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Photovoltaic (PV) module performance testing and energy rating - Part 2: Spectral responsivity, incidence angle and module operating temperature measurements

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Photovoltaic (PV) module performance testing and energy rating – Part 2: Spectral responsivity, incidence angle and module operating temperature measurements

Essais de performance et caractéristiques assignées d'énergie des modules photovoltaïques (PV) – Partie 2: Mesurages de réponse spectrale, d'angle d'incidence et de température de fonctionnement des modules

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

FOREWORD

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International Standard IEC 61853-2 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this standard is based on the following documents:

FDIS	Report on voting
82/1133/FDIS	82/1156/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61853 series, published under the general title *Photovoltaic (PV) module performance testing and energy rating*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication 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- withdrawn,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 $W \cdot m^{-2}$ irradiance, and air mass (AM) 1.5 global (G) spectrum. However, the PV modules in the field operate over a range of temperatures, irradiance, and spectra. To accurately predict the energy production of the modules 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. The outdoor test method introduces little/no spectral mismatch error and is much less expensive than the indoor test method because it avoids the use of very expensive solar simulators. However, obtaining an accurate and repeatable P_{max} matrix using the outdoor method over time (several months or years) would be extremely challenging.

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[1]: *Energy rating of PV modules*, which describes the calculations for PV module energy (watt-hours) ratings; and
- IEC 61853-4[2]: *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.

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1 Under preparation: Stage at the time of publication: IEC/ACDV 61853-3:2016.

2 Under preparation: Stage at the time of publication: IEC/ACDV 61853-4:2016.

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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60410[3], *Sampling plans and procedures for inspection by attributes*

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*

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3 Withdrawn.

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

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

IEC 61646, *Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61853-1:2011, *Photovoltaic (PV) module performance testing and energy rating – Part 1: Irradiance and temperature performance measurements and power rating*

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