SUNMETER® PRO COUNTER

USER MANUAL

fw ver. 80.00-04.00 / hw rev. RGA801F

GENERAL DESCRIPTION

The **SunMeter® PRO counter** (SM PRO Counter) is a high technology 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.

In addition to the normal functions of irradiance sensor, it has **functions of totalizer of the irradiation measured through different meters**. These meters allow an easier, complete and accurate measurement of the performances of a PV system. Also, a special meter indicates whether the sensor has been turned on again: in this way you can know whether in the time span the meter measurement indicates a reliable measure or not.

The meters of SunMeter counter are:

A – IRRADIATION COUNTER A[kWh/m2] = Σirr

B - COUNTER CONDITIONED BY A THRESHOLD B[kWh/m2] = ΣIrr with Irr > threshold

C - COUNTER CONDITIONED BY A CONTACT C[kWh/m2] = ΣIrr if contact=on

S - RESTART COUNTER the counter increases each time it is turned on again

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

FEATURES

Inputs:

irradiance range:	0 ÷ 1500 W/m^2 temperature compensated
temperature range:	-30 ÷ +90 °C measurable with external PT100 RTD
digital:	PNP-like connection

Outputs:

serial:	RS485, standard Modbus RTU protocol

Measurements precision:

irradiance:	< ± 2%
temperature:	< ± 0.5 °C

Supply: 9 ÷ 30 Vdc, protected against reverse polarity

Encapsulation: small microprismatic glass for photovoltaic modules and E.V.A

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

Wiring: 50 cm cable, UV resistant

Connectors: male M12 8 pincircular, IP67 code, UV resistant, matching female supplied

female M8 3 pin circular IP67

Dimensions: 114 x 70 x 22 mm, with mounting bracket 128 x 70 x 65 mm (overall)

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

Every SM is factory calibrated.

PART LIST

- SM PRO with aluminium bracket
- female M12 8 pin circular connector
- 1 long stainless steel screw (temporary positioning)
- 2 short stainless steel screws (permanent positioning)
- instruction manual

FINAL TEST AND CALIBRATION REPORT:

S/N .....

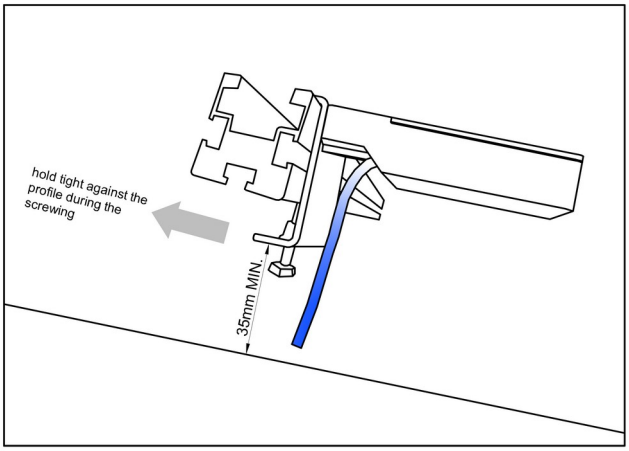
OPER.....

DATE.....

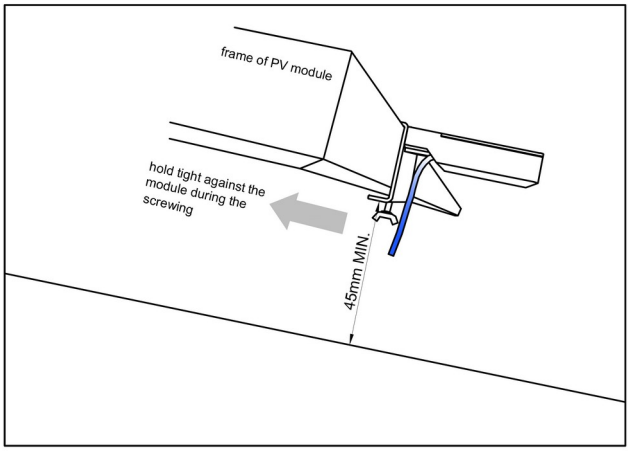
Important : the case presents a hole with a diameter of a few mm, this hole is terminated by a transpiring membrane whose purpose is the barometric compensation to avoid condensation.
DON'T PERFORATE. WARRANTY VOID IF REMOVED OR PERFORATED.

ASSEMBLY

SM PRO is provided with a bracket to apply it to structures or directly to a PV module as show in Fig. 1 and 2:



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

CONNECTIONS

The IP67 8-pin circular male connector carries all the signals to and from the SM PRO as in Tab. 1 and Fig. 3, which shows a back view of the female connector (the fourth column indicates the colours of cables in the free pin version):

#	Name	Description	Cable colors
1	SUPPLY +VIN	power supply input, 9-30 Vdc, typ. 90mA @ 12 Vdc (**note 1**)	Red
2	GND	power supply ground reference and for output signals	Black
3	PT100.1	2-wire RTD connection 1	
4	Analog Output	configurable as 0-5 Vdc, 0-10 Vdc, 0-20 mA, 4-20 mA (**note 3**)	
5	RS485-/A	communication bus inverting bus signal (**note 2**)	White/Green
6	RS485+/B	communication bus non inverting signal (**note 2**)	Green
7	Digital Input	PNP-like digital input (to be shorted to GND Signal to activate) (**note 4**)	
8	PT100.2	2-wire RTD connection 2	

Tab. 1

Female connector back view with connection scheme

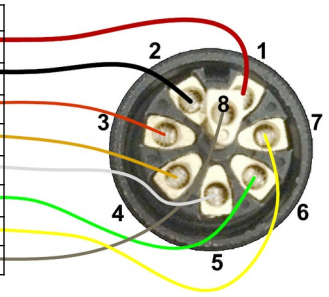


Fig.3

SM PRO typical connections/usage Fig. 4:

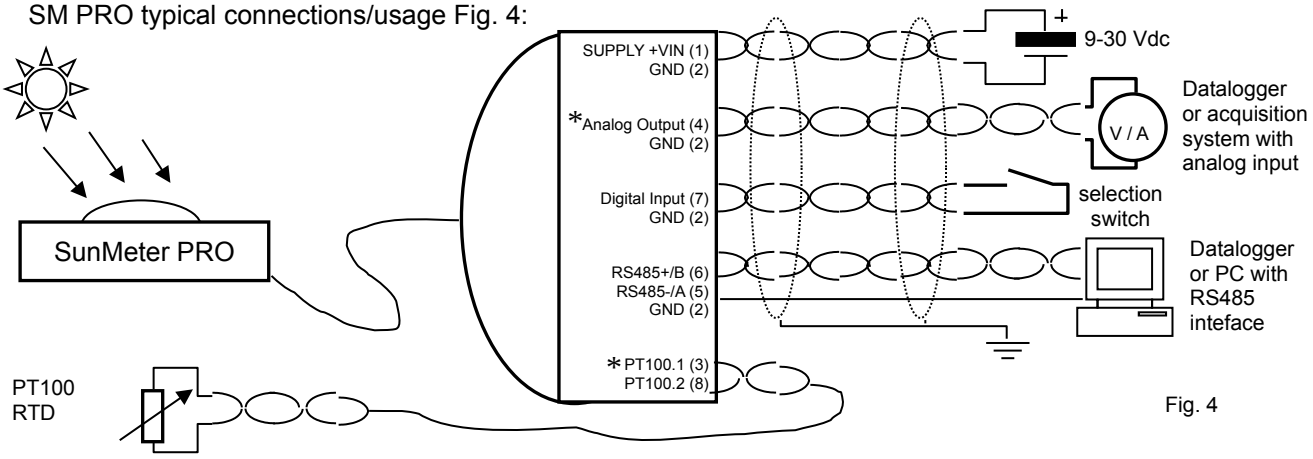


Fig. 4

* Only for the complete model (Digital and Analog Output)

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 Ω 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 PRO's Signal GND.

3) 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 that is widely used as an industry standard. It is simple, efficient and reliable,. It 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 PRO 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 PRO 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 PRO these registers are available:

Register #	Description	Access	NV save
0x0101	**Current irradiance level** [W/m^2],	R	
0x0102	**Current PT100 temperature** [°C], 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 impedance/output voltage approaching positive supply Bit 5: Watchdog — 1 = reset by watchdog timeout occurred; 0 = normal operation Bit 6: 1 = "statistics" correctly loaded in EEPROM; 0 = data corrupted Bit 7: 1 = "statistics" has to be saved 0 = "statistics" saved. If SM come in OFF, counter data not saved are lost all undefined bits read as 0	R	
0x0104	**Counter number.switching** range 0 ÷ 65535, roll-over in overflow cases	R	

0x0105 .. 0x0106	Least significant and more significant bytes of **Total energy Counter**, in Wh/ m2.	R	
0x0107 .. 0x0108	Least significant and more significant bytes of **threshold energy Counter**, in Wh/m2.	R	
0x0109 .. 0x010A	Least significant and more significant bytes of **external enabling energy Counter**, in Wh/m2.	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
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
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	
0x8301	**Comandi statistics Registers;** Accepted values are : **0x1111** for to erase ALL counters (Counter of power-on, N# of power on, all Energy Counters). **0x2222** for to erase ALL energy counter . **0x3333** for to erase the Threshold Energy Counter and 'external enabling counter' **0x4444** for to erase the 'external enabling counter' **0xABCD** for to force the saving of statistics.	W	
0x800C	**Threshold for energy counter**, in W/m2, default 50, range 0-2000. Value can be modified during its job.	R/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 from its number. That's meaningful depending on, as a master, you are using a high level Modbus utility/program (that normally refers to the registers' number) or a low level driver (that normally directly works with addresses).

Sunmeter Parameter

Sunmeter Counter Parameter

Note:
In the status register (0x0103) there are 2 new bits:
Bit 6 (starting from 0) indicates whether the "statistics" have been correctly loaded from the non-volatile memory (1) or if the data is irreparably corrupted (0)

Bit 7 (always starting from 0) instead indicates whether the statistics must be saved (1) or not (0). In case of statistics to be saved, if the SM is turned off / reset the unsaved data is lost. If necessary, the SM automatically saves the statistics every 10 minutes so in case of high irradiation they could lose up to about 200Wh / m2

The Statistics Command Register (0x8301) could be used by the control, as well as to reset the counters, to save the statistics before a forced / scheduled system shutdown.
For example, in a battery-powered monitoring system (or where you want to maximize energy savings by turning off unnecessary components during the night), ithe control could command the disconnection of the power supply after sunset, waiting for that the status register signals the last statistics have been saved; alternatively, a quick way is to force **save** command (it become permanent within 2 seconds. Visible on Status Register).
Obviously we must not abuse the command because the n. of writes on the non-volatile memory is limited to 500,000 writes and once this number is approached, the data becomes irrecoverable and the totalizer functionality is no longer usable.This means that the counter will be able to operate for about 16 years, counting that during the night there is no writing on the volatile memory.

So if you want to program 'forced writes' every 5 minutes in the data acquisition system, the useful life of the meter would be reduced to 8 years. If 'forced writes' were programmed to write every minute, the useful life would be reduced to just a year and a half !

CALIBRATION

Each SM PRO is factory calibrated, with 2 points 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.

OPTIONALS

Available upon request:

- Configuration and supply cable USB - RS485

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