Hukseflux
Thermal Sensors

Solar irradiance sensor (pyranometer) calibration services, all brands, for PV system asset management

System performance monitoring nowadays requires regular pyranometer calibration

Solar radiation measurement is a cornerstone of the Performance Ratio (PR) measurement of a PV power plant. It also is the weakest link. This is why according to the latest (2017) version of the IEC 61724-1 you must perform regular pyranometer calibration. This requires sending instruments to a lab. Our worldwide calibration and servicing organisation is at your disposal.

Figure 1 *Cover of the recent update of the IEC 61724-1 standard - for PV system performance monitoring published in February 2017*

Introduction

In utility scale PV system performance monitoring the solar irradiance is nowadays measured with pyranometers. The PR calculation essentially takes the system's electrical output and divides it by irradiance. The PR is a key performance indicator of the PV system performance. Accurate day to day and year to year PR records increase the PV system value.

The IEC 61724-1 standard update

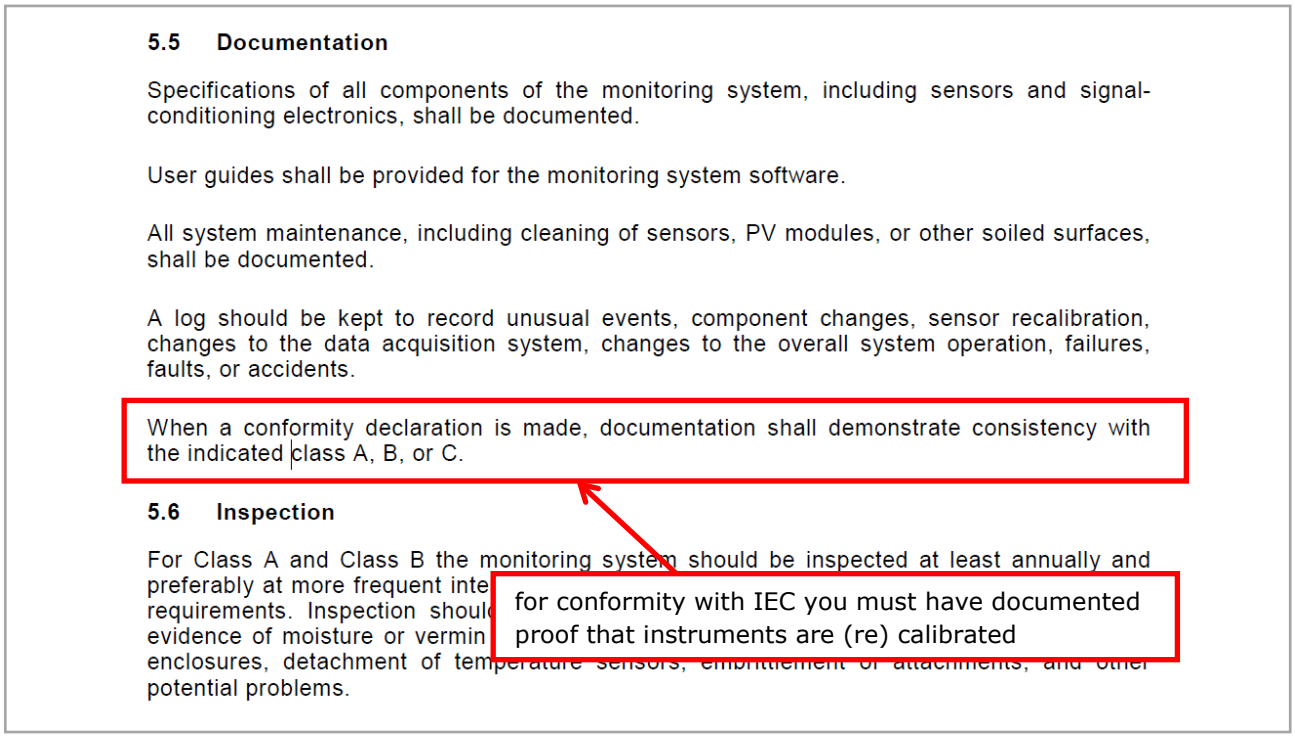
The first edition of IEC 61724-1: *Photovoltaic system performance monitoring – Guidelines for measurement, data exchange and analysis –*, dates from 2008. The updated 2017 version of the standard is fundamentally different from the 2008 version. The new scope not only defines the measuring system components and procedures (as in the 2008 version), but it also aims to keep measurement errors within specified limits.
In the new standard regular recalibration of pyranometers is a requirement.

Why calibration?

Regular calibration is part of quality management for all "mission critical" measuring instruments. Its purpose is verification that the measurement instrument is stable; and if not to correct for this. Pyranometers, due to prolonged exposure to the sun, are not perfectly stable; to attain the high accuracy necessary to monitor PV system performance and degradation you must frequently recalibrate pyranometers.

How often?

Most instrument owners use a calibration interval of 1 year for all their instruments. With pyranometers, the manufacturer's recommendation is 2 years; it is too costly to calibrate every year. IEC recommends either to work with a 1-year interval or to follow the manufacturer's recommendation (see Figures 2 and 3). The consensus is that a calibration interval of more than 2 years involves a significant risk. Most utility scale PV power plants employ multiple pyranometers. They may send 50 % away for calibration in year one, and the other 50 % in year two.



5.5 Documentation

Specifications of all components of the monitoring system, including sensors and signal-conditioning electronics, shall be documented.

User guides shall be provided for the monitoring system software.

All system maintenance, including cleaning of sensors, PV modules, or other soiled surfaces, shall be documented.

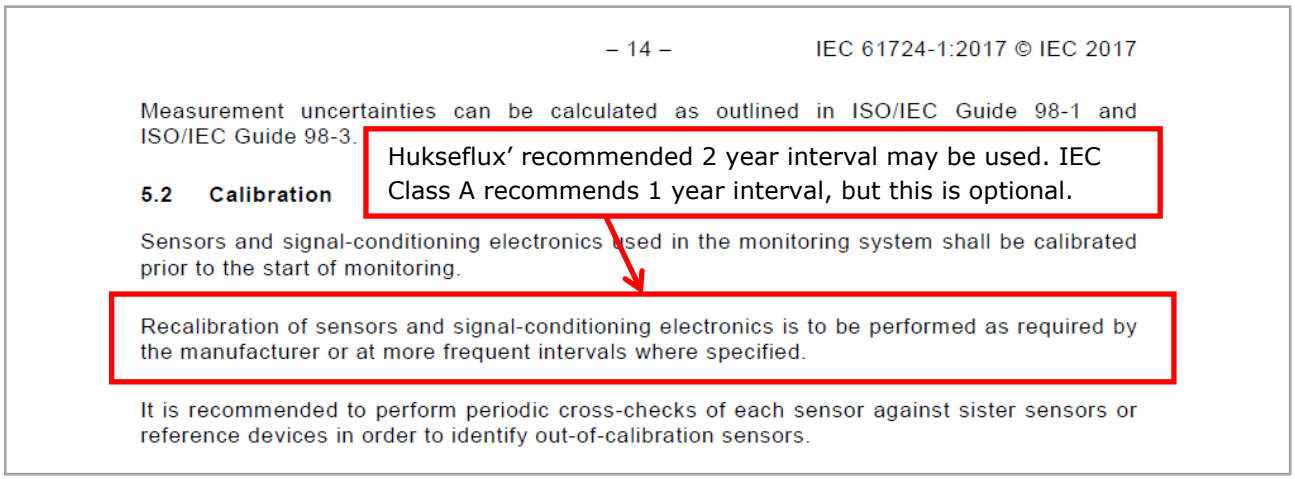
A log should be kept to record unusual events, component changes, sensor recalibration, changes to the data acquisition system, changes to the overall system operation, failures, faults, or accidents.

When a conformity declaration is made, documentation shall demonstrate consistency with the indicated class A, B, or C.

5.6 Inspection

For Class A and Class B the monitoring system should be inspected at least annually and preferably at more frequent inte requirements. Inspection shoul evidence of moisture or vermin enclosures, detachment of temperature sensors, embrittlement of attachments, and other potential problems.

Figure 2 *Text from IEC 61724-1; for IEC 61724 conformity declarations you need documented proof of calibration of instruments*



Measurement uncertainties can be calculated as outlined in ISO/IEC Guide 98-1 and ISO/IEC Guide 98-3.

5.2 Calibration

Sensors and signal-conditioning electronics used in the monitoring system shall be calibrated prior to the start of monitoring.

Recalibration of sensors and signal-conditioning electronics is to be performed as required by the manufacturer or at more frequent intervals where specified.

It is recommended to perform periodic cross-checks of each sensor against sister sensors or reference devices in order to identify out-of-calibration sensors.

Figure 3 *Text from IEC 61724-1; you may use the manufacturer's recommendation, and not follow the IEC recommendation of a 1 year interval. There is consensus that an interval of larger than 2 years involves too much risk.*

Why not on-site?

Pyranometer calibration equipment is costly, bulky and vulnerable; not easy to transport.
Also on-site availability of the natural sun is not sufficiently reliable to use for calibration. Even if the sun shines it may not be sufficiently stable, or at angles that are too close to the horizon.
In practice, high-accuracy solar calibrations are nowadays done at specialised laboratories.
More details why you must send instruments to a laboratory.

Hukseflux

We are a leading manufacturer, both in technology and market share, of solar radiation sensors. We calibrate pyranometers of all commonly used brands. We can work more efficiently if you supply us your sensors in batches of 3 or more instruments. You may then benefit from our quantity discounts.

Figure 4 *A typical calibration system at the specialised laboratory of Hukseflux. We have 7 such systems around the globe*

Why work with us

- well established and traceable calibration methods
- fast turnaround times
- quantity discounts
- calibration references for the most common brands and models
- Hukseflux has calibration facilities in the main global economies: USA, EU, China, India, Japan and Brazil
- added service at added cost: temporary replacement instruments available

Figure 5 *Pyranometer and pyrheliometer users are supported by the worldwide Hukseflux calibration and servicing organisation*

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Calibration certificate

Pages: 4
Release date: 01-02-2016

Product code	**SR20-D2**
Product identification	**serial number DEMO**
Product type	pyranometer
Measurand	hemispherical solar radiation
Classification	secondary standard (ISO 9060), high quality (WMO-No. 8)
Calibration result	
Sensitivity	**S = 11.88 x 10^{-6} V/(W/m^2)**
Calibration uncertainty	**± 0.12 x 10^{-6} V/(W/m^2)**
	the number following the ± symbol is the expanded uncertainty with a coverage factor k = 2, and defines an interval estimated to have a level of confidence of 95 percent
Reference conditions	20 °C, normal incidence solar radiation, horizontal mounting, irradiance level 1000 W/m^2
Measurement process	
Metrological characteristic	S in [V/(W/m^2)]: sensitivity to irradiance in the 300 to 3000 x 10^{-9} m range, with 180° field of view angle, valid for reference conditions
Calibration method	indoor calibration according to ISO 9847, type IIc
Measurement equipment	Hukseflux Solar Radiation Calibration
Uncertainty of the method	the expanded uncertainty is ± 0.5 %
Metrological traceability	
Calibration traceability	to WRR (World Radiometric Reference)
Calibration hierarchy	from WRR through ISO 9846 and ISO 9847, applying a correction (see below) to reference conditions (see above)
Working standard	pyranometer type SR20, serial number 2171
Calibration institute	PMOD World Radiation Center, Davos, Switzerland
Standard sensitivity	17.58 x 10^{-6} V/(W/m^2)
Uncertainty of standard	± 0.4 % expanded uncertainty with a coverage factor of 1.96
Correction(s) applied	+0.4 % (to reference conditions)
Uncertainty of correction	based on experience the expanded uncertainty is ± 0.75 %
Evaluation of the uncertainty of the calibration result	
Uncertainty calculation	the uncertainty is calculated as the square root of the sum of the squares of the reported uncertainties $\sqrt{(0.5)^2 + (0.4)^2 + (0.75)^2} = 1.0$ %

Person performing calibration: W. Crezee
Date: 28-01-2016

SR20-D2 product certificate page 2/4

Example

Figure 6 *Example of a calibration certificate with each sensor documenting traceability and uncertainty evaluation*

More about compliance of pyranometers with the new IEC classification

Hukseflux is specialised in solar radiation measurement. A separate memo offers comments on consequences of the new standard concerning the selection of pyranometers.

Where can I order the IEC standard?

The standard can be purchased from *the* IEC Webshop.

Most popular pyranometer recalibration services

Table 1 *Hukseflux' most popular calibration services*

MOST COMMON CALIBRATION SERVICES			
calibration item	**brand and model**	**calibration method**	**comment**
Pyranometers	Hukseflux LP, SR series Kipp & Zonen CMP, SMP series	ISO 9847:1992 Solar energy - Calibration of field pyranometers by comparison to a reference pyranometer ISO 9847 is also applied to pyrheliometers ASTM G207 - 11 Standard Test Method for Indoor Transfer of Calibration from Reference to Field Pyranometers	

Figure 7 *Accurate calibration of all major brands*

About Hukseflux

Hukseflux Thermal Sensors offers measurement solutions for the most challenging applications. We design and supply sensors as well as test & measuring systems, and offer related services such as calibration, engineering and consultancy. Our main area of expertise is measurement of heat transfer and thermal quantities such as solar radiation, heat flux and thermal conductivity. Hukseflux is ISO 9001 certified. Hukseflux sensors, systems and services are offered worldwide via our office in Delft, the Netherlands and local distributors.

Would you like more information?
E-mail us at: info@hukseflux.com