



DATA SHEET

# Silicon Irradiance Sensors for Measurement of Solar Irradiance



Intelligent Measurement & Testing

## The World's no. 1 in Reference Cells

Measure the irradiance intensity on your photovoltaics system precisely at an affordable price with IMT Technology's robust silicon solar irradiance sensors (Si sensors). The sensor element's design is similar to that of a PV module; this means that their spectral response (SR) and incident angle modifier (IAM) are highly comparable. Consequently, these sensors are eminently suitable as a reference for PV system monitoring.

### Benefits & Features

- Reference solar cell for PV monitoring
- Calibration measurement uncertainty: 1.2% (class A as per IEC 61724-1)
- Suitability for outdoor use verified by tests as per IEC 61215
- Extremely few mismatch errors due to optical properties as those of PV modules
- Rear side irradiance measurement for bifacial PV monitoring
- Calibration in relation to spectrum as per IEC 60904-3, AM1.5
- Exceptional linearity significantly above IEC 60904-10 requirements
- Pt1000 as per IEC 60751 Class A to measure cell temperature
- Developed and manufactured in Germany

### Functionality & Construction

#### 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 high-quality 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 on the measurement signal all of our sensors with the extension „TC“ have an active temperature compensation via a temperature sensor laminated to the back surface of the solar cell.

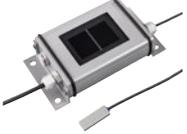
All sensors are calibrated under artificial sunlight against a reference cell calibrated by the National Metrology Institute of Germany (PTB).

#### Construction

The solar cell is embedded in ethylene vinyl acetate (EVA) between glass and Tedlar. The laminated cell is integrated into a powder-coated aluminium case. Therefore the sensor's construction is comparable to that of a standard PV module.

## Sensor Types

### Digital Reference Cells (RS485 / MODBUS)

Sensor Type	Measured Parameters	Notes
<b>Irradiance 0 to 1500 W/m<sup>2</sup>, Temperatures -40 to +90 °C</b>		
Si-RS485TC-T-MB 	<ol style="list-style-type: none"> <li>Solar irradiance</li> <li>Cell temperature</li> </ol>	-
Si-RS485TC-2T-MB 	<ol style="list-style-type: none"> <li>Solar irradiance</li> <li>Cell temperature</li> <li>Ambient temperature</li> </ol>	Firmly connected ambient temperature sensor (3 m connection cable) Optional Shield-Tamb-Si as a weather and radiation protection
Si-RS485TC-T-Tm-MB 	<ol style="list-style-type: none"> <li>Solar irradiance</li> <li>Cell temperature</li> <li>PV module temperature</li> </ol>	Firmly connected module temperature sensor (3 m connection cable)
Si-RS485TC-2T-v-MB 	<ol style="list-style-type: none"> <li>Solar irradiance</li> <li>Cell temperature</li> <li>Temperature (PV module or ambient temperature)</li> <li>Wind speed</li> </ol>	Two waterproof connectors for one temperature sensor and one wind speed sensor To order separately <ul style="list-style-type: none"> <li>External sensors with preconfigured plug</li> <li>Optional Shield-Tamb-Si as a weather and radiation protection</li> </ul>
Si-RS485TC-3T-MB 	<ol style="list-style-type: none"> <li>Solar irradiance</li> <li>Cell temperature</li> <li>Temperature 1 (PV module or ambient temperature)</li> <li>Temperature 2 (PV module or ambient temperature)</li> </ol>	Two waterproof connectors for two temperature sensor (for example Tmodul-Si and Tamb-Si) To order separately <ul style="list-style-type: none"> <li>External sensors with preconfigured plug</li> <li>Optional Shield-Tamb-Si as a weather and radiation protection</li> </ul>

### Analogue Reference Cells

Sensor Type	Output Signal	
	Irradiance 0 to 1500 W/m <sup>2</sup>	Cell Temperature -40 to +90 °C
Si-I-420TC	4 to 20 mA	-
Si-I-420TC-T	4 to 20 mA	4 to 20 mA
Si-V-10TC	0 to 10 V	-
Si-V-10TC-T	0 to 10 V	0 to 10 V
Si-V-1.5TC	0 to 1.5 V	-
Si-V-1.5TC-T	0 to 1.5 V	0 to 2 V
Si-mV-85	0 to approx. 85 mV	- (optional Pt100 / Pt1000)

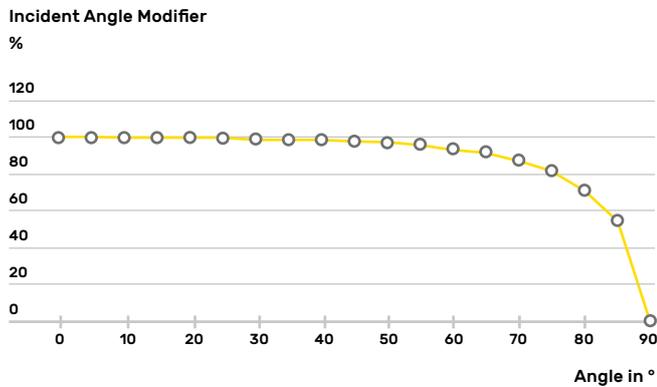
## Technical Data

### All Reference Cells

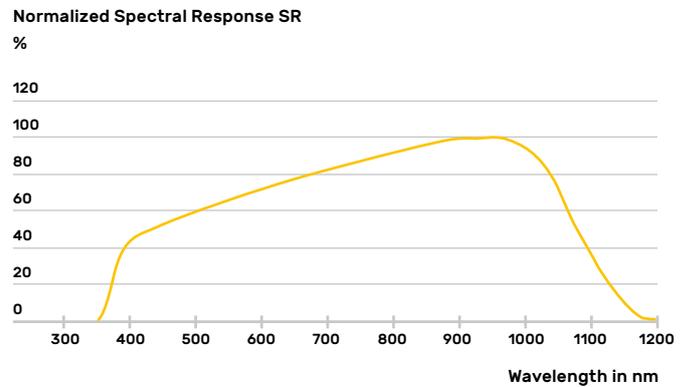
PV cell	Monocrystalline silicon; 50 mm x 33 mm, vendor: BigSun, type: B156X1D2A-2010
Case	Powder-coated aluminium, 155 mm x 85 mm x 39 mm, 350 to 470 g
Connection cable	Length: 3 m, PUR sheath, shielded, UV and weather resistant, LiYC11Y, 4 x 0.14 mm <sup>2</sup>
Voltage supply	Typical 24 V <sub>DC</sub>
Operating temperature	-35 to +80 °C
Degree of protection	IP 67
Customs tariff number	90 15 80 20

→ For further technical information please see also the instruction manual.

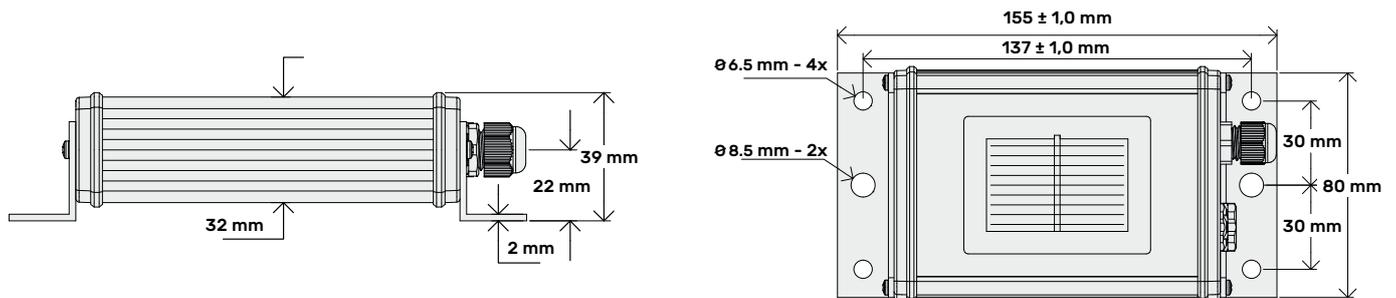
### Incident Angle Modifier IAM



### Normalized Spectral Response SR



### Dimensions



## Measurement Uncertainty

### Irradiance

Parameter	Sensor Type	Uncertainty <sup>2</sup>
Response time (99 % for G > 50 W/m <sup>2</sup> )	All types with RS485	1 s
	Si-V-1.5TC(-T), Si-V-10TC(-T), Si-I-420TC(-T)	0.15 s
	Si-mV-85(-Pt100/-Pt1000)	0.001 s
Offset	All types with RS485	0.3 W/m <sup>2</sup>
	Si-I-420TC(-T)	4.2 W/m <sup>2</sup>
	Si-V-1.5TC(-T), Si-V-10TC(-T)	3.7 W/m <sup>2</sup>
	Si-mV-85(-Pt100/-Pt1000)	0 W/m <sup>2</sup>
Stability per year <sup>1</sup>	All types	0.30 %
Non-linearity typ.	All types (100 to 1000 W/m <sup>2</sup> )	0.20 %
Temperature error <sup>1</sup> for -35 to +80 °C	All Types with RS485	0.40 %
	Si-V-1.5TC(-T), Si-V-10TC(-T), Si-I-420TC(-T)	0.40 %
	Si-mV-85-Pt100(0) with external temperature compensation	0.20 %
	Si-mV-85(-Pt100(0)) without external temperature compensation	3.00 %
Inhouse calibration	All types (repeatability against primary reference)	0.5 %
	All types (uncertainty of primary reference at STC)	0.5 %

Sensor Type	Measurement Uncertainty in W/m <sup>2</sup> ± % of Value <sup>2</sup>	
	Irradiance 100 to 1500 W/m <sup>2</sup>	Irradiance 0 to 1500 W/m <sup>2</sup>
All types with RS485	±0.4 ± 1.6 %	±0.4 ± 1.6 %
Si-I-420TC-T	±3.5 ± 1.6 %	±4.5 ± 1.6 %
Si-V-1.5TC(-T), Si-V-10TC(-T)	±3.0 ± 1.6 %	±4.0 ± 1.6 %
Si-mV-85-Pt100(0)-(4L) <sup>3</sup>	±0.3 ± 1.6 %	±0.3 ± 1.6 %
Si-mV-85	±0.3 ± 4.6 %	±0.3 ± 4.6 %
Measurement uncertainty of calibration <sup>4</sup> : 1.2 %, meets class A as per IEC 61724-1		

### Temperature

Sensor Type	Condition	Measurement Uncertainty
All types with RS485	-35 to +80 °C	1.0 K
Si-I-420TC-T	-35 to +60 °C / -35 to +80 °C	1.0 K / 1.3 K
Si-V-1.5TC-T, Si-V-10TC-T	-35 to +70 °C / -35 to +80 °C	1.0 K / 1.1 K
Si-mV-85-Pt100(0)-(4L)	-35 to +80 °C	0.35 K

## Options

- DaKKS calibration, DIN EN ISO/IEC 17025
- Customised cable length
- Version with water-proof plug-socket connection
- Si-V-1.5TC also as battery powered version available
- Ready-made multimeter cable for battery powered version
- Customised scaling or measuring range
- RS485 versions with MT protocol (ASCII)

## Accessories

Ambient temperature	Tamb-Si	Ambient temperature sensor with 3 m cable and plug connector (IP67) for Si-RS485TC-2T-v-MB / Si-RS485TC-3T-MB
PV Module temperature	Tmodul-Si	PV module temperature sensor with 3 m cable and plug connector (IP67) for Si-RS485TC-2T-v-MB / Si-RS485TC-3T-MB
Wind speed	Vwind-Si	Wind speed sensor with 5 m cable and plug connector (IP67) for Si-RS485TC-2T-v-MB
Protection shield	Shield-Tamb-Si	Weather and radiation shield for ambient temperature sensor (fits to Tamb-Si und Si-RS485TC-2T-MB)
Junction box set	JB-01	Junction box with cable glands and spring terminals
→ See also data sheet of accessories for further technical information.		

## Scope of Delivery

All types	Instruction manual
	Calibration certificate

- 1 Percentage rate referred to the measurement value
- 2 Based on GUM (Guide to the Expression of Uncertainty in Measurement) with k=2, valid for spectrum AM 1.5, vertical light beam and complete operating temperature range
- 3 External temperature compensation must be calculated on data acquisition side (temperature coefficient at AM 1.5: 0.0005 1/K)
- 4 Under standard test conditions, STC

## Intelligent Measurement & Testing