	3 – 57600 bps 4 – 115200 bps		
0x8007	**Serial configuration**, coded, range 0 ÷ 3, decimal, **default 0** 0 – 8N1 (8 bit / no parity / 1 stop bit) 1 – 8E1 (8 bit / even parity / 1 stop bit) 2 – 8O1 (8 bit / odd parity / 1 stop bit) 3 – 8N2 (8 bit / no parity / 2 stop bit)	R/W	Y
0x8008	**Serial reply delay** [ms], range 0 ÷ 100, decimal, **default 1**	R/W	Y
0x8009	**Analog output mode**, coded, range 0 ÷ 4, decimal, **default 2** 0 – output disabled 1 – 0 ÷ 10 V 2 – 0 ÷ 5 V 3 – 0 ÷ 20 mA current loop 4 – 4 ÷ 20 mA current loop	R/W	Y
0x800A	**Analog output select**, coded, range 0 ÷ 3, decimal, **default 2** 0 – irradiation 1 – PT100 temperature 2 – selected by digital input status: open = irradiation; close = PT100 temp. 3 – value setted by register 0x8201	R/W	Y
0x800B	**PT100 RTD reading enable**, coded, range 0 ÷ 1, decimal, **default 1** 0 – disabled 1 – enabled	R/W	Y
0x8101	**Not volatile params save command**, write 1 to execute (then wait 1 s before to send next message)	W	
0x8102	**Software reset command**, write 1 to execute (then wait 6 s before to send next message)	W	
0x8201	**Analog output level** [], range 0 ÷ 65535, decimal, fixed point 0.16 format (16 bits fractional)	W	

Tab. 3

Please note that, conventionally, Modbus register's numbering starts from 1 but register's addressing start from 0 so, to obtain the register's address you had simply to subtract 1 form its number. That's meaninful depending on, as a master, you are using an high level Modbus utility/program (that normally refer to the registers' number) or a low level driver (that normally directly work with addresses).

CALIBRATION

Each SM is factory calibrated, with 2 point reference by a primary sensor referred to a first class radiometer.
Re-calibration is recommended every 2 years in order to maintain the original precision.

The analog output is normalized to a full scale range of 0 ÷ 1250 W/m² for irradiation and -30 ÷ +90 °C for temperature. Values outside these ranges are saturated (to min or max output's value).
Analog output reading ratios Tab. 4:

Analog output mode	Irradiance ratio	Temperature ratio
0 ÷ 10 V	125 [W/m²/V]	12 [°C /V] with –30 °C @ 0 V
0 ÷ 5 V	250 [W/m²/V]	24 [°C /V] with –30 °C @ 0 V
0 ÷ 20 mA	62.5 [W/m²/mA]	6 [°C /mA] with –30 °C @ 0 mA
4 ÷ 20 mA	78.125 [W/m² /mA] with 0 W/m² @ 4 mA	7.5 [°C /mA] with –30 °C @ 4 mA

Tab. 4

OPTIONALS

Available upon request:

- Analog output adapter kit for dataloggers with 0-40 mV or 0-100 mV input range
- EzTemp: PT100 RTD element for PV moduls temperature sensing, 2 wire, with fast mounting bracket for PV mounting profiles and auto-fitting system
- SMscan: handheld LCD display unit and SM power supply for direct real-time reading of irradiance and temperature, available in cabled and wireless versions

CONTACTS

Software utilities (for MS Windows systems) and other solar products can be requested to the following address:

Soluzione Solare
Tel. +39.0444.530234 - Fax +39.0444.1830563 Vicenza – Italy E-mail: support@soluzionesolare.it

SUNMETER®

USER MANUAL

fw ver. 80.00-03.00 / hw rev. RGA801A

GENERAL DESCRIPTION

The SunMeter® (SM) is an high tecnology electronic device primary designed to accurately measure the solar radiation and make it available to the user in the best suitable way for its applications.

It's mainly intended, but not limited, to be used in solar energy conversion applications (both thermal and photovoltaic) for preliminary studies, for commissioning testing and for continuous performance checking and monitoring.

It's based on a sensing silicon element that through our proprietary TZOS® (True Zero Ohm Shunt) technology is sampled and managed by an high performance DSP (Digital Signal Processor) in order to enhance the signal precision and stability, achieving results that are comparable to best class radiometers.

It's equipped with an additional input for an external 2-wire PT100 RTD element in order to sensing the temperature of nearby items, i.e. photovoltaic moduls, ambient, etc.

The measures can be read by two outputs: an "universal" multistandard analog output for all old-fashion viewing devices and dataloggers and a powerful versatile EIA/TIA-RS485 bus interface with the well known industry standard protocol Modbus RTU.

FEATURES

Inputs:
- irradiation range: 0 ÷ 1250 W/m² temperature compensated
- temperature range: -30 ÷ +90 °C measurable with external PT100 RTD
- digital: PNP-like connection

Outputs:
- analog: configurable as voltage (0 ÷ 10 V / 0 ÷ 5 V) or current (0 ÷ 20 mA / 4 ÷ 20 mA)
- serial: RS485, standard Modbus RTU protocol

Measurements precision:
- irradiation: < ± 3%
- temperature: < ± 0.5 °C

Supply: 8 ÷ 32 Vdc, protected against reverse polarity

Encapsulation: resin, UV resistant, wide spectral transparency

Case: stainless steel with screw-clamp to fix it on modules or montage profile

Wiring: 50 cm cable, UV resistant

Connectors: male 10 pin circular, IP67 degree, UV resistant, matching female supplied

Dimensions: 66 x 82 x 12 mm, with mounting bracket 68 x 120 x 75 mm (overall)

Operating temperature: -20°C ÷ +80 °C (transport and storage -35°C ÷ +95 ° C)

Every SM is factory calibrated.

PIECE'S LIST

- SM with stainless steel bracket
- female 10 pin circular connector
- 2 batterfly screws (temporary positioning)
- 2 stainless steel screws (permanent positioning)
- instruction manual

FINAL TEST AND CALIBRATION REPORT:

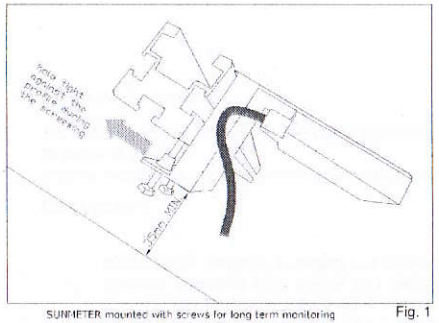
S/N .....

OPER.....

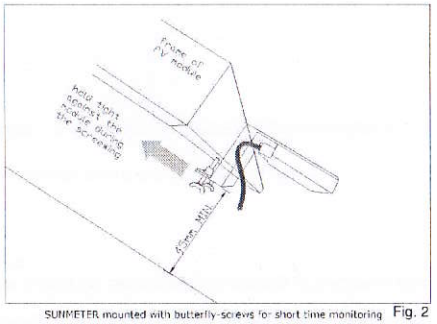
DATE.....

Some "inclusions" may be present and clearly visible into the protective encapsulation resin; could be present bubbles in the area of wires soldered to PCB too. This is due to the resin coating process and do not affect overall performance and/or accuracy.

Important : Do not use alcool to clean exposed surface of Sunmeter but use cleanser and water.



SUNMETER mounted with screws for long term monitoring Fig. 1



SUNMETER mounted with butterfly-screws for short time monitoring Fig. 2

We suggest to mount SM on the bottom side of a PV module because, if applied on the top side, it may be chosen by a bird as springboard! Same considerations are for the applying when fastening to a structure's profile.
Stainless screws are provided for permanent mounting of SM on your PV plant.

CONNECTIONS

The IP67 10-pin circular male connector carries all the signals to and from the SM as in Tab. 1 and Fig. 3, that shows a front view of the male connector (or a back side view of the female connector supplied):

#	Name	Description
1	SUPPLY GND	power supply ground reference
2	SUPPLY +VIN	power supply input, 8-32 Vdc, typ. 90mA @ 12 Vdc (**note 1**)
3	-	not connected
4	RS485+/B	communication bus non inverting signal (**note 2**)
5	RS485-/A	communication bus inverting bus signal (**note 2**)
6	Analog Output	configurable as 0-5 Vdc, 0-10 Vdc, 0-20 mA, 4-20 mA (**note 3**)
7	Signal GND	ground reference for output signals
8	PT100.1	2-wire RTD connection 1
9	PT100.2	2-wire RTD connection 2
10	Digital Input	PNP-like digital input (to be shorted to GND Signal to activate) (**note 4**)

Tab. 1

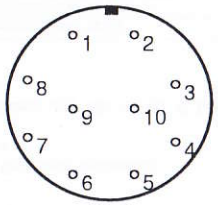


Fig. 3

SM typical connections/usage Fig. 4:

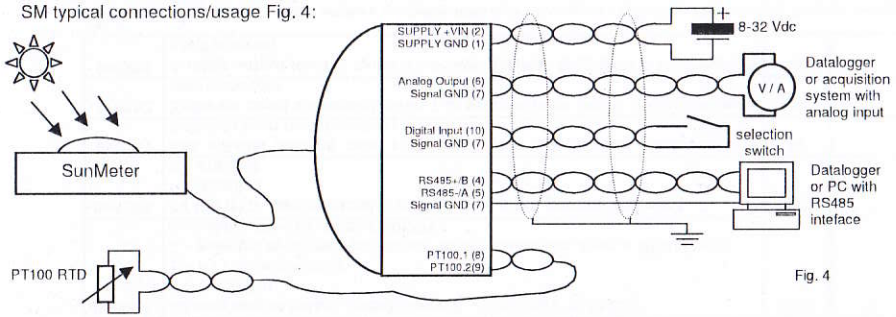


Fig. 4

We strongly suggest to use a shielded connection cable with twisted pairs, AWG22 / 0.32mm^2

Notes:
1) if analog output is used, please pay attention to choose a power supply greater than the compliance voltage, see also note 3.
2) balanced differential bus RS485 needs to be terminated, at the extremities of the bus, by a 100-120 Ohm resistor (1/4 W) between RS485+/RS485- lines in order to avoid signal's reflections. In the case that SM is the device at one extremity, place the resistor into the supplied female connector.
   Even if RS485 have –7/+12Vdc common mode rejection range, normally sufficient to compensate ground potential difference between connected devices, it is strongly recommended to always carrying a ground reference among the bus's signals and to connect it to the SM's Signal GND.
3) please check load restrictions:
   - in voltage modes (0÷5 / 0÷10 V) minimum load impedence is 250 / 500 Ohm, we recommend a load impedence > 5 kOhm
   - in current modes (0÷20 / 4÷20 mA) maximum load impedence is 1.2 kOhm, we recommend a load impedence in the 200-500 Ohm range
   - the compliance voltage (maximum output voltage) at full 20 mA output current and beyond, is about 2.5V less than power supply voltage so choose it accordingly in order to leave sufficient margin.
4) the digital input need to be activated by shorting to GROUND (either supply or signal, latter preferably). Do not attempt to supply voltage to this input.

MODBUS PROTOCOL

Modbus is a Master-Slave protocol, widely used as an industry standard. Simple, efficient and reliable, can be easily used to access and collect data or exchange information between digital systems over a serial line local bus (and with its TCP/IP extension through a LAN or World Wide Web).
Please refer to specific detailed documentation and implementations freely available at www.modbus.org

SM is a Modbus RTU slave that implements the following standard access functions:

Function code	Description
0x03	READ HOLDING REGISTERS
0x04	READ INPUT REGISTERS
0x06	WRITE SINGLE REGISTER
0x10	WRITE MULTIPLE REGISTERS

Tab. 2

Please note that in the current implementation of SM function codes 0x03 and 0x04 are equivalent and address the same data area.

Data is accessible through Modbus's functions by 16 bits units called "registers". In the current implementation of SM are available these registers:

Register #	Description	Access	NV save
0x0101	**Current irradiation level** [W/m^2], range 0 ÷ 1250, decimal	R	
0x0102	**Current PT100 temperature** [°C], range –30 ÷ +90, 2-complent value, fixed point 14.2 format (14 bits integer, 2 bits fractional)	R	
0x0103	**Status**, bit coded Bit 0: Factory calibration/configuration; 1 = OK; 0 = need recalibration Bit 1: Not volatile parameters; 1 = OK; 0 = default loaded, need to be changed/saved Bit 2: Digital input monitor; 1 = not active (open); 0 = active (shorted to GND) Bit 3: PT100 RTD element; 1 = OK; 0 = shorted or open circuit (not present/malfunctioning) Bit 4: Analog output; 1 = OK; 0 = output current can't flow at desired level due to wire break/high load impedence/output voltage approaching positive supply Bit 5: Watchdog; 1 = reset by watchdog timeout occurred; 0 = normal operation all undefined bits read as 0	R	
0x8001	**Serial number**, least significant word	R	
0x8002	**Serial number**, most significant word	R	
0x8003	**Firmware main version**, hexadecimal	R	
0x8004	**Firmware minor version**, hexadecimal	R	
0x8005	**Node address**, range 1 ÷ 247, decimal, **default 1**	R/W	Y
0x8006	**Bitrate**, coded, range 0 ÷ 4, decimal, **default 1** 0 – 9600 bps 1 – 19200 bps 2 – 38400 bps 3 – 57600 bps 4 – 115200 bps	R/W	Y