भारतीय मानक
Indian Standard

IS 16170 (Part 3) : 2022
IEC 61853-3 : 2018

फोटोवोल्टिक (पीवी) मॉड्यूल प्रदर्शन परीक्षण और ऊर्जा रेटिंग

भाग 3 पीवी मॉड्यूल की ऊर्जा रेटिंग

(पहला पुनरीक्षण)

Photovoltaic (PV) Module Performance Testing and Energy Rating

Part 3 Energy Rating of PV Modules

(First Revision)

ICS 27.160

भारतीय मानक ब्यूरो
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Solar Photovoltaic Energy Systems Sectional Committee, ETD 28

NATIONAL FOREWORD

This Indian Standard which is identical with IEC 61853-3:2018 "Photovoltaic (PV) module performance testing and energy rating – Part 3: Energy rating of PV modules" issued by the International Electrotechnical Commission (IEC) will be adopted by the Bureau of Indian Standards on recommendation of the Solar Photovoltaic Energy Systems and approval of the Electrotechnical Division Council.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminologies and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective places, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60891 Photovoltaic devices — Procedures for temperature and irradiance corrections to measured I-V characteristics	IS 12763 : 2013 Photovoltaic devices — Procedures for temperature and irradiance corrections to measured I-V characteristics (*First Revision*)	Identical with IEC 60891 : 2009
IEC 60904-3 Photovoltaic devices — Part 3 : Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data	IS 12762 (Part 3) : 2020 Photovoltaic Devices Part 3 Measurement Principles for Terrestrial Photovoltaic PV Solar Devices with Reference Spectral Irradiance Data (*Third Revision*)	Identical with IEC 60904-3 : 2019
IEC 60904 -7 Photovoltaic devices — Part 7 : Computation of the spectral mismatch correction for measurements of photovoltaic devices	IS 12762 (Part 7) : 2013 Photovoltaic devices Part 7 Computation of the spectral mismatch correction for measurements of photovoltaic devices	Identical with IEC 60904-7 : 2008
IEC 60904-8 Photovoltaic devices — Part 8: Measurement of spectral Responsivity of a photovoltaic (PV) device	IS 12762 (Part 8) : 2018 Photovoltaic Devices Part 8 Measurement of Spectral Responsivity of a Photovoltaic (PV) Device (*First Revision*)	Identical with IEC 60904-8 : 2014
IEC 60904-8-1 Photovoltaic devices Part 8 - 1 : Measurement of spectral responsivity of multi-junction photovoltaic (PV) devices	IS 12762 (Part 8/Sec 1) : 2020 - Photovoltaic Devices Part 8 Measurement of Spectral Responsivity of a Photovoltaic (PV) Device Section 1 Multi-junction (PV) devices	Identical with IEC 60904-8-1 : 2017

IEC TS 61836 Solar photovoltaic energy systems — Terms, definitions and symbols	IS 12834 : 2013 Solar Photovoltaic Energy Systems –Terms, Definitions And Symbols (*First Revision*)	Identical with IEC TS 61836 : 2007
IEC 61853-1 Photovoltaic (PV) module performance testing and energy rating — Part 1: Irradiance and temperature performance measurements and power rating	IS 16170 (Part 1) : 2014 Photovoltaic (PV) Module Performance Testing and Energy Rating Part 1 Irradiance and Temperature Performance Measurements and Power Rating	Identical with IEC 61853-1 : 2011
IEC 61853-2 Photovoltaic (PV) module performance testing and energy rating — Part 2 : Spectral responsivity, incidence angle and module operating temperature measurements	IS 16170 (Part 2) : 2018 Photovoltaic (PV) Module Performance Testing and Energy Rating: Part 2 Spectral Responsivity, Incidence Angle and Module Operating Temperature Measurements	Identical with IEC 61853-2 : 2016
IEC 61853-4 Photovoltaic (PV) module performance testing and energy rating — Part 4: Standard reference climatic profiles	IS 16170 (Part 4) : 2022 Photovoltaic (PV) Module Performance Testing and Energy Rating — Part 4: Standard reference climatic Profiles	Identical with IEC 61853-4 : 2018

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding of numerical values (second *revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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PHOTOVOLTAIC (PV) MODULE PERFORMANCE TESTING AND ENERGY RATING –

Part 3: Energy rating of PV modules

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61853-3 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

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

FDIS	Report on voting
82/1441/FDIS	82/1451/RVD

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

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

A list of all parts in the IEC 61853, 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 document will remain unchanged until the stability date indicated on the IEC website under "http://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

This International Standard series establishes IEC requirements for determining PV module performance in terms of power (watts), specific module energy rating (kWh/kW) and climatic specific energy rating (dimensionless). It is written to be applicable to all PV technologies including non-linear devices. The methodology does not take into account either progressive degradation or transient behaviour such as light induced changes and/or thermal annealing.

This series consists of four parts:

- IEC 61853-1: *Photovoltaic (PV) module performance testing and energy rating – Part 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: *Photovoltaic (PV) module performance testing and energy rating – Part 2: Spectral responsivity, incidence angle, and module operating temperature measurements*, which describes test procedures for measuring the effect of varying angles of incidence and sunlight spectra as well as the estimation of module temperature from irradiance, ambient temperature, and wind speed;
- IEC 61853-3*: Photovoltaic (PV) module performance testing and energy rating – Part 3: Energy rating of PV modules*, which describes the calculations for PV module ratings; and
- IEC 61853-4: *Photovoltaic (PV) module performance testing and energy rating – Part 4: Standard reference climatic profiles*, which describes the standard time periods and environmental data set that shall be used for the energy rating calculations.

Indian Standard

PHOTOVOLTAIC (PV) MODULE PERFORMANCE TESTING AND ENERGY RATING

PART 3 ENERGY RATING OF PV MODULES

1 Scope

This part of IEC 61853 describes the calculation of PV module energy rating values. IEC 61853-1 describes requirements for evaluating PV module performance at various temperatures and irradiances in terms of power (watts) rating. IEC 61853-2 describes test procedures for determining module temperature from irradiance, ambient temperature and wind speed, a method for measuring angle of incidence effects, and spectral responsivity. IEC 61853-4 describes the standard reference climatic profiles (standard environmental data sets) that are used for calculating energy rating values.

The purpose of this document is to define a methodology to determine the PV module energy output (watt-hours), and the climatic specific energy rating (dimensionless) for a complete year at maximum power operation for the reference climatic profile(s) given in IEC 61853-4. It is applied to determine a specific module output in a standard reference climatic profile for the purposes of comparison of rated modules.

The methodology does not take into account either progressive degradation or transient behaviour such as light induced changes and/or thermal annealing.

The present document applies to mono-facial modules.

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.

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

IEC 60904-3, *Photovoltaic devices – Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data*

IEC 60904-7, *Photovoltaic devices – Part 7: Computation of the spectral mismatch correction for measurements of photovoltaic devices*

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

IEC 60904-8-1, *Photovoltaic devices – Part 8-1: Measurement of spectral responsivity of multi-junction photovoltaic (PV) devices*

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols*

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

IEC 61853-2, *Photovoltaic (PV) module performance testing and energy rating – Part 2: Spectral responsivity, incidence angle and module operating temperature measurements*

IEC 61853-4, *Photovoltaic (PV) module performance testing and energy rating – Part 4: Standard reference climatic profiles*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
climatic specific energy rating
CSER
normalised energy collection for the reference climatic profile, i.e. the ratio of the actual energy collection to that which would have been obtained if the PV module always performed with the energy conversion efficiency measured under standard test conditions

Note 1 to entry: CSER is dimensionless.

4 Testing

No testing is performed within this document; however, the energy rating calculations defined in Clause 7 use data from measurements made according to IEC 61853-1 and IEC 61853-2 and the standard reference climatic profiles from IEC 61853-4.

5 Report

Following completion of the procedure, a report with the resulting energy ratings shall be prepared by the test agency. Each certificate or test report shall include at least the following information.

a) a title;
b) name and address of the test laboratory and location where the calibration or tests were carried out;
c) unique identification of the report and of each page;
d) name and address of client, where appropriate;
e) description and identification of the item calibrated or tested;
f) characterization and condition of the calibration or test item;
g) date of receipt of test item and date(s) of calibration or test, where appropriate;
h) identification of calibration or test method used;
i) reference to sampling procedure, where relevant;
j) any deviations from, additions to or exclusions from the calibration or test method, and any other information relevant to a specific calibration or test, such as environmental conditions;
k) the filenames of the reference climate data files and the version of IEC 61853-4 corresponding to the data files;

l) a specification of the interpolation routines used to derive the module data from the measured performance tables;

m) module energy output for the individual test devices, as well as the averaged data (for the three modules submitted for testing in IEC 61853-1);

n) climatic specific energy rating for the individual test devices, as well as the averaged data (for the three modules submitted for testing in IEC 61853-1);

o) a statement of the estimated uncertainty of the energy rating results;

p) a signature and title, or equivalent identification of the person(s) accepting responsibility for the content of the report, and the date of issue;

q) where relevant, a statement to the effect that the results relate only to the items calibrated or tested;

r) a statement that the report shall not be reproduced except in full, without the written approval of the laboratory.

6 Module energy collection

6.1 General

The output power of a PV module depends primarily on the following parameters:

- Irradiance incident on the module
- Module temperature

Module temperature is a derived parameter, and is determined from the tabulated irradiance, ambient temperature and wind speed, together with module thermal parameters as determined in IEC 61853-2.

These parameters are a function of the environmental conditions over the defined year long time period of each standard reference climatic profile, tabulated as an hourly data set in IEC 61853-4. Angle of incidence and spectral effects are considered in the calculations for reasons of completeness, and to ensure that modules with special characteristics are rated correctly.

6.2 Input module data for energy rating

The following module performance parameters influence the instantaneous power output and hence energy production of a PV module:

a) Matrix of P_{max} versus irradiance (at AM 1,5 g) and versus module temperature (IEC 61853-1) which may be interpolated to obtain the instantaneous power at a given irradiance and module temperature.

b) Thermal coefficients u_0, u_1 describing module operating temperature as a function of irradiance and wind speed, which are used to calculate instantaneous module temperature (IEC 61853-2).

c) Angle of incidence response a_{r} (IEC 61853-2) used to calculate the effective light transmission into the module at different incidence angles.

d) Spectral responsivity (IEC 61853-2), used to calculate spectral mismatch and hence correct to reference spectral conditions. It is provided as a table of values for a range of wavelengths over which the module is responsive.

The performance parameters listed in a) are measured by procedures given in IEC 61853-1. The performance parameters listed in items b), c) and d) are determined according to procedures given in IEC 61853-2. In accordance with procedures in IEC 61853-2, in some cases the parameters in points b), c) may be nominal values provided therein.

6.3 Input standard reference climatic profiles

IEC 61853-4 provides the standard reference climatic profiles to be used for energy rating. The information provided with each standard reference climatic profile is described in IEC 61853-4:2018, subclause 4.2.

7 Procedure for energy rating

7.1 General

For each of the three modules and for the average of the values of the three modules reported from IEC 61853-1 the following procedure shall be followed. The module peak power and energy output for a particular time step is determined by following a series of calculations described in this clause. The module energy output is calculated per hour. These individual hourly energy values are then summed over the data set to determine the annual energy production.

The procedures for each time step are outlined in Figure 1.

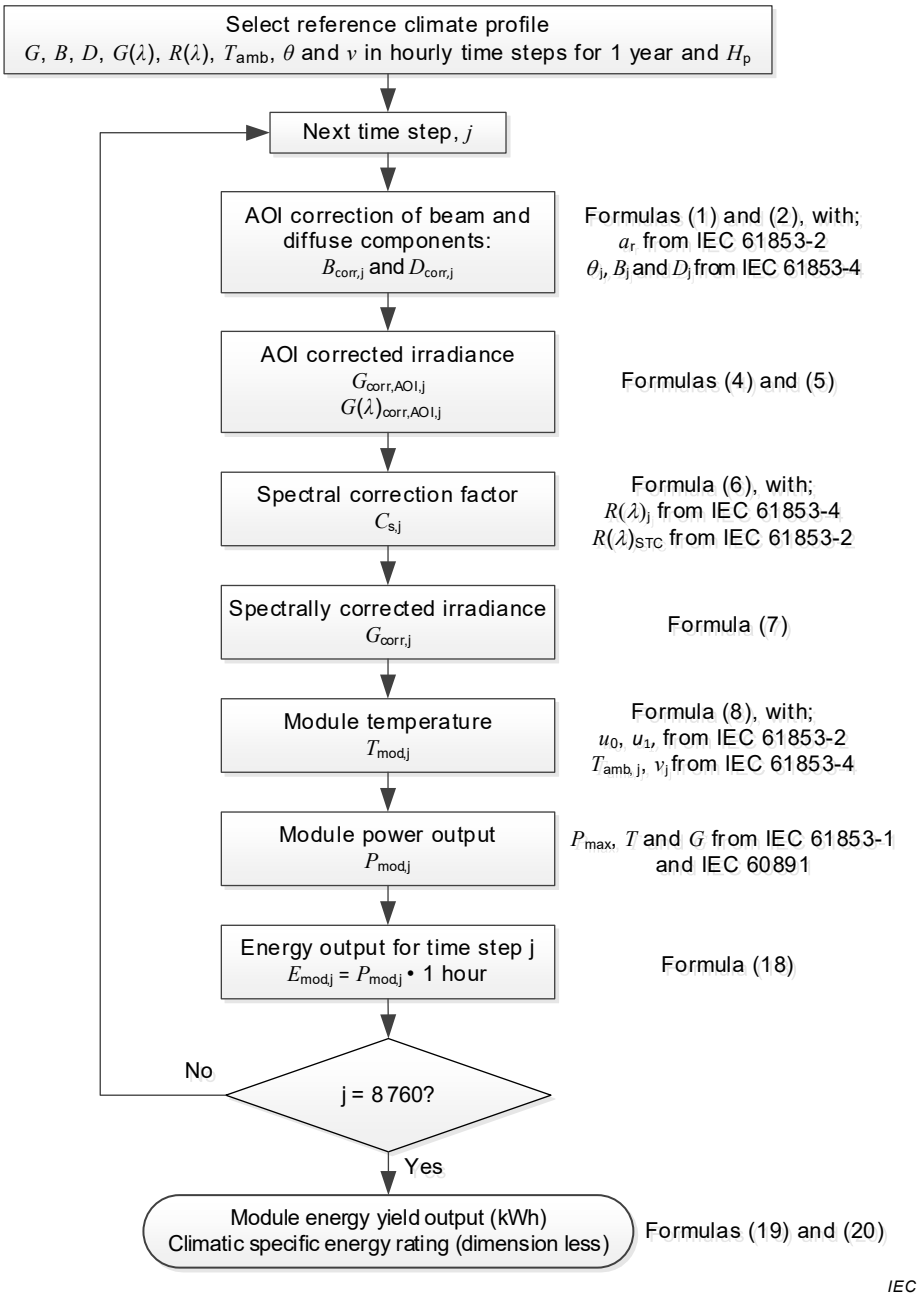

Figure 1 – Flow chart of calculation procedure

7.2 In-plane global irradiance corrected for angular incidence effects

The corrected in-plane direct B_{corr} and diffuse D_{corr} components for angle of incidence are given by:

$$B_{\text{corr,j}} = B_{\text{j}} \left[\frac{1-\exp(-\frac{\cos(\theta_j)}{a_{\text{r}}})}{1-\exp(-\frac{1}{a_{\text{r}}})} \right] \tag{1}$$

$$D_{\text{corr,j}} = D_{\text{j}} \left\{ 1 - exp\left[-\frac{1}{a_{\text{r}}} \left(\frac{4}{3\pi} \left(\sin\beta + \frac{\pi-\beta-\sin\beta}{1+\cos\beta} \right) + (0{,}5a_{\text{r}} - 0{,}154) \left(\sin\beta + \frac{\pi-\beta-\sin\beta}{1+\cos\beta} \right)^2 \right) \right] \right\} \tag{2}$$

where

B_{j} is the uncorrected in-plane direct irradiance at the j$^{\text{th}}$ hour,

D_{j} is the uncorrected in-plane diffuse irradiance at the j$^{\text{th}}$ hour,

θ_j is the angle between sun and the normal to the module surface at hour j,

β is the inclination angle (in units of radians) of the module relative to horizontal, and

factor a_r is provided by the analysis of the angle-of-incidence measurements, as carried out in IEC 61853-2.

D_j is not given directly in the data sets but can be calculated from the global in-plane irradiance G_j and the direct in-plane irradiance B_j:

$$D_j = G_j - B_j \tag{3}$$

Finally, the angular corrected in-plane global irradiance $G_{\text{corr,AOI,j}}$ can be calculated as:

$$G_{\text{corr,AOI,j}} = B_{\text{corr,j}} + D_{\text{corr,j}} \tag{4}$$

The climatic data sets contain the in-plane global and direct broadband irradiance and the spectrally resolved in-plane global irradiance for a set of discrete bands but not the direct or diffuse spectrally resolved irradiance. To calculate the angular corrected in-plane spectrally resolved global irradiance, the following formula shall be applied:

$$G(\lambda)_{\text{corr,AOI,j}} = \frac{G_{\text{corr,AOI,j}} \cdot G(\lambda)_j}{G_j} \tag{5}$$

where

$G_{\text{corr,AOI,j}}$ is the angular corrected broadband in-plane irradiance for the jth hour, and

$G(\lambda)_j$ is the in-plane global spectral irradiance in discrete bands at hour j.

7.3 Spectrally corrected global in-plane irradiance

Normally the spectral correction is applied to the short-circuit current according to IEC 60904-7. The change in short-circuit current when applying a different spectrum can be used to apply a proportional change to the irradiance, obtaining an “effective” or “corrected” irradiance, G_{corr}.

The module spectral responsivity $S(\lambda)$ measured for different wavelengths λ as prescribed in IEC 61853-2 and IEC 60904-8 is used. The spectral correction factor C_s at hour j can then be calculated as:

$$C_{s,j} = \frac{1000 \int_{\lambda_s}^{\lambda_e} S(\lambda) R_{\text{corr,AOI,j}}(\lambda) d\lambda}{G_{\text{corr,AOI,j}} \int_{\lambda_s}^{\lambda_e} S(\lambda) R_{STC}(\lambda) d\lambda} \tag{6}$$

where

$G_{\text{corr,AOI,j}}$ is the AOI-corrected global in-plane irradiance,

$R_{\text{corr,AOI,j}}(\lambda)$ is the spectrally resolved in-plane irradiance in W/(m^2·nm) and calculated as the ratio of the $G(\lambda)_{\text{corr,AOI,j}}$ and the width of each spectral band, in nm,

$R_{\text{STC}}(\lambda)$ is the corresponding spectral intensity for the standard test condition spectrum AM 1,5 g (IEC 60904-3).

The integration limits are: λ_s = 300 nm, λ_e = 4 000 nm and the calculation is performed by numerical integration. The spectrally corrected global in-plane irradiance at the j hour, $G_{\text{corr,j}}$, is calculated as:

$$G_{\text{corr,j}} = C_{s,j} \cdot G_{\text{corr,AOI,j}} \tag{7}$$

For multi-junction PV modules the spectral correction may only be made when the same junction is limiting under both the reference and the hourly spectral irradiances (refer to IEC 60904-8-1).

7.4 Calculation of module temperature

The module temperature T_{mod} shall be calculated using the following formula:

$$T_{\text{mod,j}} = T_{\text{amb,j}} + \frac{G_{\text{corr,AOI,j}}}{u_0 + u_1 v_j} \tag{8}$$

where

T_{amb} is the ambient temperature, extracted from IEC 61853-4,

v_{j} is the wind speed at the height of the module, extracted from IEC 61853-4, and

$G_{\text{corr,AOI,j}}$ is the in-plane global irradiance, corrected for angle-of-incidence effects, for the j$^{\text{th}}$ hour,

the two parameters u_0 and u_1 are reported from the procedure described in IEC 61853-2.

7.5 Determination of instantaneous module power

The calculated parameters from formulas (7) and (8) (G_{corr} and T_{mod}) can now be used to determine the module power $P_{\text{mod}}(G_{\text{corr}},T_{\text{mod}})$ by using the power table (P_{max}) generated from IEC 61853-1. In general, it is necessary to perform a 2-D bilinear interpolation, or equivalent, of the P_{max} values given in the table at different temperature and irradiance conditions. When the values of G_{corr} and T_{mod} are outside the range of values in the power table a linear extrapolation should be used.

To calculate the module power $P(G,T)$ for given values of in-plane irradiance G and module temperature T by bilinear interpolation the following procedure should be used. Find the values T_1 and T_2 in the power table such that $T_1 < T < T_2$, and similar G_1 and G_2 such that $G_1 < G < G_2$.

For each of the pairs of (G,T) values calculate the quantity $\eta(G,T) = P(G,T)/G$. Then calculate:

$$\eta(G,T_1) = \eta(G_1,T_1) + \frac{G-G_1}{G_2-G_1}\left(\eta(G_2,T_1) - \eta(G_1,T_1)\right) \tag{9}$$

$$\eta(G,T_2) = \eta(G_1,T_2) + \frac{G-G_1}{G_2-G_1}\left(\eta(G_2,T_2) - \eta(G_1,T_2)\right) \tag{10}$$

$$\eta(G,T) = \frac{T_2-T}{T_2-T_1}\eta(G,T_1) + \frac{T-T_1}{T_2-T_1}\eta(G,T_2) \tag{11}$$

The interpolated power can then be found as $P(G,T) = \eta(G,T)\cdot G$.

Linear extrapolation when only one of the variables G,T is outside the range of the power table values can be found in the following way, where T_{max} is the highest temperature value in the table:

$$\eta(G,T_{max}) = \eta(G_1,T_{max}) + \frac{G-G_1}{G_2-G_1}\left(\eta(G_2,T_{max}) - \eta(G_1,T_{max})\right) \tag{12}$$

$$\eta(G,T_{max-1}) = \eta(G_1,T_{max-1}) + \frac{G-G_1}{G_2-G_1}\left(\eta(G_2,T_{max-1}) - \eta(G_1,T_{max-1})\right) \tag{13}$$

$$\eta(G,T) = \eta(G,T_{max-1}) + \frac{T-T_{max-1}}{T_{max}-T_{max-1}}\left(\eta(G,T_{max}) - \eta(G,T_{max-1})\right) \quad (14)$$

Finally, if G > G_{max} and T > T_{max}:

$$\eta(G,T_{max}) = \eta(G_{max-1},T_{max}) + \frac{G-G_{max-1}}{G_{max}-G_{max-1}}\left(\eta(G_{max},T_{max}) - \eta(G_{max-1},T_{max})\right) \quad (15)$$

$$\eta(G_{max},T) = \eta(G_{max},T_{max-1}) + \frac{T-T_{max-1}}{T_{max}-T_{max-1}}\left(\eta(G_{max},T_{max}) - \eta(G_{max},T_{max-1})\right) \quad (16)$$

$$\eta(G,T) = \eta(G,T_{max}) + \eta(G_{max},T) - \eta(G_{max},T_{max}) \quad (17)$$

7.6 Calculation of hourly module energy output

The energy output $E_{\text{mod,j}}$ of the module in the time period j (1 h) is:

$$E_{\text{mod,j}} = P_{\text{mod,j}}\,(G_{corr,j}, T_{mod,j}) \cdot 1\ hour \quad (18)$$

7.7 Calculation of annual module energy output

The energy produced by the module over one year is determined as the sum of the energy produced by the module at each time period.

A sum is performed over all time periods of the selected reference profile (see IEC 61853-4).

$$E_{\text{mod,year}} = \sum_{j=1}^{j=8760} E_{\text{mod,j}} \quad (19)$$

where

j ranges from 1 to 8 760 in the reference period (one year).

7.8 Climatic specific energy rating

The climatic specific energy rating $CSER$ is the normalised energy collection for the reference climatic profile:

$$CSER = \frac{E_{mod,year}\cdot G_{\text{ref}}}{P_{\text{max,STC}}\cdot H_p} \quad (20)$$

where

H_{p} is the total of the hourly global in-plane irradiance values G for the reference climatic period (1 year) from IEC 61853-4,

G_{ref} = 1 000 W/m^2 is the irradiance at standard test conditions,

$P_{\text{max,STC}}$ is the maximum power under standard test conditions, taken from the power measurements according to IEC 61853-1.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: ETD 28 (18549).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

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