User Manual:

Solar Spectral Irradiance Meter

SolarSIM-GPV

User information

Spectrafy Inc. strongly recommends reading this instruction manual prior to installation and operation of your global Solar Spectral Irradiance Meter (SolarSIM-GPV).

If you have any comments about this manual or our products, please send them to:

Spectrafy Inc. Inc.
4 Florence St, Suite 204
Ottawa, Ontario, Canada
K2P 0W7
Tel: 1-613-237-2020
`info@spectrafy.com`
`www.spectrafy.com`

Spectrafy Inc. reserves the right to make modifications to the user manual without prior notice.

Warranty and liability

Spectrafy Inc. guarantees that the Solar Spectral Irradiance Meter (SolarSIM-GPV) has been thoroughly tested to ensure that it meets all of the stated specifications. A two year warranty is provided from date of invoice, subject to correct installation and operation. Spectrafy Inc. accepts no liability for any loss or damages arising from improper usage of this product.

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Introduction

Dear customer, thank you for purchasing the Solar Spectral Irradiance Meter (SolarSIM-GPV) from Spectrafy. Please become familiar with this instruction manual for a full understanding of the use of your SolarSIM-GPV.

The SolarSIM-GPV is designed to be a cost-effective tool for accurately determining spectrally corrected global horizontal/tilted irradiance (GHI/GTI) for use in solar resource measurement campaigns and PV plant performance monitoring. The instrument uses silicon photodiodes, integrated with hard-coated bandpass filters to measure the solar spectral irradiance in nine narrow wavelength bands. The SolarSIM-GPV's proprietary software uses these measurements to resolve the global horizontal/tilted solar spectral irradiance and subsequently, the global horizontal/tilted irradiance and PV spectral correction factors for up to nine difference PV panels. This SolarSIM-GPV's data can be used within any standard PV modelling software to quantify and account for the effects of solar spectral variation on PV performance.

If you have any questions, please feel free to contact a Spectrafy representative or e-mail us at `info@spectrafy.com`

1 Main components

A side view of the SolarSIM-GPV's primary components is shown in Figure 1, which include:

- a glass dome,
- an enclosure,
- bandpass filters,
- bubble level,
- a connector, and
- a backplate.
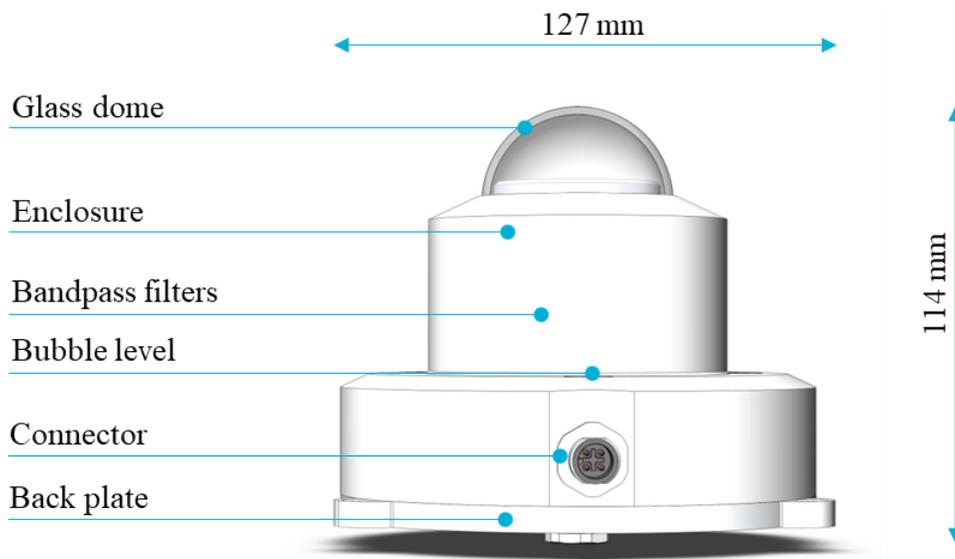
Figure 1: SolarSIM-GPV components and main dimensions.

1.1 Glass dome

The glass dome prevents the ingress of moisture and debris.

1.2 Enclosure

The anodized aluminum enclosure secures SolarSIM-GPV components in place, while providing robust protection from the environment.

1.3 Bandpass filters

Nine bandpass filters transmit a narrow band of spectral irradiance to the detectors.

1.4 Bubble level

The bubble level ensures the SolarSIM-GPV is leveled when measuring the irradiance in global horizontal orientation.

1.5 Connector

The connector provides power and communication to the SolarSIM-GPV electronics.

1.6 Backplate

The anodized aluminum backplate seals the back of the enclosure with four screws.

2 Installation

2.1 Contents of delivery

A typical SolarSIM-GPV delivery contains:

- 1 × SolarSIM-GPV,
- 1 × communication cable,
- 1 × SolarSIM-G COMBOX (optional),
- 1 × MP-G mounting plate (optional),
- 3 × mounting screws and springs, and
- a USB key loaded with the SolarSIM-GPV user manual and calibration certificate.

Please check the contents of your package and note if any damages have occurred during shipment. A claim should be filed with the shipment carrier should this be the case. Additionally, please contact a Spectrafy representative to facilitate the repair or replacement of the instrument and/or its accessories.

2.2 Mechanical installation

Installation of the SolarSIM-GPV consists of fastening it to a mounting plate using three M4 screws and springs, as demonstrated in Figure 2. The mounting plate can then be mounted to a pole or table as required. The mounting plate is 7.3 mm thick and has three slots with a 132 mm diameter that are 4.5 mm wide for external fastening, as shown in Figure 3. The screws/bolts for external mounting are not provided. The procedure for mechanical installation (in horizontal orientation) is described as follows:

1. Place the SolarSIM-GPV on the mounting plate as per Figure 3.

2. Place the springs under the SolarSIM-GPV so that they roughly align with the mounting holes on the SolarSIM-GPV.

3. Insert the M4 mounting screws through the SolarSIM-GPV mounting holes and springs. Then thread the screws into the mounting plate for several revolutions.

4. Adjust the mounting screws until the bubble level is centered within the circle.

5. The SolarSIM-GPV mounting plate can then be mounted to a table or tube/pipe with screws or u-bolts as required.

6. Once mounted, adjust the SolarSIM-GPV's mounting screws/springs until the bubble level is centered within the circle.

Note that the SolarSIM-GPV can also be deployed in fixed-tilt and plane-of-array applications, in which cases the springs and levelling process are not necessary.

3   Maintenance

The SolarSIM-GPV requires very little maintenance. The primary concern is to ensure that the glass dome of the SolarSIM-GPV is clean at all times, as the accumulation of dirt can lead to underreported and inaccurate data. Spectrafy's GV-1 ventilator can aid in this. Furthermore, the levelling of the SolarSIM-GPV should be checked periodically.

3.1   Cleaning

As a general rule, we recommend cleaning the SolarSIM-GPV's front glass with a dry, non-abrasive cloth once per week, in order to maintain optimal performance. This frequency can be altered depending on your local climatic conditions.

3.2   Alignment

With each cleaning, it is also advised to check the levelling of the instrument using the bubble level. If the bubble is not centered within the circle, adjust the mounting screws as needed to re-level the SolarSIM-GPV.

3.3   Desiccant

The desiccant is used to maintain an appropriate humidity level within the SolarSIM-GPV. The internal humidity of the device is reported as one of the sensor's data outputs and can therefore be monitored over time. The lifetime of the desiccant is expected to exceed two years, although it may vary based on local climatic conditions. The desiccant can be replaced as part of the SolarSIM-GPV's re-calibration procedure.

3.4   Recalibration

We recommend that the SolarSIM-GPV is returned to Spectrafy for recalibration every 1-2 years in order to maintain the SolarSIM-GPV's specified measurement accuracy.
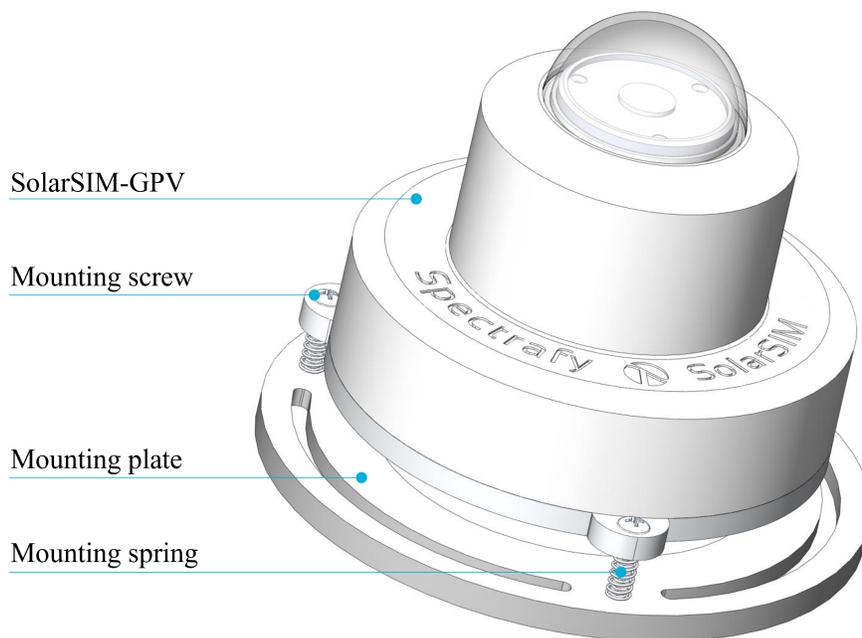
Figure 2: Assembled SolarSIM-GPV on the mounting plate.
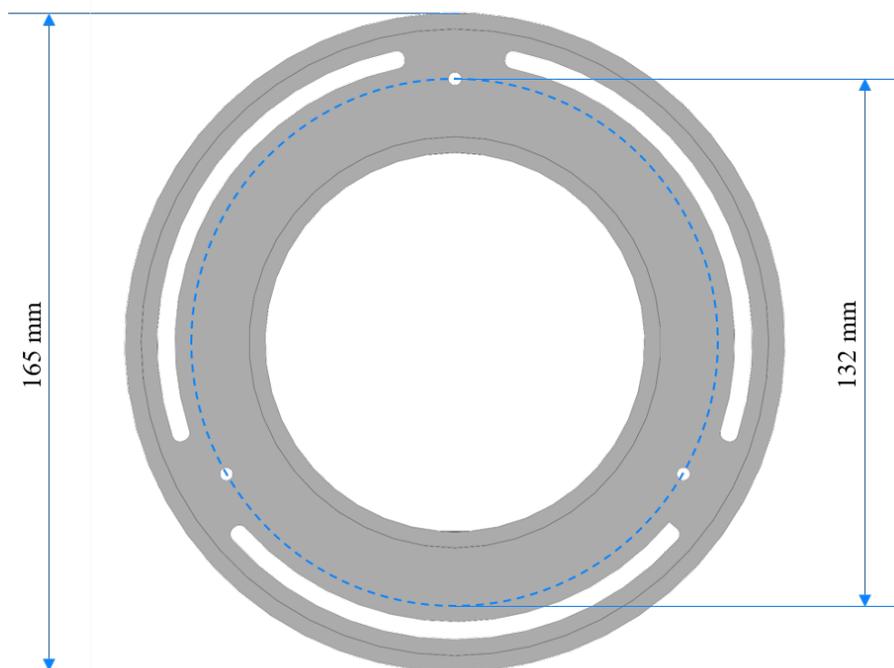
Figure 3: Dimensional drawing of the mounting plate. Note the three mounting holes are M4 thread.

4 Connectivity

The SolarSIM-GPV uses the iSG Integrated Spectrum Generator add-on to automatically process it's raw data and output global solar irradiance (GHI/GTI/POAI) and PV spectral correction factors directly to a datalogger over RS-485 modbus. The iSG consists of a 150x100x50mm, IP66 rated aluminium enclosure that can be deployed in open air, or within a datalogger enclosure, where it mounts by standard DIN rail. For more information regarding the operation and integration of the iSG, please see our Application note entitled: SolarSIM-iSG Datalogger Integration.
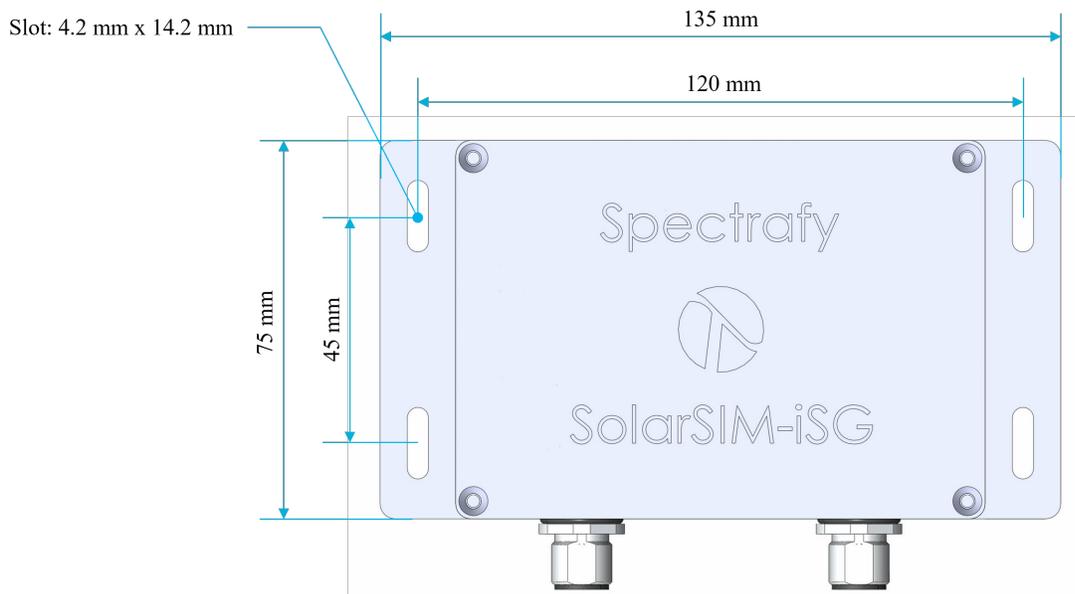
Figure 4: Main dimensions of the iSG.

5 Data outputs

The SolarSIM-GPV uses Spectrafy's innovative multispectral measurement approach to accurately resolve the global solar spectrum over the 280-4000nm wavelength range. From this spectral irradiance data, the SolarSIM-GPV outputs the global irradiance (calculated from the wavelength integral of the spectral irradiance) and PV spectral correction factors (SCF) for up to nine different PV panels. The spectral correction factors are automatically calculated using an equation derived from IEC 60904-7:2019 "Photovoltaic devices - Part 7: Computation of the spectral mismatch correction for the measurement of photovoltaic devices":

$$SCF = \frac{\int_{280}^{4000} E_{\text{AM1.5G}}\, d\lambda \times \int_{280}^{4000} E_{\text{M}} \cdot SR_{\text{PV}}\, d\lambda}{\int_{280}^{4000} E_{\text{M}}\, d\lambda \times \int_{280}^{4000} E_{\text{AM1.5G}} \cdot SR_{\text{PV}}\, d\lambda}$$

 Where:

SCF is the spectral correction factor.
$E_{\text{AM1.5G}}$ is the AM1.5G (ASTM G-173) reference spectrum.
E_{M} is the measured spectral irradiance resolved by the SolarSIM-GPV.
SR_{PV} is the spectral response of the PV panel of interest.

Spectral correction factors provide simple, intuitive datapoints that quantify the effect of local spectral conditions on the performance of the PV panel of interest. An SCF greater than one indicates that the local spectral condiitons are providing a boost to the PV panel performance as compared to reference spectral conditions. Conversely, a SCF less than one indicates the local spectral conditions are reducing the PV panel performance as compared to reference spectral conditions.

Spectrally corrected global irradiance can be obtained from the SolarSIM-GPV's global irradaince and SCF data outputs as follows:

$$GI_{spec.corr.} = GI \times SCF$$

Spectrally corrected irradiance data can then be used, much like uncorrected GHI would be, within any standard PV performance modelling software (eg. PVSyst, Plant Predict). Please note that when using spectrally corrected irradiance data, any spectral correction algorithms within the PV modelling software should be turned off.

5.1 Data outputs

The SolarSIM-GPV+iSG, outputs data as detailed in Table 1 below.

Table 1: SolarSIM-GPV data outputs

Parameter	Name	Units	Notes
TimeStamp	Local timestamp	N/A	
G_Irradiance	Global irradiance	W/m^2	GHI/GTI (Class A)
G_SCF_1	Spectral corr. factor 1	N/A	First Solar S3+
G_SCF_2	Spectral corr. factor 2	N/A	First Solar S4v1
G_SCF_3	Spectral corr. factor 3	N/A	First Solar S4v2
G_SCF_4	Spectral corr. factor 4	N/A	First Solar S6
G_SCF_5	Spectral corr. factor 5	N/A	PERC Mono Si
G_SCF_6	Spectral corr. factor 6	N/A	PERC Poly Si
G_SCF_7	Spectral corr. factor 7	N/A	Poly Si
G_SCF_8	Spectral corr. factor 8	N/A	CIGS
G_SCF_9	Spectral corr. factor 9	N/A	a-Si panel
G_AMBIENT_PRESSURE	Ambient pressure	kPa	
G_AMBIENT_TEMP	Ambient temperature	°C	
G_AMBIENT_HUMIDITY	Ambient humidity	%	
G_INTERNAL_TEMP	Internal temperature	°C	
G_INTERNAL_HUMIDITY	Internal humidity	%	
G_VOLTAGE_CH1	Channel 1 voltage	mV	
G_VOLTAGE_CH2	Channel 2 voltage	mV	
G_VOLTAGE_CH3	Channel 3 voltage	mV	
G_VOLTAGE_CH4	Channel 4 voltage	mV	
G_VOLTAGE_CH5	Channel 5 voltage	mV	
G_VOLTAGE_CH6	Channel 6 voltage	mV	
G_VOLTAGE_CH7	Channel 7 voltage	mV	
G_VOLTAGE_CH8	Channel 8 voltage	mV	
G_VOLTAGE_CH9	Channel 9 voltage	mV	

5.2   User defined spectral response curves

The SolarSIM-GPV comes with nine default spectral response (SR) curves as detailed in Table 5. The SolarSIM-GPV can also be used with user-defined SR curves. If you would like to use alternative SR curves, please contact us at info@spectrafy.com before your SolarSIM-GPV unit is shipped, so that your SR curves can be incorporated into the software. User-defined SR curves need to be formatted to 1nm resolution and span the wavelength range from 280-4000nm.

6   Support

Please contact us at info@spectrafy.com if you have any questions about the implementation or operation of the SolarSIM-GPV.