

# ENGLISH

## User manual



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## 1. INTRODUCTION

The remote unit **SOLAR-02** has been designed to measure irradiation [ $W/m^2$ ] and temperature [ $^{\circ}C$ ] by means of appropriate probes connected to it. It can also be used in combination with a MASTER instrument to carry out the above-mentioned measurements for testing/recording the efficiency of single-phase and three-phase photovoltaic installations.

The unit SOLAR-02 can be connected to the following accessories and MASTER instruments:

Description	Acronym	HT model
Pyranometer	Irr-P	HT303, HT303N
Irradiation sensor with 2 silicon cells	Irr-S2	HT304, HT304
Temperature sensor	Tmp	PT300N
Master instrument - USB connection	M-USB	SOLAR300, SOLAR300N
Master instrument - RF connection	M-RF	SOLAR I-V, I-V 400, PVCHECK

Table 1: List of master instruments and accessories

**For the sake of brevity, in this manual, the master instruments and the accessories are indicated with the acronym given in column “Acronym” of the previous Table 1**

The unit SOLAR-02 has the following functions:

- Real-time display of irradiation and temperature values of PV module cells and environment
- Connection with a solarimeter type Irr-P or reference cell type Irr-S2
- Connection to master unit via USB connection (M-USB) or radio frequency connection (M-RF)
- Synchronization with master unit M-USB or M-RF when starting testing/recording.
- Measurement of the tilting angle of PV panels

### CAUTION



- The remote unit SOLAR-02 is a measuring instrument capable of using radio frequency for data transfer. For internal reasons it was been adopted a 2.4GHz harmonized frequency band. The above said radio based device is built under Class 1 according to the Agreement stipulated among EEC and EFTA countries, as defined by ERC/REC 70-03 protocols
- About a WiFi portable devices the European standards dictate maximum radiated transmit power of 100mW EIRP and frequency range 2.400 ÷ 2.4835GHz. In France these types of equipment must be restricted to the 2.4465 ÷ 2.4835GHz frequency range and must be restricted to indoor use

## 2. PRECAUTIONS AND SAFETY MEASURES

The instrument was designed in compliance with the requirements of R&TTE Directive as well as of harmonized directives for electronic measuring instruments. Before and during measurements, carefully observe the following instructions:

- Do not perform any measurement in humid environments, in the presence of gas or explosive or inflammable material or in dusty areas.
- Avoid any contact with the circuit to be tested if no measurements are being carried out.
- Avoid any contact with exposed metal parts, with unused measuring leads, circuits, etc.
- Do not perform any measurement when anomalies are found in the instrument, such as deformations, breaks, substance leaks, no display view, etc.
- Only use HT original accessories.



### CAUTION

In accordance with the recommendations of the European Council 1995/519/EC and the standard EN62311, the instrument can be used safely while you are holding it in your hands. Under this circumstance power levels with 2.4GHz transmission are thoroughly covered as per the basic restrictions for human exposure to RF according to the above mentioned European rules

In this manual, the following symbol is used:



Warning: observe the instructions reported in the manual. An improper use could damage the instrument or its components

## 2.1. PRELIMINARY INSTRUCTIONS

- This instrument has been designed for use in the environmental conditions specified in § 7.3
- We recommend following the usual safety rules to protect yourself from dangerous voltages and currents and to protect the instrument against improper use
- Do not apply any voltage to the instrument's inputs
- Only the accessories supplied with the instrument guarantee safety standards. They must be in good conditions and replaced, if necessary, with identical models
- Do not subject the input connectors of the instrument to strong mechanical stress
- Check that the batteries are correctly inserted



### CAUTION


The RF connection of remote unit SOLAR-02 is normally disabled for default. **For use of this unit with the Master meter "M-RF" (see Table 1) is necessary to activate the RF connection** (see § 5.6.1)

## 2.2. DURING USE

We recommend carefully reading the following recommendations and instructions:



### CAUTION

- Failure to observe the warnings and/or instructions may damage the instrument and/or its components or generate a danger for the operator.
- The symbol "" indicates that the batteries are flat. Stop testing and replace the batteries according to the procedure described in § 6.2
- When the instrument is connected to the circuit being tested, never touch any lead, even if unused.

## 2.3. AFTER USE


When measurements are completed, turn off the instrument by pressing and holding the ON/OFF key for some seconds. If the instrument is not to be used for a long time, remove the batteries and follow the instructions given in § 7.3

## 3. PREPARATION FOR USE

### 3.1. INITIAL INSPECTIONS

Before shipment, the instrument's electronics and mechanics have been inspected. All possible precautions have been taken in order for the instrument to be delivered without damage. However, we recommend generally inspecting the instrument in order to detect any damage suffered during transport. Should you detect any anomalies, immediately contact the forwarding agent. Moreover, we recommend checking that the package contains all parts listed in § 0. Should you find any discrepancy, please contact the dealer. Should it become necessary to return the instrument, please follow the instructions reported in § 8

### 3.2. POWER SUPPLY

The instrument is supplied by 4 x 1,5V batteries type IEC LR03 AAA. When batteries are almost flat, the symbol "" appears on the display. To replace the batteries, see § 6.2

### 3.3. CALIBRATION

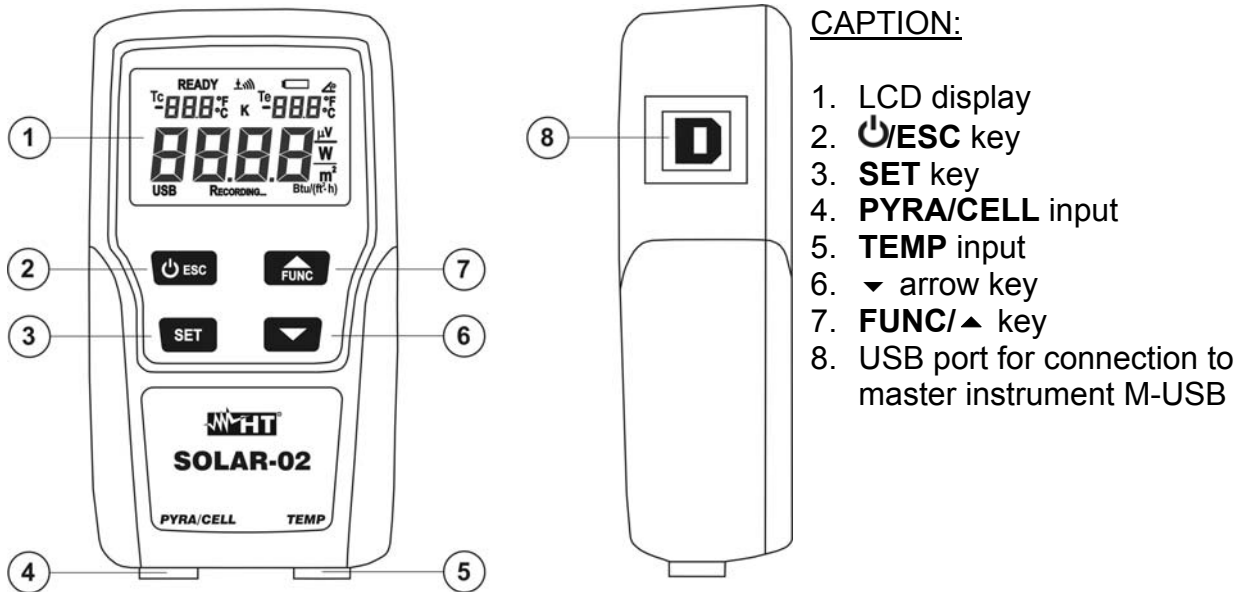
The instrument complies with the technical specifications reported in this manual. The instrument performance is guaranteed for 12 months.

### 3.4. STORAGE

In order to guarantee precise measurements, after a long storage period, in extreme environmental conditions, wait for the instrument to return to normal conditions (see § 7.3)

## 4. DESCRIPTION OF THE REMOTE UNIT SOLAR-02

### 4.1. DESCRIPTION OF CONTROLS



CAPTION:

1. LCD display
2. **⏻/ESC** key
3. **SET** key
4. **PYRA/CELL** input
5. **TEMP** input
6. **▼** arrow key
7. **FUNC/▲** key
8. USB port for connection to master instrument M-USB

Fig. 1: Description of the remote unit SOLAR-02

### 4.2. DESCRIPTION OF FUNCTION KEYS



This key has a double function of turning ON/OFF the unit and of returning to the previous screen (**ESC**)



The **SET** key allows a rapid selection of the sensitivity of the solarimeter/reference solar cell in use



This key has a double function of increasing (**▲**), which can be used when programming, and of passing from the display of the environmental temperature  $T_e$  to the display of the tilting angle (**FUNC**).

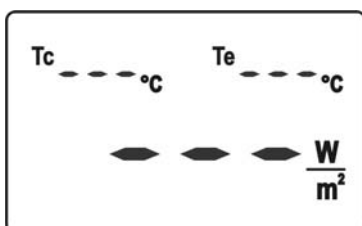


The **▼** key is used when programming the unit to set the parameter values,

### 4.3. CONDITIONS WHEN TURNING ON



1. Press the **⏻/ESC** key to turn on the instrument
2. After the initial screen, where all display symbols appear, the screen beside, relevant to the loaded firmware version (FW, e.g. 4.01), is displayed by the unit for a few seconds



3. The screen beside is displayed in order to show that no probe is connected. From this moment on it is possible to use the unit
4. Press and hold the **⏻/ESC** key for a few seconds to turn off the unit

## 5. USING THE REMOTE UNIT SOLAR-02

### 5.1. GENERAL

The remote unit SOLAR-02 can be used in the following modes:

1. Independent operation without connection to any master instrument for measuring in real time the values of irradiation, cell temperature and environmental temperature on PV installations. To this purpose, the unit accepts, as inputs:

For irradiation measurement (expressed in  $W/m^2$  - **PYRA/CELL** input):

- Solarimeter probe with thermobattery type **Irr-P** (see Table 1)
- Double reference silicon cell type **Irr-S2** (see Table 1)

For module and environmental temperature measurement (expressed in  $^{\circ}C$  – **TEMP** input)

- Temperature probe type **Tmp** (see Table 1)

2. Operation for testing/recording synchronized with a master instrument for measuring and saving irradiation and temperature values of cells and environment. The type of connection with the master instruments is the following:

- Connection via USB cable C2007 → Master instrument type **M-USB** (see Table 1)
- Connection with radio frequency (RF) → Master instrument type **M-RF** (see Table 1)

According with settings received by MASTER instrument, SOLAR-02 display a  $T_c$  value:

- Measured by the temperature probe “Tmp” (see Table 1)
- Calculated using NOCT (set in MASTER instrument), Irradiance and Environment Temperature measured by SOLAR-02 according to relationship

$$T_{cel} = T_{env} + (NOCT - 20) \times \frac{G_p}{800}$$

where:

- $T_{env}$ = Environment Temperature  
 $G_p$ = Irradiance measured  
 NOCT= Normal Operating Cell Temperature

### CAUTION



The presence of “**K**” symbol on the left of “ $T_c$ ” temperature value, indicates that the Cell temperature ( $T_c$ ) value displayed is not a measured value but is a calculated value according with previous relationship.

When the SOLAR-02 is switched on (before connection to MASTER instrument) the  $T_c$  value is the measured value.

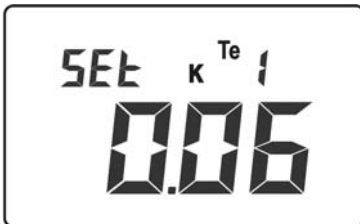
### 5.2. PROGRAMMING THE REMOTE UNIT SOLAR-02

In order to obtain correct irradiation measurement results, it is necessary to carry out a correct preliminary setting of the sensitivity values of the probes connected to the **PYRA/CELL** input of the unit. The set values will be read and considered by the master instruments upon testing/recording and will be kept by the SOLAR-02 even when the unit is turned off, until they are modified.

The unit SOLAR-02 allows setting the parameters of max 3 irradiation sensors. In detail:

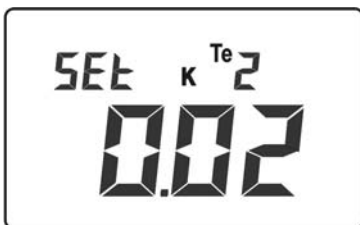
- The use of a sensor type **Irr-S2** → requires setting the sensitivity (K) expressed in  $mV/kW \cdot m^{-2}$  or in  $\mu V/W \cdot m^{-2}$  and the parameter Alpha expressed in  $\%/^{\circ}C$  for the various types of silicon (monocrystalline, polycrystalline, etc.)
- The use of a sensor type **Irr-P** → requires setting the sensitivity (K) expressed in  $mV/kW \cdot m^{-2}$  or in  $\mu V/W \cdot m^{-2}$ . The parameter Alpha expressed in  $\%/^{\circ}C$  is ignored.

### 5.2.1. Setting the values of sensor 1 (PYRA or MONO)



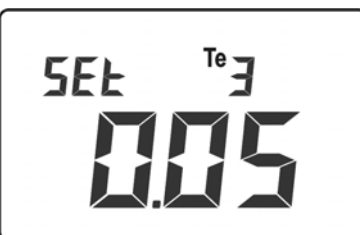
1. Press and hold the **SET** key while turning on the instrument by means of the **ON/ESC** key. The unit shows the screen beside.
2. Use the arrow keys **▲** and **▼** to set the correct K sensitivity value reported on the (front or rear) label, located on the sensor itself.
3. Press the **SET** key to confirm the value.
4. With sensor type Irr-P, press the **ESC** key to exit the programming mode, saving the changes made. In case a sensor type Irr-S2 is used, it is necessary to set the parameter "Alpha" instead.
5. Use the arrow keys **▲** and **▼** to set the value of **Te** (Alpha) corresponding to the value of sensitivity K previously set.
6. Press the **SET** key to confirm the value and go on setting sensor 2.

### 5.2.2. Setting the values of sensor 2 (MULTI)



1. Use the arrow keys **▲** and **▼** to set the correct K sensitivity value reported on the (front or rear) label, located on the sensor itself.
2. Press the **SET** key to confirm the value.
3. Use the arrow keys **▲** and **▼** to set the value of **Te** (Alpha) corresponding to the value of sensitivity K previously set.
4. Press the **SET** key to confirm the value.

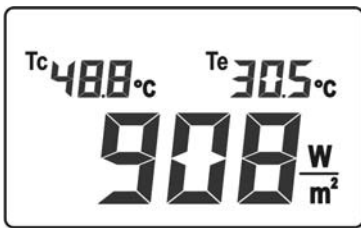
### 5.2.3. Setting the values of sensor 3



1. With sensor type Irr-S2, press the **ESC** key to exit the programming mode, saving the changes made.
2. Use the arrow keys **▲** and **▼** to set the correct K sensitivity value reported on the (front or rear) label, located on the sensor itself.
3. Press the **SET** key to confirm the value.
4. Use the arrow keys **▲** and **▼** to set the value of **Te** (Alpha) corresponding to the value of sensitivity K previously set.
5. Press the **SET** key to confirm the value and to exit the programming mode, saving the changes made.

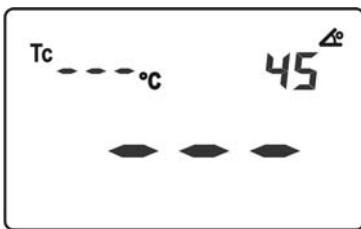
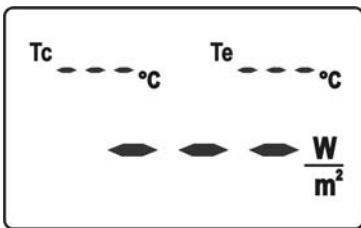


### 5.3. USING THE SOLAR-02 IN INDEPENDENT MODE



1. Turn on the instrument by pressing the **ON/ESC** key.
2. Press the **SET** key. The unit shows the screen beside in which the K value of the currently set sensor is selected.
3. Use the arrow keys **▲** and **▼** to select the desired type of sensor considering the unit programming (see § 0)
4. Confirm selection with the **SET** key to go back to the measuring mode
5. Position the irradiation measuring probe type "Irr-P" or "Irr-S2" (see Table 1) on the modules' surface and connect the relevant output lead to the **PYRA/CELL** input of the unit SOLAR-02
6. Fasten the temperature probe type Tmp with adhesive tape (see Table 1) on the rear side of the modules and connect the relevant output lead to the **TEMP** input of the unit SOLAR-02
7. Read on the display, in real time, as shown in the figure beside, the values of:
  - Irradiation on the main display, expressed in **W/m<sup>2</sup>**
  - Tc = temperature of cells expressed in **°C**
  - Te = temperature of environment expressed in **°C**

### 5.4. USING THE INCLINOMETER FUNCTION



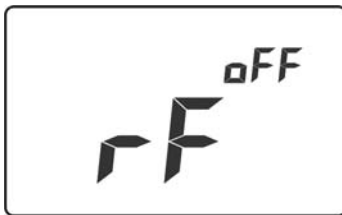
1. Turn on the unit by pressing the **ON/ESC** key. The display shows the following screen
2. Press the **FUNC/▲** key to activate the inclinometer mode of the unit SOLAR-02 instead of the measurement of temperature Te as shown on the screen beside
3. Fasten the unit on the module's surface, if necessary by means of the two magnets available on the rear side
4. Wait for a few seconds
5. Read, in real time, the value (expressed in °) of the tilting angle against the horizontal plane of the object to be tested

## 5.5. USING THE SOLAR-02 WITH MASTER INSTRUMENT TYPE “M-USB”

For the definitions of the instrument types, see Table 1. For the use, functions and activation of a testing/recording on the master instrument, please see the user manual of the master instrument itself.

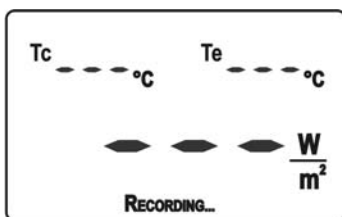
### 5.5.1. Preliminary check

For the “M-USB” master instruments the enable of internal RF module is NOT necessary. Check that the parameter which enable/disable the RF module should be corrected set at the first usage of the unit in the herewith way:



By press and hold the **FUNC/▲** key while switching on the meter by **ON/ESC** key. The message “rF<sup>OFF</sup>” is displayed for a few seconds. If the message “rF<sup>ON</sup>” is displayed switch off the unit and repeat the operation. Afterwards the initial screen is displayed by the meter. The setting of “RF” parameter is maintained also during the replace of batteries

### 5.5.2. Use of the unit



1. Switch on the unit and press the **SET** key. The unit shows the screen beside in which sensor 1 is selected
2. Use the arrow keys ▲ and ▼ to select the desired type of sensor considering the unit programming (see § 5.2)
3. Confirm selection with the **SET** key to go back to the measuring mode
4. Connect the unit SOLAR-02 to the master instrument by means of the USB cable. The symbol “USB” is shown on the display while the unit is detected by the master instrument
5. By activating a testing/recording on the master instrument, the unit SOLAR-02 waits for the synchronization, showing the message “**HoLd**” on the display and the indication of the waiting time necessary before being able to activate the testing procedures (see example in the screen beside)
6. Once the waiting phase (HOLD) has ended, the message “**Recording...**” will be displayed. It is now possible to disconnect the USB cable from the unit SOLAR-02 and take the unit near the PV modules. Possible hyphens “- - -” indicate that no irradiation and temperature probes are connected to the unit SOLAR-02 yet

7. Place the Irradiance probe (Irr-P or Irr-S2 – see Table 1) parallel to PV modules surface and connect the output connector to SOLAR-02 PYRA/CELL input
8. Using a tape fix the temperature probe (Tmp – see Table 1) on the backside of the module and connect the output connector to SOLAR-02 TEMP input



9. Upon reaching an irradiation value higher than the threshold set by the MASTER instrument, the unit SOLAR-02 shows the message "**READY**" on the display
10. Disconnect the irradiation and temperature probes, connect the unit to the master instrument again by means of the USB cable
11. Upon detecting the control to stop testing/recording from the master instrument, the unit stops working, shows on the display the message "**SEnd**" and sends the data to the master instrument to determine the final result of the testing

## 5.6. USING THE SOLAR-02 WITH MASTER INSTRUMENT TYPE “M-RF”

For the definitions of the instrument types, see Table 1. For the use, functions and activation of a testing/recording on the master instrument, please see the user manual of the master instrument itself.

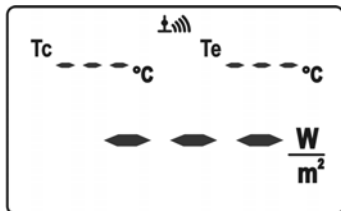
### 5.6.1. Preliminary check

For the “M-RF” master instruments the enable of internal RF module IS NECESSARY. Check that the parameter which enable/disable the RF module should be corrected set at the first usage of the unit in the herewith way:



By press and hold the **FUNC/▲** key while switching on the meter by **POWER/ESC** key. The message “rF<sup>ON</sup>” is displayed for a few seconds. If the message “rF<sup>OFF</sup>” is displayed switch off the unit and repeat the operation. Afterwards the initial screen is displayed by the meter. The setting of “RF” parameter is maintained also during the replace of batteries

### 5.6.2. Use of the unit

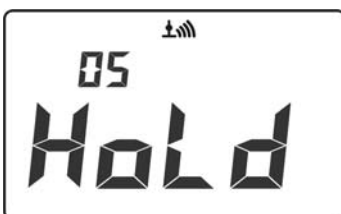


1. Switch on and approach the unit SOLAR-02 to the master instrument (max distance 1m). The symbol “”:

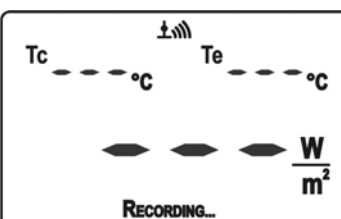
- Is blinking approx 30s at display while searching a M-RF master unit
- Is fixed at display when a M-RF master unit is found
- Disappears from display if no M-RF master unit is found within approx 30s. Press the **▼** key for re-start a new search of a “M-RF” master unit



2. Press the **SET** key. The unit shows the screen beside in which sensor 1 is selected.
3. Use the arrow keys **▲** and **▼** to select the desired type of sensor considering the unit programming (see § 5.2)
4. Confirm selection with the **SET** key to go back to the measuring mode

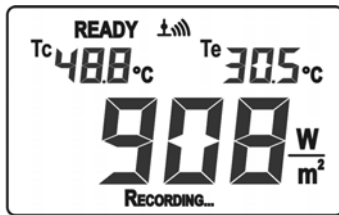


5. With operative RF connection, by activating a testing/recording on the master instrument, the unit SOLAR-02 waits for the synchronization, showing the message “**Hold**” on the display and the indication of the time during which it is necessary to keep the unit SOLAR-02 near the master instrument before being able to activate the testing procedures



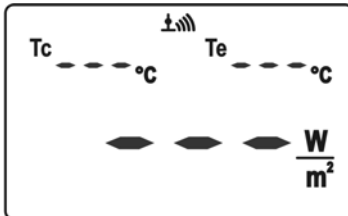
6. Once the waiting phase (HOLD) has ended, the message “**Recording...**” will be displayed. It is now possible to take the unit SOLAR-02 away from the master instrument and take it near the PV modules. Possible hyphens “- - -” indicate that no irradiance and temperature probes are connected to the unit SOLAR-02 yet

7. Place the Irradiance probe (Irr-P or Irr-S2 – see Table 1) parallel to PV modules surface and connect the output connector to SOLAR-02 **PYRA/CELL** input
8. Using a tape fix the temperature probe (Tmp – see Table 1) on the backside of the module and connect the output connector to SOLAR-02 **TEMP** input




9. Upon reaching an irradiation value higher than the threshold set by the MASTER instrument, the unit SOLAR-02 shows the message **“READY”** on the display

10. Disconnect the irradiation and temperature probes and take the unit again near the master instrument in order to activate the RF connection



11. Approach the unit SOLAR-02 to the master instrument (max distance 1m):

➤ If the “” symbol is blinking at display wait for the reciprocal detection of both units and after this the symbol is fix at display

➤ If the “” is missed at display press the  key for re-start a new search of a “M-RF” master unit




10. Upon detecting the control to stop testing/recording from the master instrument, the unit stops working, shows on the display the message **“SEnd”** and sends the data to the master instrument to determine the final result of the testing

## 6. MAINTENANCE

### 6.1. GENERAL INFORMATION

1. To prevent possible damage or dangers during the accessory's use or storage, carefully observe the recommendations listed in this manual.
2. Do not use the accessory in environments with high humidity levels or at high temperatures. Do not directly expose to sunlight.
3. If the accessory is to be left unused for a long time, remove the batteries to prevent any leaks of liquids which could damage the internal circuits.

### 6.2. REPLACING THE BATTERIES

The presence of the symbol "" on the display indicates that the internal batteries are flat and must be replaced. To this purpose, proceed as follows:

1. Turn off the remote unit SOLAR-02
2. Remove any probe from the inputs and the USB cable, if present
3. Open the cover of the battery compartment on the rear side of the accessory
4. Remove the flat batteries and replace them with the same number of batteries of the same type (see § 7.2), observing the indicated polarities.
5. Restore the cover of the battery compartment into place.
6. Do not scatter flat batteries in the environment. Use the appropriate containers for disposal.

**The instrument is capable of keeping the data stored also without batteries.**

### 6.3. CLEANING

To clean the accessory, use a soft dry cloth. Never use humid cloths, solvents, water, etc.

### 6.4. END OF LIFE



**CAUTION:** the symbol reported on the accessory and on the batteries indicates that the appliance and the batteries must be disposed of separately and treated correctly.

## 7. TECHNICAL SPECIFICATIONS

### 7.1. TECHNICAL SPECIFICATIONS

Uncertainty is due to reference conditions: 23°C, <80%RH

#### Irradiation – PYRA/CELL input

Range [W/m <sup>2</sup> ]	Resolution [W/m <sup>2</sup> ]	Uncertainty
0 ÷ 1400	1 + INT (100 * 0.1/K)	±[1.0%reading + INT(1000 * 0.1/K) dgt]

K = sensitivity of the probe used to measure irradiation (expressed in mV/kW/m<sup>2</sup> or in uV/W/m<sup>2</sup>)

Probe sensitivity	Range [mV]	Resolution [mV]	Uncertainty
K<10	0.00 ÷ 15.00	0.01	±(1.0%reading+0.1mV)
K≥10	0.00 ÷ 65.00	0.02	

K = sensitivity of the probe used to measure irradiation (expressed in mV/kW/m<sup>2</sup> or in uV/W/m<sup>2</sup>) ; Input Vmax = 5V

#### Temperature – TEMP input (measured with “Tmp” temperature probe – see Table 1)

Range [°C]	Resolution [°C]	Uncertainty
-20.0 ÷ 99.9	0.1	±(1.0%reading + 1°C)

Input Vmax = 5V

#### Tilting angle

Range [°]	Resolution [°C]	Uncertainty
0 ÷ 90	1	±(1.0%reading + 1°)

### 7.2. GENERAL CHARACTERISTICS

#### Display

Characteristics: 4 LCD (2000 dots), decimal comma and point

#### Power supply

Batteries: 4x1,5V alkaline type AAA LR03

Duration of batteries: approx. 480 hours

Auto Power OFF: after 5 minutes of idleness (not in rec. oper.)

#### Radio module specifications

Frequency range: 2.400 ÷ 2.4835GHz

R&TTE category: Class 1

Max transmission power: 30μW

#### Input connectors

USB port: USB 2.0

PYRA/CELL and TEMP inputs: type Hypertac

#### Internal memory

Autonomy: approx. 1.5 hours (@ PI master = 5s)

#### Mechanical characteristics

Dimensions: 120(L) x 65(W) x 35(H) mm ; 5(L)x3(W)x1(H) “

Weight (batteries included): 215g (8ounces)

### 7.3. ENVIRONMENTAL CONDITIONS

Reference temperature: 23°C ± 5°C ; (73°F ± 41°F)

Operating temperature: 0° ÷ 40°C ; (32°F ÷ 104°F)

Relative operating humidity: < 80%RH

Storage temperature: -10 ÷ 60°C ; (14°F ÷ 140°F)

Storage humidity: < 80%RH

- This instrument complies with LVD 2006/95/EC and EMC 2004/108/EC Directives
- HT declares (see Declaration of Conformity) that the instrument is complying with prerequisites and other requirements of 1999/5/CE Directive

### 7.4. ACCESSORIES

- ISO9000 calibration certificate
- User manual

## 8. SERVICE

### 8.1. WARRANTY CONDITIONS

This instrument is warranted against any material or manufacturing defect, in compliance with the general sales conditions. During the warranty period, defective parts may be replaced. However, the manufacturer reserves the right to repair or replace the product.

Should the instrument be returned to the After-sales Service or to a Dealer, transport will be at the Customer's charge. However, shipment will be agreed in advance.

A report will always be enclosed to a shipment, stating the reasons for the product's return. Only use original packaging for shipment; any damage due to the use of non-original packaging material will be charged to the Customer.

The manufacturer declines any responsibility for injury to people or damage to property.

The warranty shall not apply in the following cases:

- Repair and/or replacement of accessories and batteries (not covered by warranty).
- Repairs that may become necessary as a consequence of an incorrect use of the instrument or due to its use together with non-compatible appliances.
- Repairs that may become necessary as a consequence of improper packaging.
- Repairs which may become necessary as a consequence of interventions performed by unauthorized personnel.
- Modifications to the instrument performed without the manufacturer's explicit authorization.
- Use not provided for in the instrument's specifications or in the instruction manual.

The content of this manual cannot be reproduced in any form without the manufacturer's authorization.

**Our products are patented and our trademarks are registered. The manufacturer reserves the right to make changes in the specifications and prices if this is due to improvements in technology.**

### 8.2. SERVICE

If the instrument does not operate properly, before contacting the After-sales Service, please check the status of the batteries and replace them, if necessary.

Should the instrument still operate improperly, check that the product is operated according to the instructions given in this manual.

Should the instrument be returned to the After-sales Service or to a Dealer, transport will be at the Customer's charge. However, shipment will be agreed in advance.

A report will always be enclosed to a shipment, stating the reasons for the product's return. Only use original packaging for shipment; any damage due to the use of non-original packaging material will be charged to the Customer.