ISFH CalTeC: Certification of irradiance sensors

Technical information (23b)

DAkkS Deutsche Akkreditierungsstelle D-K-18657-01-00

An irradiance sensor converts the irradiance hitting its light-sensitive sensor to a measurable signal, usually a current, voltage or data signal. For photovoltaic applications an irradiance sensor mostly consists of an encapsulated solar cell within a housing and the irradiance is converted to a voltage signal using a shunt resistance.

ISFH CalTeC is DAkkS / ILAC accredited for the certification of irradiance sensors. As a result, our costumers get the irradiance sensitivity (or “calibration value”) with accompanied uncertainty, allowing converting the signal of the sensor directly into an irradiance value. This value is usually determined for the AM1.5G-spectrum (1000 W/m²) as defined in the IEC 60904-3 standard. Other irradiances are possible.

For lowest uncertainties our accredited procedure takes the temperature “history” of the device into account by measuring during a heat-up and a cool-down phase. For this accredited procedure (“T-ramps” procedure) the sensor must be equipped with a temperature sensor ideally directly contacting the light-sensitive sensor. For lowest uncertainty, a spectral mismatch correction can be carried out. Please note that in this case the spectral responsivity of the device must be measurable.

For sensors without temperature sensor, we can only offer a proprietary certification (i.e. no DAkkS / ILAC) which determines the irradiance sensitivity at room temperature and room-temperature history (“T-room” procedure).

We strongly recommend the “T-ramps” procedure for field or outdoor applications. For indoor applications, where the irradiance sensor is hold at room temperature and does not heat up during operation (e.g. in a solar simulator flash system), also the “T-room” procedure might be sufficient.

To allow for certification we investigate the temperature hysteresis from the above-defined ramping procedure. Therefore, we fit the heat-up signal with a second order polynomic function. We then calculate the deviation of each cool-down value to its corresponding value of the fit. This deviation has to be below +/- 0.30%. Moreover, the arithmetic mean of all deviations has to be smaller than 0.10%. If the irradiance sensor does not comply these conditions, we only provide a measurement report.

Please note that for all sensors the customer must provide the distance of the active sensor element to bottom of the housing and the documentation about the electrical connection.

Table 1 clarifies which sensor can be currently measured at ISFH CalTeC with which procedure. The following parameters are used:

SHUNT-REMOVABLE: YES/NO
YES: Shunt-resistance removable and direct electrical contact to solar cell possible. A four-point electrical contact to the solar cell is required. Please note that this can also be realized with an equally built sensor having same optical properties as the irradiance sensor under test.
NO: Irradiance sensor has a built-in shunt resistance that cannot be removed.

T-SENSOR: YES/NO
YES: Temperature measurement of solar cell possible. A four-point contacting of the temperature sensor is required. PT1000/PT100 sensors are preferred and sensor should ideally be in direct contact with the solar cell.
NO: Temperature cannot be measured (i.e. no temperature sensor).

T-CONTROL: YES/NO
YES: Temperature control of solar cell through bottom side of sensor possible. This implies that there is a good thermal conductive from the bottom side of the sensor up to the solar cell. It is also recommended that the bottom side of the sensor is flat to allow for a good thermal conduction to our temperature-controlled plate.
NO: Temperature control not possible (e.g., solar cell has no direct contact to rear side of housing).

OPT-IDENT-SENSOR: YES/NO
YES: Optically identical sensor available with SHUNT-REMOVABLE, T-SENSOR and T-CONTROL.
NO: Optical identical sensor not required

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Table 1: Overview of the different certification possibilities of irradiance sensors.

Category	SHUNT-REMOVABLE	OPT-IDENT-SENSOR	T-SENSOR	T-CONTROL	Type of irradiance sensor	Measurements and certifications	Typical* expanded measurement uncertainty U(s), k=2	Available?
A	YES	No	YES	YES	All irradiance sensors with spectral responsivities from 280 nm to 1200 nm.	DSR/SR at 25°C with DAkkS-certificate. MM calculated with measured curves. s(25°C) with "T-ramps" procedure and DAkkS-certificate.	1.2%	Yes
B	YES	No	YES	NO	All irradiance sensors with spectral responsivities from 280 nm to 1200 nm.	DSR/SR at T-room and low bias, without certificate. MM calculated with measured curves. s(25°C) with "T-ramps" procedure and DAkkS-certificate.	1.4%	planned
C	NO	YES	YES	NO	All irradiance sensors with spectral responsivities from 280 nm to 1200 nm.	DSR/SR at 25°C with DAkkS-certificate for identical sensor. MM calculated with measured curves. s(25°C) with "T-ramps" procedure and DAkkS-certificate.	1.6%	Yes
D	NO	NO	YES	NO	Only unfiltered irradiance sensors using typical silicon solar cells as active device	DSR/SR cannot be measured. MM=1 s(25°C) with "T-ramps" procedure and DAkkS-certificate.	2.4%	Yes
E	NO	NO	NO	NO	Only unfiltered irradiance sensors using typical silicon solar cells as active device	DSR/SR cannot be measured. MM=1 s(25°C) with "T-room" procedure and proprietary certificate (**no** DAkkS).	2.6%	Yes

*typical uncertainty values are realistic reachable values in contrast to "smallest uncertainty that can be specified" as stated in the annex to accreditation certificates.