



TRISENSE

- SILICON IRRADIANCE SENSOR
- TRISense Ta-IR
- VWIND-SI



TRINITY
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SILICON IRRADIANCE SENSOR

Silicon irradiance sensors 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 built 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 have an active temperature compensation via a temperature sensor laminated to the back surface of the solar cell.

All sensors are calibrated in artificial sunlight against a reference cell calibrated at the Physikalisch-Technische Bundesanstalt (PTB, National Metrology Institute of Germany).

Mechanical Construction

The solar cell is embedded in Ethylen-Vinyl-Acetate (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 3m cable or a water proof (Ip67) connector.

Temperature Measurement

Additionally to the irradiance measurement our silicon sensors are able to measure the temperature of the solar cell using a temperature sensor laminated to the back of the cell. This solar cell temperature can approximately be used as module temperature.

Technical Data

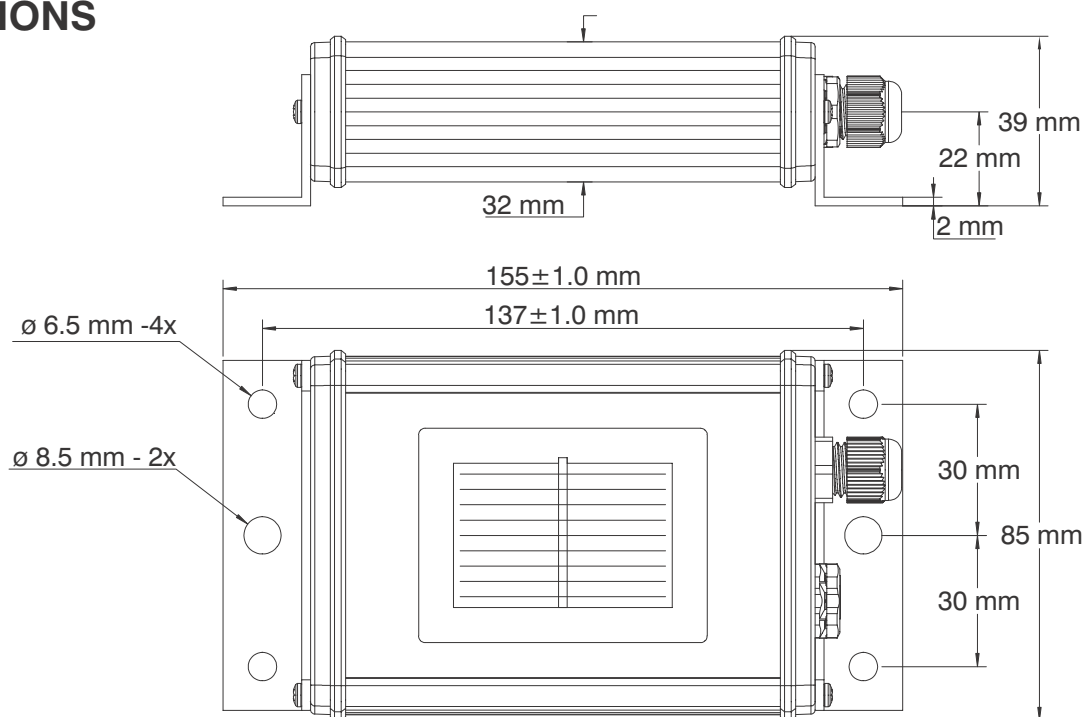
SI - SENSOR - General Information

Solar cell	Monocrystalline silicon (500 mm x 33 mm)
Operating temperature	-35°C to 80°C
Electrical Connection	3 m shielded cable
Load impedance for Si-V-1.5TC-batt	minimal 1 MΩ
Load impedance for Si-V-1.5TC and -TC-T, Si-V-10TC and -TC-T	min. 10 MΩ
Load impedance for Si-I-420TC and -TC-T	Minimal 20 Ω and maximal 400 Ω
Case, Protection mode	Power-coated aluminium, IP 65
Dimension, Weight	155mm x 85 mm x 39mm, approx. 350 to 470 g

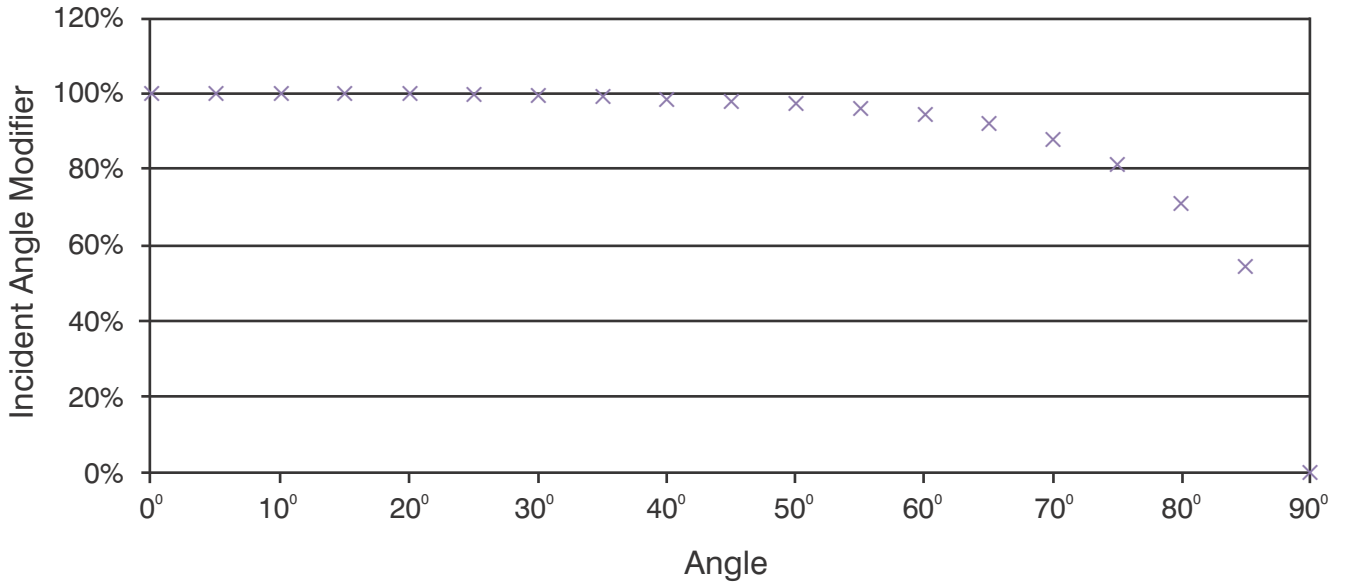
Digital

Protocol	MODBUS RTU (type - MB)
Interface	RS485 up to 38.4 kBaud
Galvanic isolation	1,000 V between power supply and bus

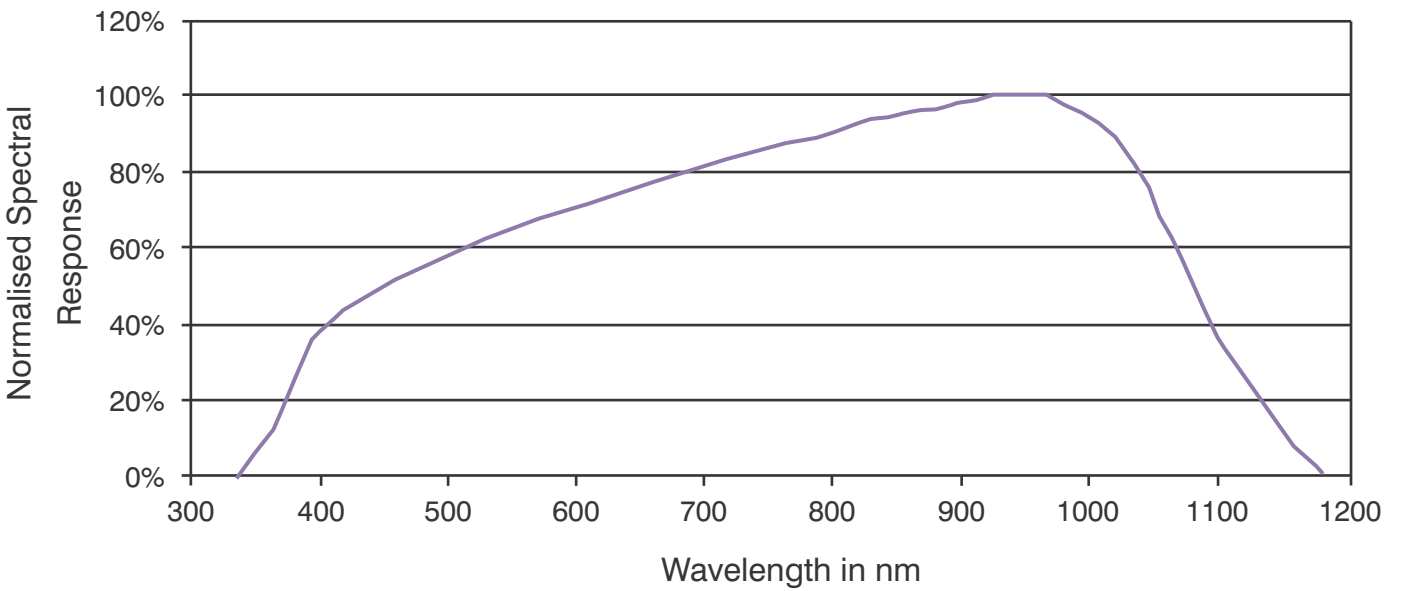
DIMENSIONS



INCIDENT ANGLE MODIFIER



SPECTRAL RESPONSE



SILICON IRRADIANCE SENSOR

Technical Data

Sensor Types:

Type Measured Variable	Power Supply Current Consumption	Irradiance		Cell Temperature
		Temperature compensation	Output Signal	Output Signal
TRISense IR-MOD-T-Ta Irradiance, Cell Temperature, Ambient Temperature (sensor firmly connected with 3 m cable)	24 V _{DC} (12 to 28 V _{DC}) typic 25 mA	Yes	MODBUS 0 to 1,500 W/m ²	MODBUS -40 to +90°C
TRISense IR-MOD-T-Ta-W Irradiance, Cell Temperature, Accessories: External Temperature Wind Speed	24 V _{DC} (12 to 28 V _{DC}) typic 25 mA	Yes	MODBUS 0 to 1,500 W/m ²	MODBUS -40 to +90°C

Accessories for TRISense IR-MOD-T-Ta-W

- TRISense Ta-IR-, Ambient temperature sensor in stainless steel sleeve with 3 m cable and connector (IP67), measuring range : -40 to +90°C
- Tmodul-Si, Module temperature sensor in aluminium block with 3 m cable and connector (IP67), measuring range : -40 to +90°C
- Vwind-Si, Wind speed sensor with 5 m cable and connector (IP67), measuring range : 0.9 to 40 m/s

SILICON IRRADIANCE SENSOR

Measurement Uncertainty of Irradiance

(does not apply for sensors with filter glass or polycrystalline cells)

Parameter	Sensor Type	Typical Measurement Uncertainty
Response time (99%) for $G > 50 \text{ W/m}^2$	TRISense IR-MOD-XX	1 s
Offset	TRISense IR-MOD-XX	1 W/m^2
Stability per anno 1)	All	0.50%
Non-Linearity 2)	All	0.10%
Temperature Dependency 2) for -35 to $+80^\circ\text{C}$	TRISense IR-MOD-XX	0.40%
Factory-Calibration	all (repeatability against reference)	0.75%
	all (measurement uncertainty of reference at STC and vertical light beam)	0.50%
Measurement Uncertainty over all 4)	$\pm 5 \text{ W/m}^2 \pm 2.5 \%$ of reading valid for temperature compensation, spectrum AM 1.5 and vertical light beam	

Sensor Type	Measurement Uncertainty of the internal Temperature Measurement	
	Condition	Measurement Uncertainty
TRISense IR-MOD-XX	-35 to $+80^\circ\text{C}$	1.0 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 $k=2$.

SILICON IRRADIANCE SENSOR

Option Connector

Electrical Connection

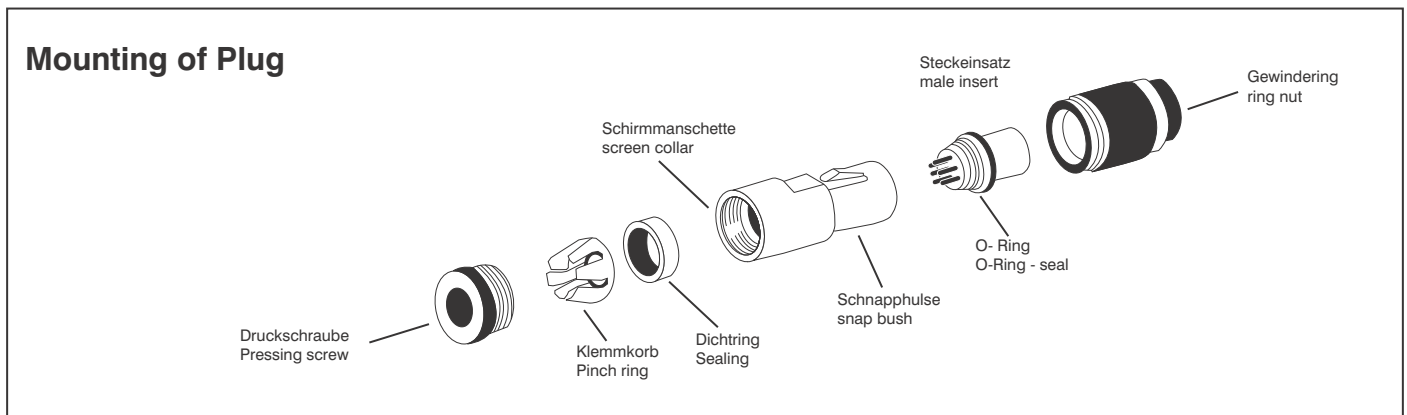
Optional Version With Connectors

The Electrical Connection Of The Si Sensor Is Realized With The Inbuilt Connector and The Suitable Plug.

Technical Data Of The Plug

- Cable Dimensions (best / Max.): 0.14 mm² / 0.25 mm² (AWG26 / AWG24)
- Diameter Of Cable: 3.5 ... 5 mm
- Protection Mode: IP67 In Conjunction With The Suitable Connector

The pin numbers are printed at the inside of the plug. Please take care of the mounting of the plugs as Shown below. Only if these mounting steps are realised the plug meets IP67 when connected.



TRISense Ta-IR

External Temperature Sensor for TRISense IR-MOD-T-Ta-W



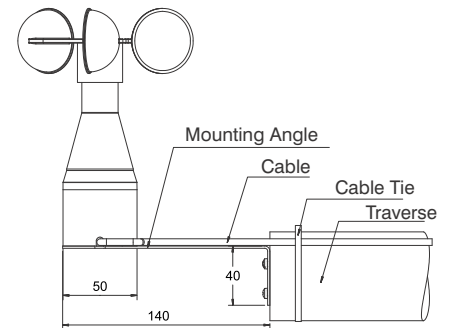
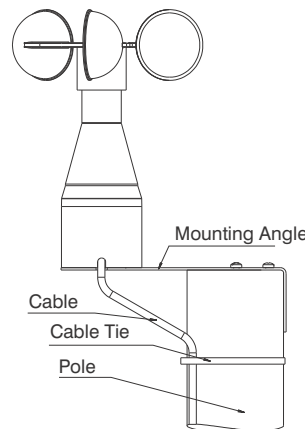
Sensor type	Pt1000 1/3 class B
Temperature range	-40...+85°C
Sensor housing	INOX steel tube, 6 mm diameter, 50 mm length
Cable	3 m LiYC11Y, 4 x AWG 26, black, weather and uv-resistant
Connector	Binder connector series 712
Protection	IP67
Pin assignment	Pin 1 – Pt1000 Pin 2 – Pt1000 Pin 3 – cable shield, isolated to INOX steel tube

Mounting Advices

In case of outdoor installation avoid direct rain and sun contact on INOX steel tube. Probably use sun respectively rain protection.

VWIND-SI

Wind speed Sensor for TRISense IR-MOD-T-Ta-W



Sensor type	Cup star anemometer
Signal	Reed relais, 2.5 Hz/(m/s)
Range	0.9...40 m/s (60 m/s for short time)
Accuracy	0.5 m/s or 5% of reading
Cable	5 m LiYC11Y, 4 x AWG 26, black, weather and uv-resistant
Connector	Binder connector series 712
Pin assignment	Pin 1 – Reed relais
	Pin 2 – Reed relais

Mounting Advices

Storing, mounting and operation under weather conditions is only allowed in vertical position, as otherwise water can get into the sensor. So an installation with roof inclination is not allowed. No installation in wind protected areas or in wind shadow of any construction. On flat roofs a installation in the middle of the roof is preferable. The wind sensor must be integrated into the lightning protection system.

Maintenance

Heavy air pollution can clog up the slit between the rotating and the stationary part of the wind sensor. This slit must be kept clean. After longer use abrasion might occur at the bearings and the reed relais. This can cause a higher starting torque or missing output impuls. Therefore we recommend a yearly maintenance and checking of the rotating ability of the cup star.



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