New sensors for monitoring photovoltaic plants

Words: Dirk Tegtmeyer et al.

Over the last years, some new sensors have been developed, for monitoring photovoltaic plants. This has been possible due to close co-operation, in research and development, between Ingenieurbüro Mencke & Tegtmeyer GmbH (M&T) and Institut für Solarenergieforschung Hameln/ Emmerthal (ISFH). The new PVIS reference irradiance sensor will be available later this year, once the final optimization and accelerated environmental testing is completed.

Whilst we now concentrate on this sensor, which conforms to the IEC 61724-1:2017 standard as well as with WPVS (World Photovoltaic Scale), we will present the new BigRef sensor in the next issue of PES Solar.

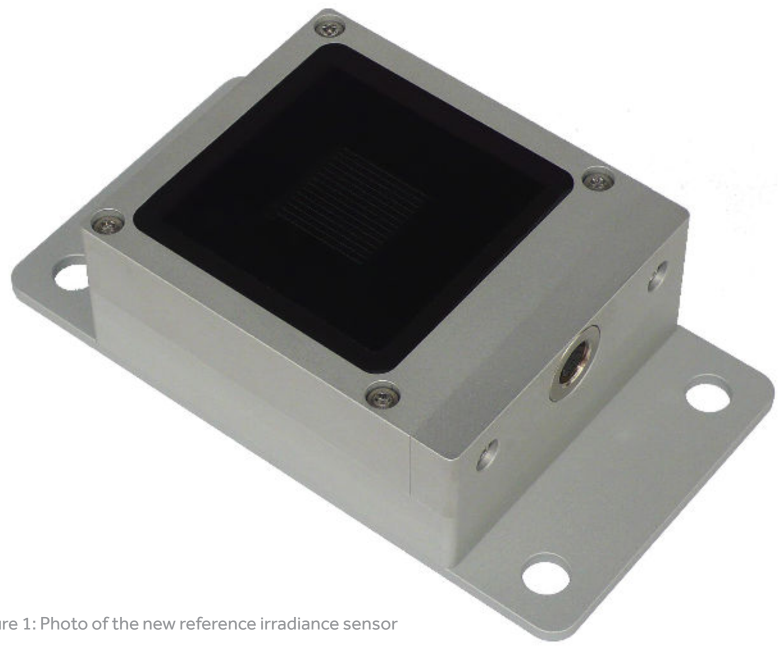

Figure 1: Photo of the new reference irradiance sensor

We would like to thank all colleagues, who have made this technique possible.

Aptitude test for reference irradiance sensors for use according to IEC 61724-1

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For investors and the O&M Management (Operation & Maintenance) of photovoltaic plants systems monitoring reliability is indispensable. One important part of the monitoring systems is the precision measurement of the global irradiance, using an irradiance sensor.

The requirements of such sensors are defined within the IEC 61724-1:2017 standard and are demanded for financial input by many investors. Section 7.2.1.4 of the standard demands for PV reference equipment (solar irradiance sensors based on solar cells) states the following:

- The fulfilment of all requirements of the IEC 60904-2:2015 standard. Among other things, this includes testing the suitability for outdoor use, according to the IEC 61215-2:2016 standard. Applicable tests to irradiance sensors are: MQT 11 temperature change load test, MQT 13 humidity heat test and MQT 10 UV pre-treatment.
- Fulfilment of linearity requirements

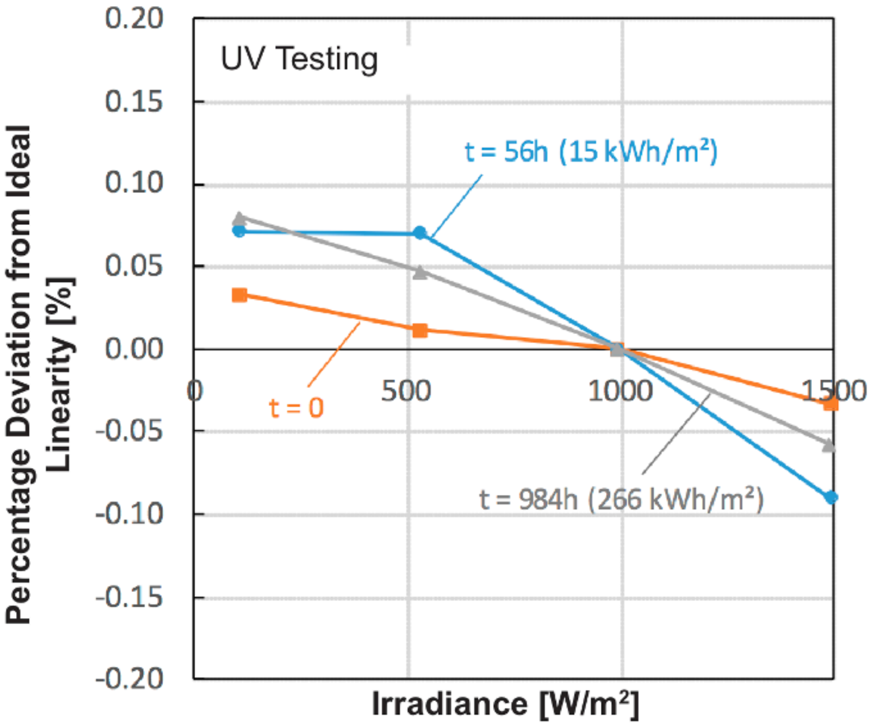

Figure 2: Non-linearity acc. IEC 60904-10 of the new designed solar irradiance sensor, exemplary shown here before during and after the UV pre-treatment.

according standard IEC60904-10:2009. Here a non-linearity of less than 2% is required.

- The calibration in respect to that in IEC 60904-3:2019 indicated reference spectrum.
- A maximum measurement uncertainty (k=2) of 3.0% for irradiances between 100 W/m² and 1500 W/m² for a high precision PV irradiance sensor (class A).

The authors have developed a new reference irradiance sensor (class A), which fulfils all requirements mentioned above and therefore, should be in conform to IEC 61724-1 standard. A photo of this sensor can be seen in figure 1.

The sensor exists as a reference sensor in WPVS format (WPVS: World Photovoltaic Scale) and a mechanically detachable case extension, using electronic measurement. The electronic measurement provides the irradiance as temperature-compensated and calibrated 10 V, or 20 mA signal respectively, via an RS485/MODBUS interface. This makes the sensor compatible with almost all common PV monitoring systems.

The results of the suitability tests show the especially low drift of −0.1 % to −2.1 % of the calibration value, after the various climatic tests. These drifts are mostly compensated during measuring mode by recalibrating the sensors and the linearity, with a maximum percent deviation of 0,1% (of measured value) in comparison to an ideal solar cell, see figure 2.

Concerning the measuring uncertainty, figure 3 shows that the maximum measuring uncertainty according to the 3.0 % standard of measuring value, is considerably undershot for irradiances from 100 W/m² to 1500 W/m² and the complete operating temperature range of −40°C to +80°C with 1.2% to maximum 2.55%.

The new reference irradiance sensor can be calibrated by the producer, with a factory calibration certificate, or within the calibration laboratory ISFH-CalTeC, using an audited measuring procedure (DAkkS calibration certificate) from the German Accreditaion Body (DAkkS).

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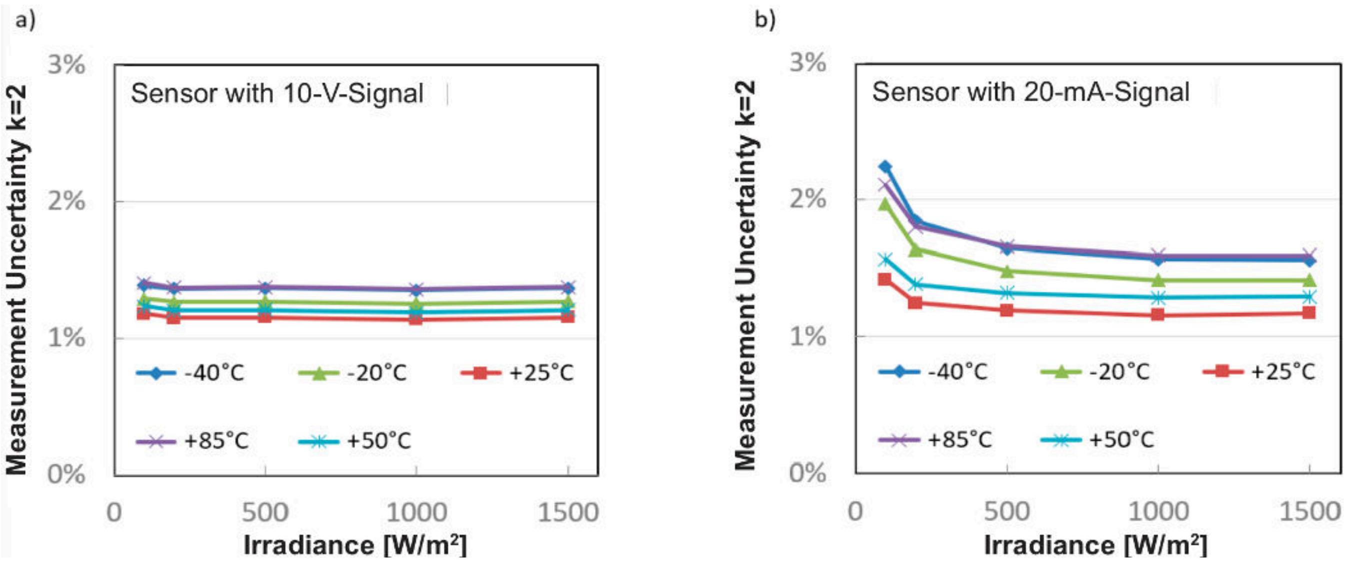

Figure 3: Measurement uncertainty of the sensor with a) 10 V signal and b) 20 mA signal for temperature range of -40°C to +85°C at irradiances of 100 W/m² up to 1500 W/m² (factory calibration).