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Responsible committee: GEL/82 Photovoltaic Energy Systems

Interested committees:

Title: BS EN IEC 61853-2 Photovoltaic (PV) module performance testing and energy rating

Part 2: Spectral responsivity, incidence angle and module operating temperature measurements

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

PROJECT NUMBER: IEC 61853-2 ED2	
DATE OF CIRCULATION: 2023-07-07	CLOSING DATE FOR COMMENTS: 2023-09-01
SUPERSEDES DOCUMENTS: 82/2158/RR	

IEC TC 82 : SOLAR PHOTOVOLTAIC ENERGY SYSTEMS	
SECRETARIAT: United States of America	SECRETARY: Mr George Kelly
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☒ QUALITY ASSURANCE ☐ SAFETY	

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE: Photovoltaic (PV) module performance testing and energy rating – Part 2: Spectral responsivity, incidence angle and module operating temperature measurements
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NOTE FROM TC/SC OFFICERS: This project was discussed and supported by WG2 during their meeting in 2023-03.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PHOTOVOLTAIC (PV) MODULE
PERFORMANCE TESTING AND ENERGY RATING****Part 2: Spectral responsivity, incidence angle and nominal module operating
temperature measurements****FOREWORD**

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IEC 61853 has been prepared by WG2: Modules, non-concentrating, of IEC technical committee 82: Solar photovoltaic energy systems. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016-09. This edition constitutes a technical revision. **This CD includes a significant technical revision of clause 7 and 9 only; the revision of clause 8 is still under discussion in the project team and will be circulated after having cleared the comments of clause 7 and 9 in a following CD stage.**

This edition includes the following significant technical changes with respect to the previous edition:

- a) New clause 3 “Terms and definitions” was added, including the definition of “NMOT” (clause 3.1) and “open-rack” (clause 3.2) ;
- b) A new procedure for data filtering was added to clause 9 “Methodology for determining coefficients for calculating the Nominal Module Operating Temperature (NMOT)”;
- c) Annex A and Annex B (both informative) were added, to clarify the procedure for described in clause 9;
- d) The term “calibration” was removed from the list in clause 6, as this term is inappropriate since this standard does not describe procedures for calibration;
- e) The wording of pre and post tests in clauses 4 and 5 was aligned to the last edition of IEC 61215.

The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Photovoltaic (PV) modules are typically rated at standard test conditions (STC) of 25°C cell temperature, 1 000 W/m² total irradiance, and air mass (AM) 1.5 global (G) spectrum. However, the PV modules in the field operate over a range of temperatures, total and spectral irradiances, and incidence angles. To predict the energy production of the modules more accurately under various field conditions, it is necessary to characterize the modules at a wide range of temperatures, irradiances, angles of incidence, and spectra.

Recognizing this issue, IEC Technical Committee 82 Working Group 2 (TC 82/WG 2) has developed an appropriate power and energy rating standard (IEC 61853). The first part of this four-part standard requires the generation of a 23-element maximum power (P_{max}) matrix at four different temperatures and seven different irradiance levels. The P_{max} matrix can be generated using an indoor solar simulator method or outdoor natural sunlight method.

This standard consists of four parts:

- IEC 61853-1: Irradiance and temperature performance measurements and power rating, which describes requirements for evaluating PV module performance in terms of power (watts) rating over a range of irradiances and temperatures;
- IEC 61853-2: Spectral responsivity, incidence angle, and module operating temperature measurements, which describes test procedures for measuring the effect of varying angle of incidence and sunlight spectra as well as the estimation of module temperature from irradiance, ambient temperature, and wind speed;
- IEC 61853-3: Energy rating of PV modules, which describes the calculations for PV module energy (watt-hours) ratings; and
- IEC 61853-4: Standard reference climatic profiles, which describes the standard time periods and weather conditions that can be used for the energy rating calculations.

Included in the IEC 61853 series of standards are: test methods designed to map module performance over a wide range of temperature and irradiance conditions (IEC 61853-1); test methods to determine spectral responsivity, incidence angle effects and the module operating temperature all as functions of ambient conditions (IEC 61853-2); methods for evaluating instantaneous and integrated power and energy results including a method for stating these results in the form of a numerical rating (IEC 61853-3); and definition of reference irradiance and climatic profiles (IEC 61853-4).

IEC 61853-1 describes requirements for evaluating PV module performance in terms of power (watts) rating over a range of irradiances and temperatures. IEC 61853-2 describes procedures for measuring the performance effect of angle of incidence, the estimation of module temperature from irradiance, ambient temperature and wind speed, and impact of spectral responsivity on module performance. IEC 61853-3 describes the calculations of PV module energy (watt-hours) ratings. IEC 61853-4 describes the standard time periods and weather conditions that can be utilized for calculating energy ratings.

IEC published the first part of the standard in January 2011. This standard specifies the performance measurements of PV modules at 23 different sets of temperature and irradiance conditions, using either a solar simulator (indoor) or natural sunlight (outdoor). There are many possible indoor and outdoor techniques, and this standard allows several of them. Validation of these techniques for repeatability over time within the same laboratory and for reproducibility among multiple laboratories is extremely important for the successful implementation of this standard.

PHOTOVOLTAIC (PV) MODULE PERFORMANCE TESTING AND ENERGY RATING

Part 2: Spectral responsivity, incidence angle and module operating temperature measurements

1 Scope

The IEC 61853 series establishes IEC requirements for evaluating PV module performance based on power (watts), energy (watt-hours) and performance ratio (PR). It is written to be applicable to all PV technologies, but may not work well for any technology where the module performance changes with time (e.g. modules change their behaviour with light or thermal exposure), or which experience significant non-linearities in any of their characteristics used for the modelling.

The purpose of this part of IEC 61853 is to define measurement procedures for measuring the effects of angle of incidence of the irradiance on the output power of the device, to determine the operating temperature of a module for a given set of ambient and mounting conditions and measure spectral responsivity of the module. A second purpose is to provide a characteristic set of parameters which will be useful for detailed energy predictions. The described measurements are required as inputs into the module energy rating procedure described in IEC 61853-3.

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 2859-1, *Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

IEC 60891, *Photovoltaic devices – Procedures for temperature and irradiance corrections to measured I-V characteristics*

IEC 60904-1, *Photovoltaic devices – Part 1: Measurement of photovoltaic current-voltage characteristics*

IEC 60904-2, *Photovoltaic devices – Part 2: Requirements for photovoltaic reference devices*

IEC 60904-5, *Photovoltaic devices – Part 5: Determination of equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-circuit voltage method*

IEC 60904-8, *Photovoltaic devices – Part 8: Measurement of spectral responsivity of a photovoltaic (PV) device*

IEC 60904-9, *Photovoltaic devices – Part 9: Solar simulator performance requirements*

IEC 60904-10, *Photovoltaic devices – Part 10: Methods of linearity measurement*

IEC 61215-1, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval*

88 IEC 61215-1-X (all parts), *Terrestrial photovoltaic (PV) modules – Design qualification and type*
89 *approval*

90 IEC 61215-2, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval –*
91 *Part 2: Test procedures*

92 IEC 61853-1, *Photovoltaic (PV) module performance testing and energy rating – Part 1:*
93 *Irradiance and temperature performance measurements and power rating*

94 ISO 9059, *Solar energy – Calibration of field pyrheliometers by comparison to a reference*
95 *pyrheliometer*

96 **3 Terms and definitions**

97 For the purposes of this document, the terms and definitions given in IEC TS 61836 and the
98 following apply.

99 ISO and IEC maintain terminology databases for use in standardization at the following
100 addresses:

- 101 • IEC Electropedia: available at <https://www.electropedia.org/>
- 102 • ISO Online browsing platform: available at <https://www.iso.org/obp>

103 **3.1** 104 **nominal module operating temperature**

105 NMOT
106 equilibrium mean solar cell junction temperature within an open-rack mounted module
107 operating near peak power in the following standard reference environment:

- 108 • Tilt angle: $(37 \pm 5)^\circ$;
- 109 • Total irradiance: 800 W/m²;
- 110 • Ambient temperature: 20 °C;
- 111 • Wind speed: 1 m/s;
- 112 • Electrical load: A resistive load sized such that the module will operate near its
113 maximum power point at STC or an electronic MPPT.

114 Note 1 to entry: Unit °C

115 **3.2** 116 **open-rack**

117 Type of mounting structure that allows air to circulate freely around the module.

118

119 **4 Sampling**

120 For performance qualification testing, three modules shall be selected at random from a
121 production batch or batches in accordance with the procedure given in ISO 2859-1. The
122 modules shall be initially stabilised in accordance with clause 5 of this standard to assure the
123 stability of the power values. One module (or equivalent reference sample) shall be used for
124 each of the three tests, angle of incidence, spectral responsivity and thermal performance. A