adjust the feet of the base (for installation on a plane) or support (for installation on a pole ø 40 mm) so that the spirit level at the top of the instrument is perfectly level (Fig. 3.6).

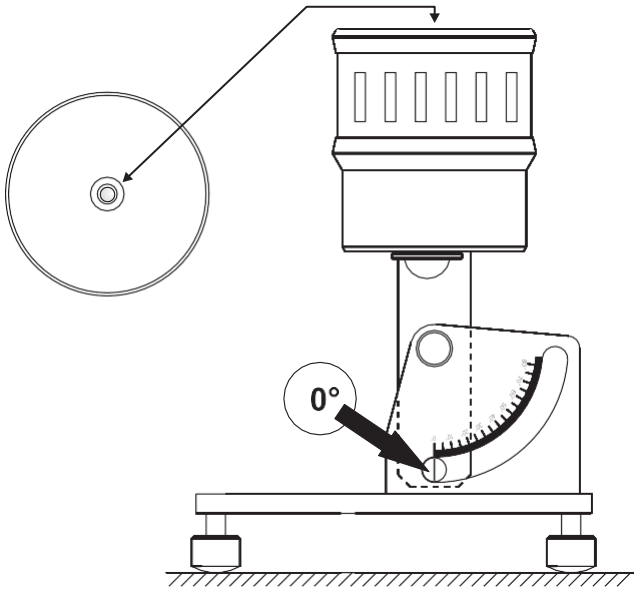



Fig. 3.6: Leveling the heliofanometer

Orient the heliofanometer so that the index of the graduated scale on the support is at the value (90° - Latitude), and with the upper part (where the bubble is) pointing towards the NORTH pole if using it in the NORTH hemisphere, and towards the SOUTH pole if using it in the SOUTH hemisphere (Fig. 3.7).

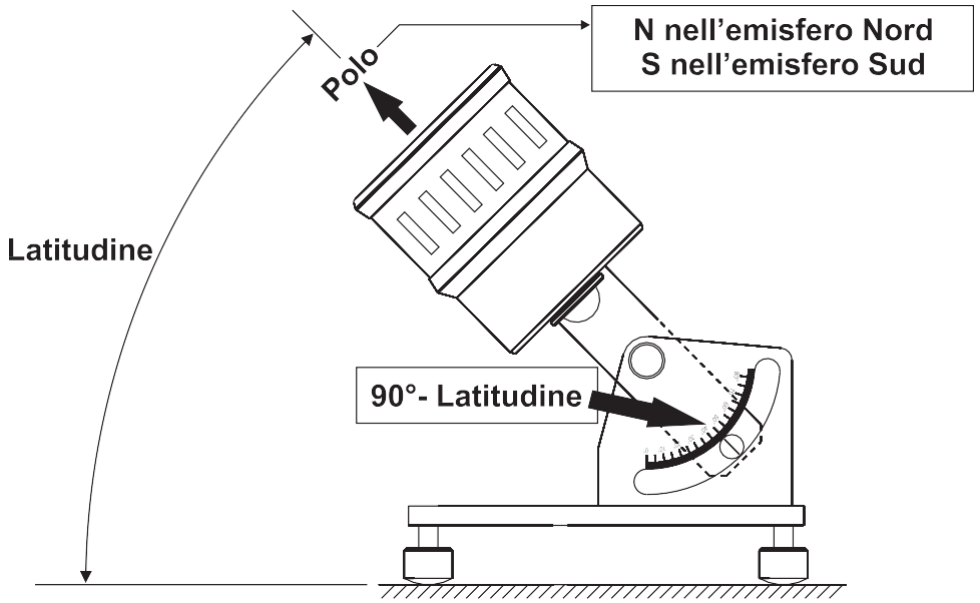



Fig. 3.7: Heliofanometer orientation

The angle that the axis of the instrument must make with the ground is equal to the latitude of the place of installation, so that the axis of the instrument will be parallel to the north-south ter- restrial axis (Fig. 3.8).

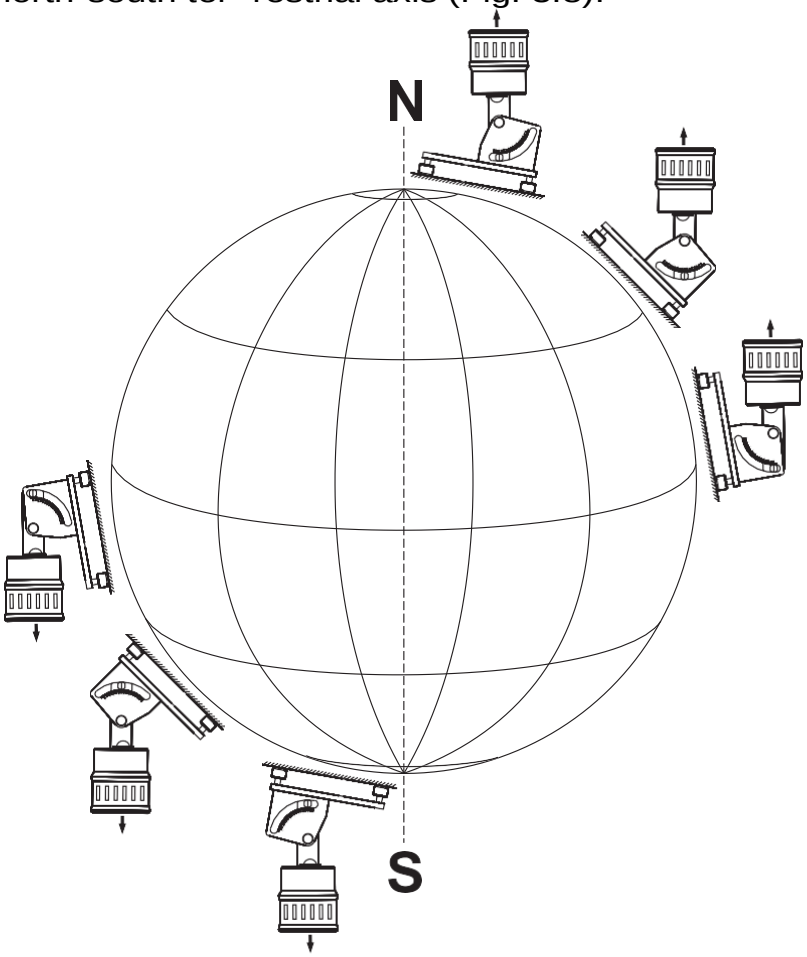
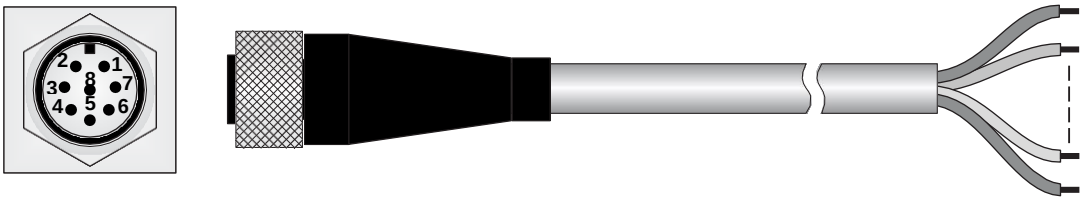



Fig. 3.8: Heliofanometer parallel to earth axis

## 3.1 *Electrical connections*

The heliospherometer has an 8-pin connector and uses the cables with 8-pin connectors on one side and free wires on the other.




**M12 male instrument connector**

Fig. 3.9: Connections

| ºConnector contact no. | Function | ºN/colour cable |
|---|---|---|
| 1 | Negative power supply | 12/Black + 7/Purple + 6/Pink (**) |
| 2 | Positive power supply | 1/Red + 2/Blue + 4/Grey-Pink (**) |
| 3 | Heating (*) | 3/Yellow |
| 4 | RS485 A/- | 9/White |
| 5 | RS485 B/+ | 5/Red-Blue |
| 6 | Potential-free contact | 8/Grey |
| 7 | Heating (*) | 10/Brown |
| 8 | Potential-free contact | 11/Green |

(*) Heating connection is not polarised; the two wires can be reversed.
(**) Shorted wires on connector contact.

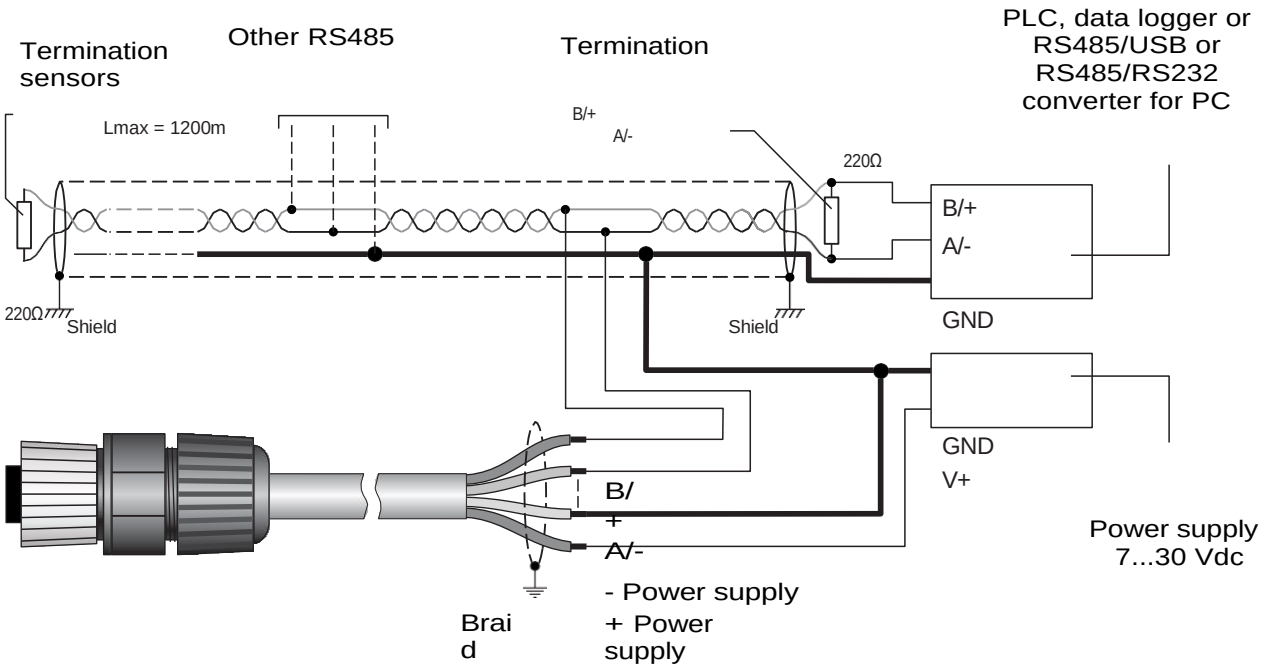



Fig. 3.10: RS485 connection

# *4* RS485 MODBUS-RTU OUTPUT

**The MODBUS-RTU protocol is active 5 seconds after switching on.**

Before connecting the sensor to the RS485 network, it is necessary to assign it an address and set its communication parameters, if different from the factory preset.

## 4.1 Setting the communication parameters

Connect the sensor to the PC using the supplied 8-pin M12 socket or the cable and an RS485/USB or RS485/RS232 converter**.** If an RS485/USB converter is used, the relevant USB drivers must be installed in the PC.

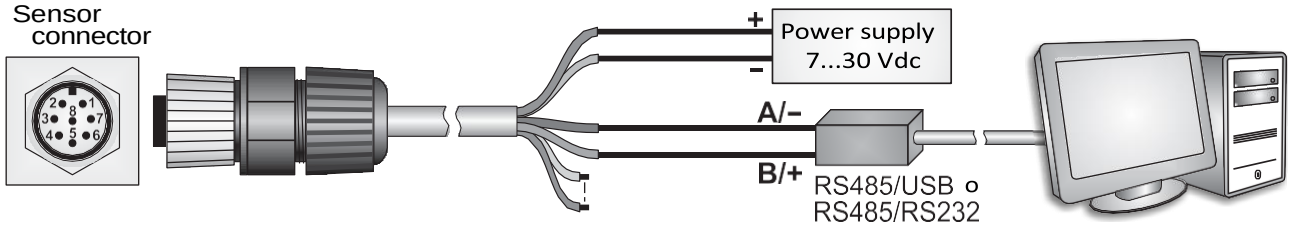



Fig. 4.1: Connection to PC

**NOTES ON INSTALLING** unsigned **USB DRIVERS**: Before installing unsigned USB drivers in operating systems from Windows 7 onwards, the PC must be restarted by disabling the driver signature prompt. On 64-bit operating systems, even after installation it is necessary to disable the driver signature prompt each time the PC is restarted.

**Procedure:**

1. Start from the non-powered sensor condition.
2. In the PC, start a serial communication programme. Set the Baud Rate to 57600 and set the communication parameters as follows (the sensor is connected to a COM port):

   Data bits: 8
   Parity: None
   Stop bits: 2

   In the programme, set the number of the COM port to which the sensor is connected.
3. Power up the sensor.
4. Wait for the sensor to transmit the **&** character, then send (within 5 seconds of the sensor being powered up) the @ command and press the **enter** key.

   *Note*: If the sensor does not receive the @ command within 5 seconds of being powered up, the RS485 MODBUS mode is automatically activated. In this case, it is necessary to switch the sensor off and on again.
5. Send **CAL USER ON** command.

   *Note*: The CAL USER ON command is deactivated after 5 minutes of inactivity.
6. Send the serial commands shown in the following table to set the RS485 MODBUS parameters:

| Command | Response | Description |
|---|---|---|
| CMAnnn | &\| | Set address to nnn Between 1 and 247<br>Preset to 1 |
| CMBn | &\| | Set Baud Rate<br>n=0 ⇒ 9600<br>n=1 ⇒ 19200<br>Preset to 1 ⇒ 19200 |
| CMPn | &\| | Set parity and stop bits<br>n=0 ⇒ 8N1 (no parity, 1 stop bit) n=1 ⇒ 8N2 (no parity, 2 stop bits) n=2 ⇒<br>8E1 (even parity, 1 stop bit) n=3 ⇒<br>8E2 (even parity, 2 stop bits) n=4 ⇒<br>8O1 (odd parity, 1 stop bit) n=5 ⇒<br>8O2 (odd parity, 2 stop bits)<br>Preset to 2 ⇒ 8E1 |
| CMWn | &\| | Sets the waiting time after transmission<br>n=0 ⇒ Immediate reception (violates protocol) n=1 ⇒ 3.5 character wait (respects protocol)<br>Preset to 1 ⇒ Waiting for 3.5 characters |

**7.** Parameter settings can be checked by sending the following commands:

| Command | Reply | Description |
|---|---|---|
| RMA | *Address* | Read address |
| RMB | *Baud Rate*<br>(0,1) | Read Baud Rate<br>0 ⇒ 9600<br>1 ⇒ 19200 |
| RMP | *Tx Mode*<br>(0,1,2,3,4,5) | Read parity and stop bits<br>0 ⇒ 8N1<br>1 ⇒ 8N2<br>2 ⇒ 8E1<br>3 ⇒ 8E2<br>4 ⇒ 8O1<br>5 ⇒ 8O2 |
| RMW | *Rx Mode*<br>(0,1) | Read waiting time after transmission<br>0 ⇒ Immediate reception (violates protocol)<br>1 ⇒ 3.5 character wait (respects protocol) |

*Note*: Reading the settings does not require sending the CAL USER ON command.

## 4.2 Reading out measurements with the Modbus- RTU protocol

The following is a list of registers.

**Input Registers**

| Address | Size | Format |
|---|---|---|
| 0 | Internal temperature °C [x10] | Integer 16 bit |
| 1 | Internal temperature °F [x10] | Integer 16 bit |
| 2 | Direct radiation (SRD, "Direct Sunshine") in W/m$^2$ | Whole 16 bit |
| 3 | Status register<br>Bit0=1 ⇒ radiation measurement in error Bit1=1 ⇒ temperature measurement in error Bit2=1 ⇒ data memory error<br>Bit3=1 ⇒ program memory error | Integer 16 bit |
| 4 | [2] Number of seconds in the last minute with radiation greater than 120 W/m (number between 0 and 60) | Integer 16 bits |
| 5 | [2] [2] Number of tens of seconds in the last 10 minutes with radiation ≥ 120 W/m (number between 0 and 60: a 1 is counted for every 10 s in the last 10 minutes if SRD ≥ 120 W/m for at least 5 s)<br>For higher resolution use register number 5. | Integer 16 bit |
| 6 | Sunshine presence/absence contact status<br>[2] 0 = SRD < 120 W/m (open contact)<br>[2] 1 = SRD ≥ 120 W/m (contact closed) | Integer 16 bit |
| 7 | Status of heating: 0 = off, 1 = on | Integer 16-bit |
| 8 | Temperature in °C [x10] below which the heating switches on | Integer 16 bits |
| 9 | Circular counter from 0 to 32767 of the number of measurement cycles. It is incremented after each measurement. | Integer 16 bits |
| 10 | [2] Radiation detected by sensor #1 in W/m [x10]. | Integer 16 bit |
| 11 | [2] Radiation detected by sensor #2 in W/m [x10]. | Integer 16 bit |
| 12 | [2] Radiation detected by sensor #3 in W/m [x10]. | Integer 16 bit |
| 13 | [2] Radiation detected by sensor #4 in W/m [x10]. | Integer 16 bit |
| 14 | [2] Radiation detected by sensor #5 in W/m [x10]. | Integer 16 bit |
| 15 | [2] Radiation detected by sensor #6 in W/m [x10]. | Integer 16 bit |
| 16 | [2] Radiation detected by sensor #7 in W/m [x10]. | Integer 16 bit |
| 17 | [2] Radiation detected by sensor #8 in W/m [x10]. | Integer 16 bit |
| 18 | [2] Radiation detected by sensor #9 in W/m [x10]. | Integer 16 bit |
| 19 | [2] Radiation detected by sensor #10 in W/m [x10]. | Integer 16 bit |
| 20 | [2] Radiation detected by sensor #11 in W/m [x10]. | Integer 16 bit |
| 21 | [2] Radiation detected by sensor #12 in W/m [x10]. | Integer 16 bit |
| 22 | [2] Radiation detected by sensor #13 in W/m [x10]. | Integer 16 bit |
| 23 | [2] Radiation detected by sensor #14 in W/m [x10]. | Integer 16 bit |
| 24 | [2] Radiation detected by sensor #15 in W/m [x10]. | Integer 16 bit |
| 25 | [2] Radiation detected by sensor #16 in W/m [x10]. | Integer 16 bit |

See figure below for sensor numbering. To identify the sensors, the reference is the square notch at the top when the sensor is installed.

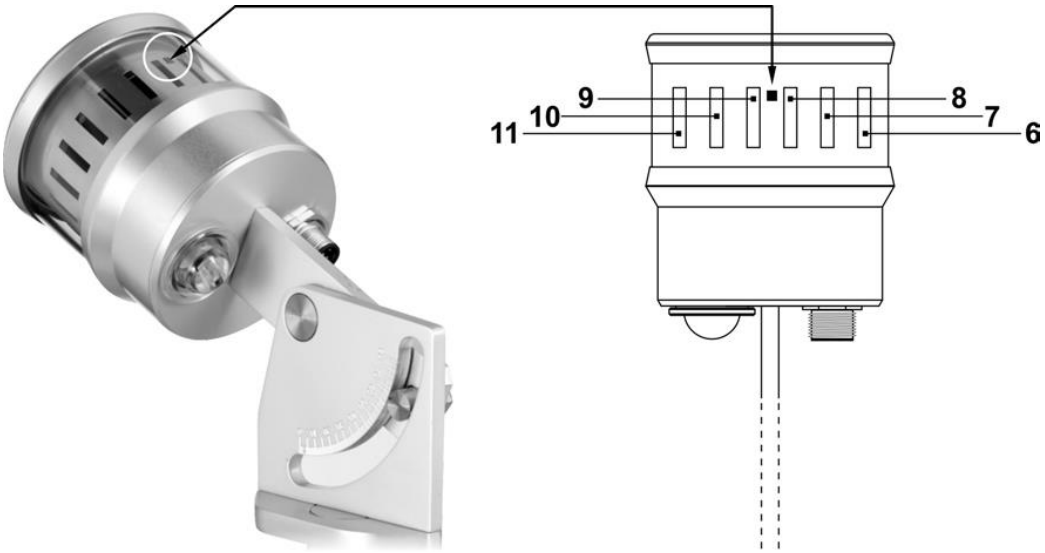



Fig. 4.2: Sensor numbering

## 4.3 Changing the heating activation temperature

The temperature below which the heating switches on can be changed by writing the value into the *Holding Register* of address 2. The value must be set in tenths of a degree in the range of -450 (-45.0 °C) to 700 (+70.0 °C).

**Changing the Holding register of address 2 only changes the value in the RAM memory, the change is therefore cancelled in the event of a power failure of the instrument.** To make the change permanent, write the hexadecimal value FF00 into the **Coil** type register of address 2.

To check whether the permanent storage has been successfully completed, check that the *Holding Register* type *register* of address 1 contains 0.

**Coils**

| Address | Data |
|---|---|
| 2 | Permanent storage of the heating activation temperature. |

**Holding Registers**

| Address | Datum | Format |
|---|---|---|
| 0 | Indicator of correct interpretation of the last Modbus command sent.<br>If 0, the command was executed correctly.<br>If 1, errors occurred in the execution of the command. | Integer 16 bit |
| 1 | Indicator of the correct permanent storage of the heating activation temperature.<br>If 0, the temperature was stored correctly. If 1,<br>storage errors have occurred. | Integer 16 bit |
| 2 | Temperature in °C [x10] of heating activation. | Integer 16 bit |

Checking **THE CORRECT INTERPRETATION OF MODBUS COMMANDS**: To check whether
the last MODBUS command sent to the instrument was interpreted correctly, check that *the Holding Register* of address 0 contains 0.

# *6* MAINTENANCE

In order to ensure high measurement accuracy, it is necessary to keep the protection glass clean.

Cleaning can be performed with microfibre cloths for cleaning photo- graphic lenses and with water. If this is not sufficient, use pure ethyl alcohol. After cleaning with alcohol, the protective glass must be cleaned again with water only and dried thoroughly.

To minimise the formation of condensation, there is a heating element inside the sensor and a special cartridge with absorbent material (silica gel). The efficiency of silica-gel crystals decreases over time as moisture is absorbed. When the silica-gel crystals are efficient, the colour is **yellow**, while as they lose efficiency the colour becomes **white/transparent**. To replace the silica-gel crystals, see the instructions in Chapter 3. Typically the lifetime of the silica-gel varies from 2 to 6 months depending on the environmental conditions in which the sensor operates.

# *7* TECHNICAL FEATURES

| | |
|---|---|
| **Sensitive elements** | 16 Silicon photodiodes |
| **Spectral range** | 360...1100 nm |
| **Measuring range direct radiation SRD** | 0...2000 W/m$^2$ |
| **Accuracy of direct radiation measurement** | Better than 90% of monthly total |
| **Accuracy** of **sunshine duration measurement** | Better than 90% of monthly total |
| **Response time** | <1 ms |
| **Threshold value** | 120 W/m$^2$ |
| **Insolation duration resolution** | 1 s |
| **Power supply Power consumption** | 7...30 Vdc<br>5mA @ 12V |
| **Heating**<br>**Anti-condensation device consumption**<br>**Antifreeze consumption** | 12...15 Vdc<br>1 W @ 12 V<br>5 W @ 12 V ON for Inside temp. > 6 °C,<br>OFF for Inside Temp. > 10 °C |
| **Inside temperature**<br>**Measuring range**<br>**Accuracy** | <br>-40...+80 °C<br>± 0,5 °C |
| **Operating temperature range** | -40...+80 °C |
| **Weight** | 0.9 kg |
| **Degree of protection** | IP66 |

# *8* SAFETY INSTRUCTIONS

## General safety instructions

The instrument has been constructed and tested in accordance with the safety standard EN61010-1:2010 'Safety requirements for electrical equipment for measurement, control and laboratory use', and left the factory in a technically safe condition.

The proper functioning and operational safety of the instrument can only be guaranteed if all normal safety measures as well as the specific measures described in this operating manual are observed.

The proper functioning and operational safety of the instrument can only be ensured under the climatic conditions specified in the manual.

Do not use the instrument in places where there are:

- Corrosive or flammable gases.
- Direct vibration or shock to the instrument.
- High electromagnetic fields, static electricity.

## User's Obligations

The user of the instrument must ensure that the following regulations and directives concerning the handling of hazardous materials are observed:

- EEC directives for safety at work.
- National legal regulations for safety at work
- Accident prevention regulations.

Generic information
The qualitative level of our instruments is the result of a continuous evolution of the product. This may cause differences between what is reported in the manual and the instrument you have purchased.
Siap+Micros S.p.A. reserves the right to modify without notice technical specifications and dimensions to adapt them to the needs of the product.

## Safety

Please read these safety instructions carefully before using this product:

- The warranty will be void if the product is used differently from the instructions described in this manual.
- Any sign of tampering will void the warranty
- Use the devices only according to the instructions (environmental management, operation, wiring, installation, etc.) provided in this manual
- The correct and safe operation of the device can only be guaranteed if the transport, storage, operation and management of the device are compliant. This also applies to product maintenance.
- The device shall not be exposed to aggressive chemicals or solvents that could damage the plastic casing and/or corrode the metal parts.
- Maintenance should only be performed by qualified and well trained personnel.

It is appropriate to carry out a careful risk assessment in relation to the context of installation and use of the device by the installer considering the possible meteorological station in its complexity without being limited to the sensor.
The instruments must be installed according to the rules of the trade, with equipment that complies with

applicable regulations and using supports correctly sized by qualified technicians and designed for the specific purpose.
During installation operations, check the suitability of the surrounding environment and compliance with local safety regulations.
The manufacturer declines all responsibility in case of failure due to negligence of the instructions, tampering, uses not described in this manual, improper use, use by operators not trained.
Read the instructions and intended use carefully and be sure you understand before installing the device
Before starting the activities, check the integrity of the instrument to be installed, prepare the equipment necessary for the work and wear the necessary PPE.
Take adequate measures to prevent the access of foreign personnel (untrained and uninformed) during the installation, maintenance or replacement of the instrument.
Take precautions to avoid falling objects, both during the installation phases and during the operation of the instrument.
Do not perform any activity in bad weather conditions.
During maintenance, particularly if the station is not frequented, visually check for the absence of dangerous insects and, if not, use suitable insecticides.
Consider the presence of any animals near the station, if so, pay attention to them.
Use only SIAP+MICROS original spare parts.
The instrument is not classified suitable (according to Directive 2014/34/EU) for use in atmospheres with potential explosion risk pursuant to Directive 99/92/EC.
SIAP+MICROS strives to minimize health and safety risks in all phases of the instrument's life, including installation, use, maintenance, decommissioning and disposal.

## Appropriate use of the equipment

Use the instrument for its intended purpose, do not use it for any other purpose or cause malfunctions and/or damage.

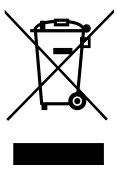
## Storage

If you do not plan to use the equipment for an extended period of time (at least one year) disconnect all cables from the equipment, place it in a clear plastic bag along with a bag of desiccant salts and seal the bag with tape. Put appropriate indication on the bag of the contents and weight of the equipment by inserting the wording "HANDLE WITH CARE".
Store the instrument in an environment with a temperature between 0°C and 60°C with a humidity not exceeding 80%. Make sure that the instrument is stored in a stable position and that it cannot be damaged or moved by inexperience or carelessness. Do not stack other tools or weights. Do not place the instrument on top of other instruments and in any case ensure the solidity and stability of the underlying support.
Non esporre, stoccare lo strumento in ambienti con presenza di vapori e/o gas corrosivi.

## Moving

In order to avoid any damage to the device during transportation, please keep it in upright position without shaking.

## 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.