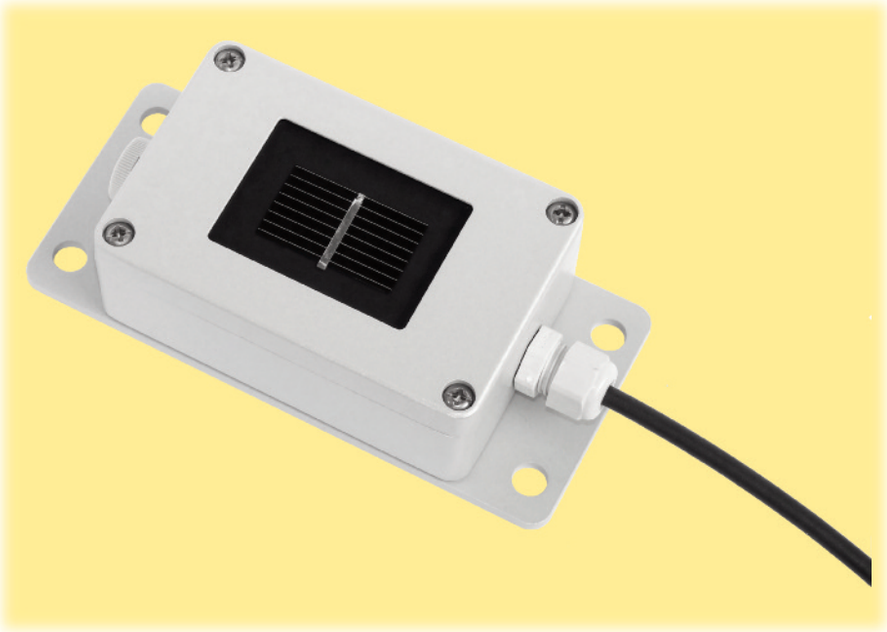
SILICON IRRADIANCE SENSOR

Measurement of Solar Irradiance

Silicon irradiance sensors (Si sensor) show a cost-effective, but rugged and reliable solution for the measurement of solar irradiance, especially for the monitoring of Photovoltaic (PV) systems. Based on the construction of the sensor element corresponding to a PV module they are ideal as reference for the monitoring of PV systems. Especially the spectral response comparable to PV modules as well as the similar inclination error (incident angle modifier) allow an exact analysis of PV energy yields using Si sensor data.



General Information

Mode of Operation

A silicon solar cell can be used as an irradiance sensor, because the short-circuit current is proportional to the irradiance. Our sensors are build out of a monocrystalline Si solar cell connected to a shunt. Due to the low resistance of the shunt the cell operates next to short-circuit.

To minimize influences of temperature to the measuring signal all of our sensors with the extension „TC“ have an active temperature compensation via a temperature sensor mounted to the back surface of the solar cell.

All sensors are calibrated in artificial sunlight against a reference cell calibrated at the Fraunhofer Institut Solare Energiesysteme ISE.

Mechanical Construction

The solar cell is embedded in Ethylen-Vinyl-Acetat (EVA) between glass and Tedlar. The laminated cell is integrated into a case of powder-coated aluminium. Therefore the sensor construction is comparable to that of a standard PV module. The electrical connection is realized by a 3 m cable or a waterproof (IP67) connector.

Optional Temperature Measurement

Additionally to the irradiance measurement our silicon sensors with the extension “-T” are able to measure the temperature of the solar cell using a temperature sensor mounted to the back of the cell. This solar cell temperature can approximately be used as module temperature.

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SILICON IRRADIANCE SENSOR

Technical Data

SIS-SENSOR

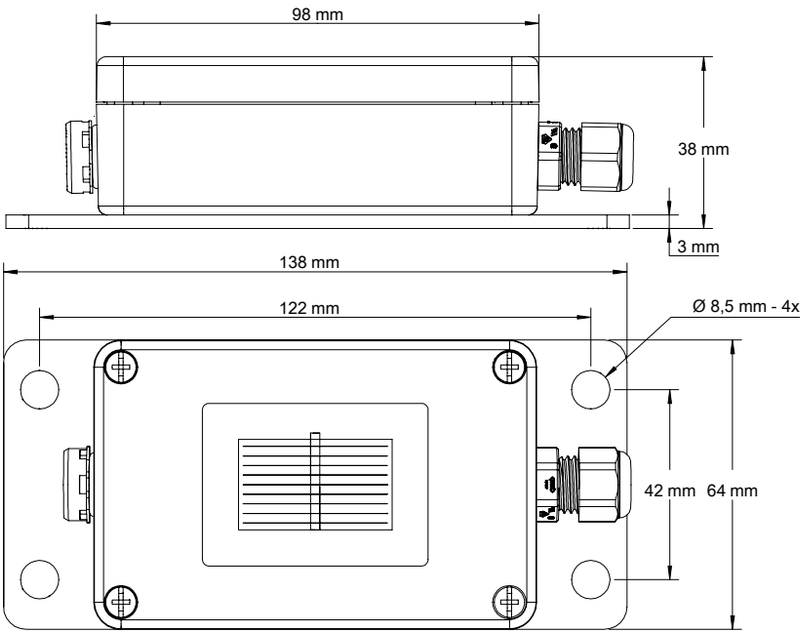
Allgemein

- Solar cell: Monocrystalline silicon (20 mm x 34 mm)
- Operating temperature: -35°C to 80°C
- Electrical connection: 3 m shielded cable
- Load impedance for SiS-01TC-batt: minimal 1 MΩ
- Load impedance for SiS-01TC and -TC-T and SiS-13TC and -TC-T: min. 10 kΩ
- Load impedance for Si-420TC and -TC-T: minimal 20 Ω and maximal 400 Ω
- Case, protection mode: Powder-coated aluminium, IP 67
- Dimension, weight: 138 mm x 64 mm x 40 mm, approx. 440 g
- Customs number for all sensors: 85 41 40 90

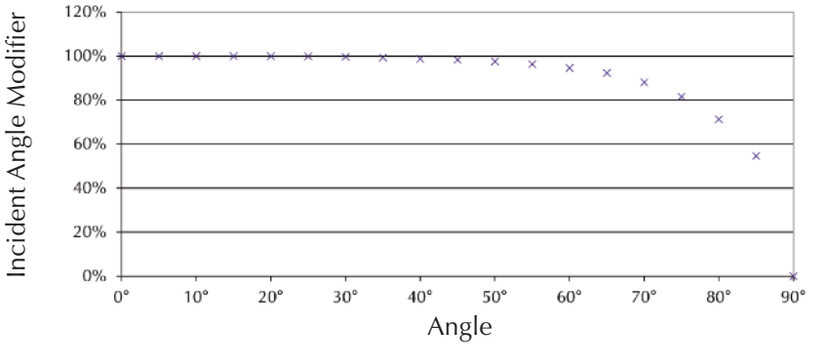
Digital

- Protocol: M&T (Type -MT)
- Interface: RS485 with 9.6 kBaud
- Galvanic isolation: none

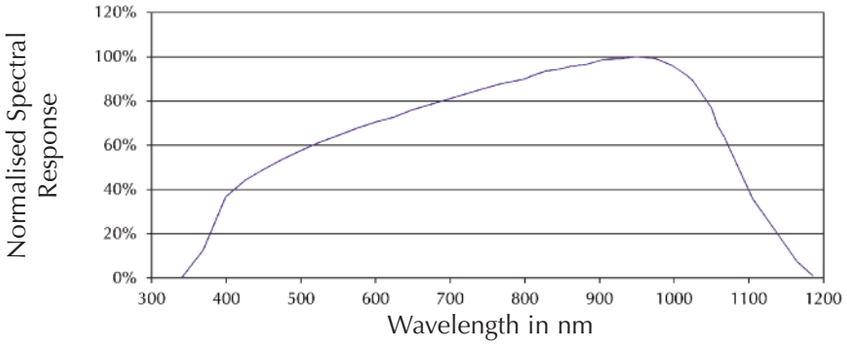
DIMENSIONS



INCIDENT ANGLE MODIFIER



SPECTRAL RESPONSE



SILICON IRRADIANCE SENSOR

Technical Data

Sensor Types:

Type Measured Variable	Irradiance Power Supply Current Consumption	Irradiance Temperature compensation	Irradiance Output Signal	Cell Temperature Output Signal
SiS-01TC-DMM Irradiance	Internal Lithium Battery typic 15 µA	Yes	0 to 1.4 V for 0 to 1,400 W/m²	./.
SiS-01TC Irradiance	24 V_{DC} (5 to 28 V_{DC}) typic < 1 mA	Yes	0 to 1.4 V for 0 to 1,400 W/m²	./.
SiS-01TC-T Irradiance, Cell Temperature	24 V_{DC} (5 to 28 V_{DC}) typic < 1 mA	Yes	0 to 1,4 V for 0 to 1,400 W/m²	0 to 2 V for -123.5 to +76.5°C
SiS-02 Irradiance	./. ./.	No	ca. 80 mV for 1,400 W/m²	./.
SiS-02-Pt100 Irradiance, Cell Temperature	./. ./.	No	ca. 80 mV for 1,400 W/m²	Pt100, Klasse A
SiS-02-Pt1000 Irradiance, Cell Temperature	./. ./.	No	ca. 80 mV for 1,400 W/m²	Pt1000, Klasse A
SiS-13TC Irradiance	24 V_{DC} (12 to 28 V_{DC}) typic < 1 mA	Yes	0 to 10 V for 0 to 1,300 W/m²	./.
SiS-13TC-T Irradiance, Cell Temperature	24 V_{DC} (12 to 28 V_{DC}) typic 4 mA	Yes	0 to 10 V for 0 to 1,300 W/m²	0 to 10 V for -26,1 to 89,0°C
SiS-420TC Irradiance	24 V_{DC} (12 to 25 V_{DC}) typic 5 bis 23 mA	Yes	4 to 20 mA for 0 to 1,200 W/m²	./.
SiS-420TC-T Irradiance, Cell Temperature	24 V_{DC} (12 to 25 V_{DC}) typic 18 bis 46 mA	Yes	4 to 20 mA for 0 to 1,200 W/m²	4 to 20 mA for -123.5 to 76.5°C
SiS-RS485TC-T Irradiance, Cell Temperature	24 V_{DC} (8 to 28 V_{DC}) typic 12 mA	Yes	M&T 0 to 1,400 W/m²	M&T -25 to +75°C

EXTEND OF Supply

Options

- Silicon sensor with shielded cable, 0.14 mm², UV- and temperature resistant, 3m length and ferrules (except Si-01TC-batt)
- Si-01TC-DMM with 3 m cable and 4 mm laboratory plug for multimeters
- Calibration protocol and quick reference guide
- DaKKS calibration certificate
- Customized cable lengths
- Customised scaling or measuring range

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Measurement Uncertainty of Irradiance for SiS Sensors

Parameter	Sensor Type	Typical Measurement Uncertainty
Response time (99 %) for G > 50 W/m²	SiS-02(-Pt100/-Pt1000)	0.001 s
	SiS-01TC(-T), SiS-13TC(-T), SiS-420TC(-T)	0.15 s
	SiS-RS485TC-T	1 s
Offset	SiS-02(-Pt100/-Pt1000)	0 W/m²
	SiS-01TC(-T), SiS-13TC(-T)	2 W/m²
	SiS-420TC(-T)	2.2 W/m²
	SiS-RS485TC-T	2.5 W/m²
Stability per anno [1]	all	0.50 %
Non-Linearity [1]	all	0.10 %
Temperature Dependancy [2] for -35 to +80°C	SiS-02(-Pt100/-Pt1000) (with ext. temperature comp.) [3]	0.40 %
	SiS-02(-Pt100/-Pt1000) (without ext. temperature comp.)	3.00 %
	SiS-01TC(-T), Si-13TC(-T), Si-420TC(-T)	0.50 %
	SiS-RS485TC-T	1.50 %
Factory-Calibration	all (repeatability against reference)	1.00 %
	all (measurement uncertainty of reference at STC and vertical light beam)	1.00 %
Measurement Uncertainty over all [4]	**All except Si-RS485TC-T: ±5 W/m² ± 3,5 % of measurement value** **SiS-RS485TC-T: ±8 W/m² ± 6,0 % of measurement value** **valid for temperature compensation, spectrum AM 1.5 and vertical light beam**	

Sensor Type	Measurement Uncertainty of the internal Temperature Measurement Condition	 Measurement Uncertainty [4]
SiS-02-Pt100, SiS-02-Pt1000	-35 to +80°C	IEC 60751, class A
SiS-01TC-T	-20 to + 70°C / -35 to + 80°C	2.0 K / 2.5 K
SiS-13TC-T	-20 to + 70°C / -25 to + 80°C	2.0 K / 2.5 K
SiS-420TC-T	-20 to + 70°C / -35 to + 75°C	2.0 K / 2.5 K
SiS-RS485TC-T	-10 to + 60°C / -25 to + 75°C	3.0 K / 4.0 K

[1] Percentage rate referred to the measurement range
[2] Percentage rate referred to the measurement value
[3] External temperature compensation must be calculated on data acquisition side (temperature coefficient at AM 1.5: 0.0005 1/K)
[4] Based on GUM (Guide to the Expression of Uncertainty in Measurement) with k=2, not valid for SiS-02 or SiS-02(-Pt100/-Pt1000) without external temperature compensation