Measurements and their results provide information for the model plate, allow the controlling of processes and even determine the yields of solar systems. In many cases the measurement values have a direct monetary impact. For example, PV module prices can be derived from the performance measured in the production flasher, and the performance of a PV system can be computed from the measurement values of the irradiance and power feed. First of all, it’s important that the employed measuring equipment be traceable and therefore comparable with other measuring equipment. Relative to their initial conditions, the measuring systems and the sensors may undergo changes due to various environmental effects, handling and ageing mechanisms, all of which can have a possibly unnoticed influence on the measurement results. Testing and measuring systems must therefore be subject to quality assurance and regular calibration, so that they can provide valid results within the limits of the calculated measurement uncertainties.

**Calibration of pyranometers**

With calibration of pyranometers according to ISO 9847 we offer factory calibration of your pyranometers that is traceable in compliance with ISO/IEC 17025. By employing a reference pyranometer directly traceable to the World Radiometric Reference (WRR) and exactly substituting this reference by your specimen during the calibration, we can achieve measurement uncertainties slightly above those of the PMOD (WRR). The possibility of an ultra-precise, weather-independent and reproducible internal calibration (three points within 600 W/m²...1100 W/m²), including factory calibration...
certificates compliant with ISO/IEC 17025, allows fast processing without additional customs-clearing formalities or problems with recognition of the calibration certificates.

**Calibration of reference modules**
Reference modules enable manufacturers to determine the performance of mass-produced modules precisely and with low measurement tolerance ranges.

For calibrating reference modules, we use a high-quality flash-light solar simulator of class AAA, with a primary calibrated reference solar cell. For the actual precision performance measurement, we also determine the temperature coefficients for Isc, Voc and Rs as well as the irradiance coefficient and non-destructively measure the relative spectral response of the modules. Thanks to the spectral mismatch correction the expanded measurement uncertainty for the calibration is merely 2.0%.

**Calibration of reference cells**
Determining the performance of PV modules and PV systems requires an exact determination of the insolation, which can be reliably found by means of the reference cells secondarily calibrated by TÜV Rheinland. Your reference cells will receive comprehensive calibration conforming to standards and relative to a primary reference. Components of the calibration are the determination of all necessary temperature coefficients, determination of the STC values and measurement of the spectral response.

**Solar simulator classification**
Solar simulator qualification – The test programme is based on on-site measurements with mobile TÜV Rheinland measuring equipment. The purpose of the measurements is the classification of individual solar simulators according to the test standard IEC 60940-9. The operators of solar simulators can then judge whether the light quality of their systems has remained unchanged after a bulb change or conversion. If necessary, optimisation possibilities can be indicated.

**Solar simulator certification with test mark**
The test programme is also based on on-site measurements with mobile TÜV Rheinland measuring equipment. The purpose of the measurements is the verification that a solar simulator type meets the class AAA requirements of the test standard IEC 60940-9. Not only the actual performance of the system is considered, but also

- the constancy of the technical properties in the consideration of different systems of the same type
- possible effects of bulb changes
- effects of bulb ageing
- the reproducibility of the installation of the system.

The tests also include calibration service and calibration management. In addition, training measures, trouble-shooting strategies and service and maintenance instructions are checked as to completeness. Armed with the certification, solar simulator manufacturers can recommend their products for measuring the characteristics of photovoltaic modules.

**Calibration of climate chambers**
The performance of temperature chambers is confirmed on the basis of IEC 60068-3. The temperature and air humidity can be determined and measured, conforming to standards, at up to 27 points, depending on the chamber size. With an external calibration you'll fulfil a requirement on the traceability of measuring and test equipment according to ISO/IEC 17025, the standard for test and calibration laboratories.

**Always a good sign.**

This mark stands for all the information about products, services and systems that are tested, certified or inspected by TÜV Rheinland. Transparent, available anytime worldwide – powerful and unique.

The TÜV Rheinland test mark.

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