Hukseflux
Thermal Sensors

Hukseflux pyranometer selection guide

Next level instruments in every class at the most attractive price level

Hukseflux offers a wide range of solutions for measurement of solar radiation. This brochure offers you general guidelines for selection of the right instrument. The application of pyranometers in PV system performance monitoring according to IEC 61724-1 is highlighted as an example. Sensors specific for diffuse radiation and meteorological networks are also addressed in this selection guide.

Figure 1 *SR30 pyranometers, our most popular solution for PV system performance monitoring according to IEC 61724-1 class A*

Figure 2 *Example of a Hukseflux pyranometer: SR25 secondary standard pyranometer with sapphire outer dome. This model is recommended for research grade diffuse radiation measurement. Output is either analogue millivolt or digital via Modbus RTU over RS-485 and analogue 4-20 mA (current loop).*

The right instrument for the application

Choosing the right instrument for your application is not an easy task. We can offer assistance. But first, you should ask yourself the following questions:

- are there standards for my application?
- what level of accuracy do I need?
- what will be the instrument maintenance level?
- what are the interfacing possibilities?

When discussing with Hukseflux, our recommendation for the best suited pyranometer will be based on:

- recommended pyranometer class
- recommended maintenance level
- estimate of the measurement accuracy
- recommended calibration policy
- recommended interface

Accuracy improvement by a factor 2

Pyranometers are subject to classification according to ISO 9060:2018. The 3 classes are:

- spectrally flat Class A
- spectrally flat Class B
- spectrally flat Class C

From Class C to Class B and from Class B to Class A, the achievable accuracy improves by a factor 2. (see Figure 3)

Hukseflux pyranometers

Measurand	hemispherical solar radiation
ISO 9060 classification	spectrally flat Class A, B and C
Options	analogue and / or digital output; with Recirculating Ventilation and Heating (RVH ™), sapphire outer dome, or use with VU01 ventilation unit; cable length; heaters and internal temperature sensors; various mounting and levelling fixtures

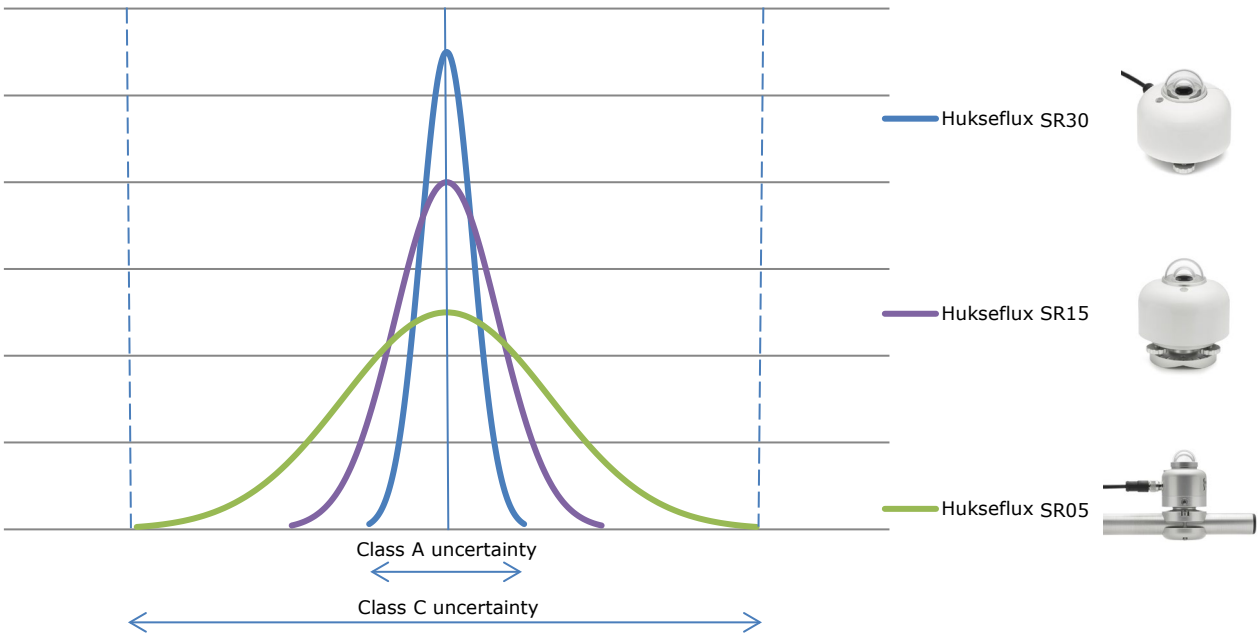

Figure 3 *A visual impression of measurement uncertainty for well maintained instruments of different ISO 9060:2018 pyranometer classes. From Class C to Class B and from Class B to Class A, the achievable accuracy improves by a factor 2.*

Hukseflux pyranometer benefits

Hukseflux is a leading manufacturer, both in technology and market share, of pyranometers. We offer you the best measurement accuracy in every class. In more detail, superior instrument design allows us to claim:

- the best calibration uncertainty
- lowest "zero offset a"
- best data availability, using the heated and ventilated SR30

Whatever your application is: Hukseflux offers the highest accuracy in every class at the most attractive price level.

Compliant with IEC, Class A and B

IEC 61724-1: Photovoltaic System Performance Monitoring - Guidelines for Measurement, Data Exchange and Analysis - requires ventilation and heating for Class A monitoring. Only SR30 offers both, without the need for additional accessories. No other manufacturer offers a pyranometer complying with class A in its standard configuration. Only Hukseflux's SR30 does. Alternatively, you may consider SR20 pyranometer with an external VU01 ventilation unit. SR15-A1 and –D1, ISO 9060 Class B models equipped with a heater, comply with IEC 61724-1 Class B. Most competing pyranometers do not even comply with Class B, which requires heating. A general summary of the IEC standard can be found in a quick explanation of IEC 61724-1:2017: what's new? A separate memo offers comments on consequences of the new standard concerning the selection of pyranometers.

Asset management of large scale PV

Asset managers of industrial and utility-scale PV power plants prefer digital secondary standard pyranometers. The reasons why:

- better stability than cells used in PV systems
- easy implementation and servicing
- no need to separately calibrate pyranometers and amplifiers
- remote diagnostics of the sensor condition

Asset managers monitor for various reasons. Apart from monitoring as a tool to assess day-to-day performance, they are interested to have documented proof of performance in case of warranty claims, when negotiating (re-) financing and when selling the asset. For monitoring the plant performance, the irradiance sensor must be more stable than the cells used in the PV system. This is only the case with secondary standard instruments, offering a stability of < 0.5 %/yr compared to a typical > 1% /yr PV cell degradation.

High data availability: use SR30

High data availability is attained by heating of the outer dome using ventilation between the inner and outer dome. RVH™ - Recirculating

Ventilation and Heating - technology, developed by Hukseflux, suppresses dew and frost deposition and is as effective as traditional ventilation systems, without the maintenance hassle and large footprint.

- low power consumption: SR30 requires only 2 W, compared to 10 W for traditional ventilation systems
- low maintenance: SR30 does not require filter cleaning

Figure 3 *Frost and dew deposition: clear difference between a non-heated pyranometer (back) and SR30 with RVH™ technology (front)*

The dome of SR30 pyranometer is heated by ventilating the area between the inner and outer dome. RVH™ is much more efficient than traditional ventilation, where most of the heat is carried away with the ventilation air. Recirculating ventilation is as effective in suppressing dew and frost deposition at 2 W as traditional ventilation is at 10 W. RVH™ technology also leads to a reduction of zero offsets.

Diffuse radiation: use SR25

Diffuse solar radiation is usually measured using shaded pyranometers. The dominant measurement error is the zero offset a. SR25, equipped with a high thermal conductivity sapphire dome, has very low offsets. SR25 outperforms the quartz dome instruments, traditionally used for this purpose, at a much lower cost level. SR25 has been tested at NREL National Renewable Energy Laboratories of Golden, Colorado, USA, and has been adopted by NREL as one of its diffuse radiation reference sensors.

National networks

In WMO-No. 8, Guide to Meteorological Instruments and Methods of Observation, WMO recommends use of first class or "good quality" pyranometers such as our model SR12 for network operation. Modern networks often use one level higher: secondary standard; such as our model SR30.

Sensors made by Hukseflux passed validation and acceptance testing for a large number of National Meteorological Networks:

- India: Centre for Wind Energy Technology (CWET), solar resource assessment network
- USA: National Ecological Observatory Network (NEON), meteorological observation network
- UK: Centre for Ecology & Hydrology (CEH), measurement / monitoring network
- India: India Meteorological Department (IMD), national measurement network
- Japan: Japan Meteorological Agency (JMA), national measurement network
- China: China Meteorological Administration (CMA), national measurement network, sensors supplied through a technology transfer project.
- Ecuador: National Meteorological and Hydrological Institute (INAMHI), national measurement network

NOTE: the fact that a sensor is tested or used in a network does not constitute a formal endorsement by the test institute or network owner.

Need for recalibration

In case you require a first class pyranometer, but wish to avoid a 2-yearly recalibration, use a higher class instrument: secondary standard. Our SR30 secondary standard pyranometer offers better stability and therefore can work within first class limits at a lower recalibration interval.
Our calibration services include traceable calibration of pyranometers of the most common brands, pyrheliometers and heat flux sensors.
Ask for Hukseflux calibration services.

Influence of instrument cleaning

The performance of high class instruments strongly depends on cleaning. At a low maintenance level, the achievable accuracy will not be reliably attained. You may then consider

using multiple instruments. The use of redundant instruments allows remote checks of one instrument using the other as a reference, which leads to a higher measurement reliability.
For lower class instruments, the relative loss of accuracy at a low maintenance level is less significant. At low maintenance intervals, although this is not formally complying with the IEC, ASTM and ISO standards, use of multiple low class instruments is a good alternative to using a single high class instrument.

Table 1 gives an overview of pyranometers and the most common considerations for choosing a particular one.

Table 1 *The most common considerations when choosing a pyranometer for PV system performance monitoring application*

					
	SR30	SR20 with VU01 unit	SR15	SR05	SR25
ISO 9060:2018 classification	Spectrally flat Class A	Spectrally flat Class A	Spectrally flat Class B	Spectrally flat Class C	Spectrally flat Class A
ISO 9060:1990 classification	Secondary standard	Secondary standard	First class	Second class	Secondary standard
PV system performance monitoring IEC 61724-1 compliance	Class A	Class A	Class B*	Class C	Class B
Heating to improve data availability	++++	++++	++*	-	++++
Ventilation	+++	++++	-	-	-
National meteorological networks	+++++	++++	++++	-	-
Agro-meteorological networks	+	+	++	++++	-
Remote diagnostics (including tilt and humidity sensor)	++++	-	-	-	-
Diffuse radiation reference	+++	-	-	-	+++++
Low relative loss of accuracy at a low cleaning interval	+	+	++	+++++	+

** Models SR15-A1 and SR15-D1*

Interfacing

We can assist you in optimising the interfacing of the pyranometer to the data collection platform at the measurement site. Solutions vary from using a datalogger as a local collection point for several different sensors to the use of transmitters incorporated in the pyranometer. Ideal for networks and the solar PV industry is SR30. SR30's output is digital and the sensor communicates using the industry standard Modbus RTU protocol over 2-wire RS-485.

Hukseflux
Thermal Sensors

Uncertainty evaluation

ASTM International has released the G213-17 "Standard Guide for Evaluating Uncertainty in Calibration and Field Measurements of Broadband Irradiance with Pyranometers and Pyrheliometers". It provides guidance and recommended practices for evaluating uncertainties when calibrating and performing outdoor measurements with pyranometers and pyrheliometers. In conformity declarations, providers can now refer to this standard. The ASTM standard follows the ISO procedure for evaluating uncertainty; the Guide to the Expression of Uncertainty in Measurement (GUM) JCGM 100:2008. Consider also reading Comments by Hukseflux on ASTM G213-7.

See also

Hukseflux offers a complete range of pyranometers. Take a look at all solar radiation sensors, accessories and related services on our website www.hukseflux.com.

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 engineering and consultancy. With our laboratory facilities, we provide testing services including material characterisation and calibration. 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.

Need for support in your selection process?
E-mail us at: info@hukseflux.com

SR30 PYRANOMETER
Next level digital secondary standard pyranometer

SR15 PYRANOMETER SERIES
First class pyranometers with various outputs

SR05 PYRANOMETER SERIES
Second class pyranometers with various outputs

SR25 PYRANOMETER
Secondary standard pyranometer with sapphire outer dome

SR20 PYRANOMETER
Secondary standard pyranometer

VU01 VENTILATION UNIT
Ventilation unit for SR20

SRA20 ALBEDOMETER
Secondary standard albedometer

PMF01
Pyranometer mounting fixture PoA