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 the latest versions of the IEC 61724-1 (2017 and 2021) require regular pyranometer calibration. This means sending instruments to a lab. Our worldwide calibration and servicing organisation is at your disposal.

Figure 1 *Cover of the new IEC 61724-1 standard, published in July 2021.*

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 also 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 and 2021 versions of the standard are 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 to verify that the measurement instrument has been and will be stable and, if not, to correct for this. Pyranometers, due to prolonged exposure to the sun, are not expected to be perfectly stable. To attain the high accuracy necessary and to monitor PV system performance and degradation, you must frequently recalibrate pyranometers. Before calibration, the laboratory performing the calibration will also assess the condition of the pyranometer dome. If needed, desiccant is replaced.

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.

4 Monitoring system classification

This document defines two classifications of monitoring system, Class A and Class B.

Class A is intended for large PV systems such as utility-scale or large commercial installations.

Class B is intended for smaller systems such as rooftop or small to medium-size commercial installations.

Users of the document may specify whichever classification is most appropriate to their application, regardless of PV system size.

The monitoring system classification shall be stated in any conformity declarations to this document.

Figure 2 *Text from IEC 61724-1:2021. For IEC 61724 conformity declarations you need documented proof of calibration of instruments.*

8.2.4 Recalibration

Recalibration of sensors shall be conducted in a manner that minimizes downtime and sensor outages in order to prevent interruption of monitoring. Effective methods may include:

- Exchanging installed sensors with new or recalibrated units
- Performing on-site recalibration of sensors where possible
- Providing redundant sensors and alternating laboratory recalibration schedules.

For Class A systems, sensors shall be recalibrated once every 2 years, or more frequently per manufacturer recommendations.

For Class B systems, recalibrate sensors according to manufacturer recommendations.

Figure 3 *Text from IEC 61724-1: 2021. There is consensus that an interval of larger than 2 years involves too much risk.*

Table 4 – Irradiance sensor requirements

Sensor type	Class A system	Class B system
Pyranometer	Front side (POA and GHI):	Class C or better per ISO 9060:2018
	Class A per ISO 9060:2018, Spectrally flat	Calibration uncertainty ≤ 3 % at 1 000 $W \cdot m^{-2}$
	Calibration uncertainty ≤ 2 % at 1 000 $W \cdot m^{-2}$	Range up to 1 500 $W \cdot m^{-2}$
	Range up to 1 500 $W \cdot m^{-2}$	Resolution ≤ 1 $W \cdot m^{-2}$
	Resolution ≤ 1 $W \cdot m^{-2}$	

Figure 4 *Text from IEC 61724-1; 2021. Calibration uncertainty of 2 % is required.*

Hukseflux
Thermal Sensors

What level of accuracy?

IEC 61724-1 requires uncertainties of calibration; expanded measurement uncertainties with a coverage factor k of 2.

- Class A: 2 %
- Class B: 3 %

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, outdoor pyranometer calibration will not attain the 2 % uncertainty level required for Class A PV system performance measurement. In some cases, the 3 % requirement of Class B systems will be attained, but this is generally considered insufficient for utility scale PV power plants. High-accuracy solar calibrations are nowadays done at specialised laboratories. More details on 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 with your sensors in batches of 3 or more instruments. You may then benefit from our quantity discounts.

Most popular pyranometer calibration services

Table 1 *Hukseflux' most popular calibration services.*

MOST COMMON CALIBRATION SERVICES	
BRAND AND MODEL	CALIBRATION METHOD
Hukseflux SR series Kipp & Zonen CMP, SMP series	ISO 9847:2023 Solar energy - Calibration of pyranometers by comparison to a reference pyranometer Indoor calibration type A1.

Figure 5 *A typical calibration system at the specialised laboratory of Hukseflux. We have 8 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, Singapore, Australia and Brazil
- added service at added cost: temporary replacement instruments available

Figure 6 *Pyranometer and pyrheliometer users are supported by the worldwide Hukseflux calibration and servicing organisation.*

Hukseflux Thermal Sensors

Hukseflux Thermal Sensors B.V.
Delftechpark 31
2628 XJ Delft, the Netherlands
www.hukseflux.com
info@hukseflux.com

Calibration certificate

ISO/IEC 17025 accredited

Pages 1
Release date: 02 NOV, 2023

Product code	**SR30-M2-D1**
Product identification	**serial number DEMO**
Product type	pyranometer
Measurand	hemispherical solar radiation
Calibration result	
Sensitivity	$S = (9.86 \pm 0.10) \times 10^{-6}$ V/(W/m²)
	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/m²
Measurement process	
Metrological characteristic	S in [V/(W/m²)]: sensitivity to irradiance in the (300 to 3000) × 10^{-9} m range, with 180 ° field of view angle, valid for reference conditions
Calibration method	Hukseflux Solar Radiation Calibration, ISO 9847:2023 type A1
Calibration conditions	Ambient air temperature (23.5 ± 1.5) °C, normal incidence solar radiation, horizontal mounting, irradiance level (283.2 ± 2.7) W/m²
Location	Delft, The Netherlands
Metrological traceability	
Calibration traceability	to WRR (World Radiometric Reference)
Calibration hierarchy	from WRR through ISO 9846 and ISO 9847
Calibration equipment	SRC02 20012: traceable to international standards for pyranometer output and ambient air temperature
Working standard	pyranometer type SR30-M2-D1, serial number 10841, calibrated at PMOD World Radiation Center, Davos, Switzerland
Evaluation of the uncertainty of the calibration result	
Uncertainty calculation	the calibration uncertainty has been determined in accordance with EA-4/02 as the square root of the sum of the squares of the calibration uncertainty of the working standard, the uncertainty of the method and the uncertainty due to deviations from the reference conditions.

Person performing calibration: N. Aktuğ — **Calibration Date:** 31 OCT, 2023

Person authorising calibration result of product: M. Rietveld — **Date:** 02 NOV, 2023

Certificate identification: 202311.SR30-M2-D1.DEMO.01
This calibration has been performed conform ISO/IEC 17025 under accreditation registration number K179.
The calibration result relates only to the calibrated product.
This certificate shall not be reproduced except in full, without written permission of Hukseflux Thermal Sensors B.V. page 1/1

Figure 7 *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 the 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 web shop.

Figure 8 *Accurate calibration of all major brands.*

About Hukseflux

Hukseflux is the leading expert in measurement of energy transfer. We design and manufacture sensors and measuring systems that support the energy transition. We are market leaders in solar radiation and heat flux measurement.
Customers are served through our headquarters in the Netherlands, and locally owned representative sales offices in the USA, Brazil, India, China, Southeast Asia and Japan.

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