Solenergi – Kalibrering af pyranometre sammenlignet med et referencepyranometer

Solar energy – Calibration of pyranometers by comparison to a reference pyranometer

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Contents

Page

Foreword ... **v**

Introduction ... **vi**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms and definitions ... **1**

4 Pyranometer calibration ... **4**
4.1 General ... 4
4.2 Pyranometer sensitivity, measurement equation, measurand ... 4
4.3 Indoor and outdoor calibration compared ... 6
4.4 Method validation ... 6
4.5 Calibration uncertainty ... 6

5 Measuring equipment ... **7**
5.1 Data acquisition and recording ... 7
5.2 Instrument platforms ... 8
5.3 Pyranometers ... 8

6 Indoor calibration (Type A) ... **8**
6.1 Introductory remarks on indoor calibration ... 8
6.2 Reference pyranometers for indoor calibration ... 8
6.3 Indoor calibration systems ... 9
6.3.1 System with a direct beam source (type A1) ... 9
6.3.2 Systems with an integrating sphere source (type A2) ... 9
6.4 Indoor calibration procedures ... 9
6.4.1 Calibration procedure requirements (types A1 and A2) ... 9
6.4.2 Indoor calibration procedures (types A1 and A2) ... 9
6.4.3 Calculation of the sensitivity ... 10
6.4.4 Calibration conditions and optional correction of reference operating conditions ... 11
6.4.5 Uncertainty evaluation ... 11

7 Outdoor calibration (Type B) ... **12**
7.1 Introductory remarks on outdoor calibration ... 12
7.2 Reference pyranometers for outdoor calibration ... 12
7.3 Outdoor calibration systems ... 12
7.3.1 Site selection for outdoor calibration ... 12
7.3.2 Tracking for normal incidence calibration (type B3) ... 13
7.4 Outdoor calibration procedures ... 13
7.4.1 Calibration procedure requirements (B1, B2, B3) ... 13
7.4.2 Outdoor horizontal calibration procedure (type B1) ... 13
7.4.3 Outdoor tilted calibration procedure (type B2) ... 14
7.4.4 Outdoor normal incidence calibration procedure (type B3) ... 15
7.4.5 Calculation of the sensitivity ... 15
7.4.6 Calibration conditions and optional correction of reference operating conditions ... 16
7.4.7 Uncertainty evaluation ... 16

8 Calibration certificate ... **17**

Annex A (informative) **Examples of calibration systems using artificial sources** ... **18**

Annex B (informative) **Calculation of daily average zenith angle** ... **22**

Annex C (informative) **Introduction of a new pyranometer sensitivity** ... **24**

Annex D (informative) **Data quality review for outdoor calibration** ... **26**

Annex E (informative) **Uncertainty evaluation for outdoor calibration** ... **29**

Annex F (informative) **Uncertainty evaluation for indoor calibration** **30**
Bibliography **31**

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 180, *Solar energy*, Subcommittee SC 1, *Climate – Measurement and data*.

This second edition cancels and replaces the first edition (ISO 9847:1992) which has been technically revised.

The main changes are as follows:

— focus on current calibration practices;

— adapted recommendations for mathematical treatment of data;

— adaptation of the terminology to the revised ISO 9060:2018 and ISO Guide 99[1];

— added comments on uncertainty evaluation of the calibration with reference to ASTM G213[2] and ISO/IEC Guide 98-3;

— inclusion of reference to non-spectrally-flat pyranometers, that are now also included in ISO 9060.

Annexes A, B, C, D, E and F are given for information only.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Pyranometers are instruments used to measure the irradiance (power per unit area) received from the sun for many purposes.

In recent years the application of hemispherical solar radiation measurement, using pyranometers, has risen sharply. The main application of pyranometers now is no longer scientific research, but assessment of the performance of solar power plants.

Accurate measurements of the hemispherical solar radiation are required for

a) the determination of the energy input to solar energy systems such as photovoltaic (PV) -, and solar thermal systems, as a basis for performance assessment,

b) the testing and assessment of solar technologies,

c) the geographic mapping of solar energy resources, and

d) other applications such as agriculture, building efficiency, material degradation and reliability, climate, weather, health, etc.

Today's growing solar energy performance assessment markets demand the lowest possible measurement uncertainties. To meet this demand, a measurement requires an uncertainty evaluation and an accurate time stamp[3].

Calibration of measuring instruments is an essential part of the uncertainty evaluation and part of any quality management system. Regular instrument re-calibration according to this standard helps attaining the required low measurement uncertainties. Calibration usually will show the instrument is stable and then serves as:

— confirmation that the measurement data collected over the time interval from the previous to the present calibration are reliable

— the instrument is expected to remain stable, future measurement data are expected to be reliable.

Uncertainties mentioned in this document are expanded uncertainties with a coverage factor $k = 2$.

Solar energy — Calibration of pyranometers by comparison to a reference pyranometer

1 Scope

This document specifies two preferred methods for the calibration of pyranometers using reference pyranometers; indoor (Type A) and outdoor (Type B).

Indoor or type A calibration, is performed against a lamp source, while the outdoor method B, employs natural solar radiation as the source.

Indoor calibration is performed either at normal incidence (type A1), the receiver surface perpendicular to the beam of the lamp or under exposure to a uniform diffuse lamp source using an integrating sphere (type A2).

Outdoor calibration is performed using the sun as a source, with the pyranometer in a horizontal position (type B1), in a tilted position (type B2), or at normal incidence (type B3).

Calibrations according to the specified methods will be traceable to SI, through the world radiometric reference (WRR), provided that traceable reference instruments are used.

This document is applicable to most types of pyranometers regardless of the type technology employed. The methods have been validated for pyranometers that comply with the requirements for classes A, B and C of ISO 9060. In general, all pyranometers may be calibrated by using the described methods, provided that a proper uncertainty evaluation is performed.

Unlike spectrally flat pyranometers, non-spectrally flat pyranometers might have a spectral response that varies strongly with the wavelength even within the spectral range from 300 to 1 500 nm, and therefore the calibration result may possibly be valid under a more limited range of conditions.

The result of a calibration is an instrument sensitivity accompanied by an uncertainty. This document offers suggestions for uncertainty evaluation in the annexes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9060, *Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*