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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements

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TERRESTRIAL PHOTOVOLTAIC (PV) MODULES – DESIGN QUALIFICATION AND TYPE APPROVAL –

Part 1: Test requirements

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61215-1:2016. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61215-1 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This second edition of IEC 61215-1 cancels and replaces the first edition of IEC 61215-1, published in 2016; it constitutes a technical revision.

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

a) Addition of a test taken from IEC TS 62782.
b) Addition of a test taken from IEC TS 62804-1.
c) Addition of test methods required for flexible modules. This includes the addition of the bending test (MQT 22).
d) Addition of definitions, references and instructions on how to perform the IEC 61215 design qualification and type approval on bifacial PV modules.
e) Clarification of the requirements related to power output measurements.
f) Addition of weights to junction box during 200 thermal cycles.
g) Requirement that retesting be performed according to IEC TS 62915.
h) Removal of the nominal module operating test (NMOT), and associated test of performance at NMOT, from the IEC 61215 series.

Informative Annex A explains the background and reasoning behind some of the more substantial changes that were made in the IEC 61215 series in progressing from edition 1 to edition 2.

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

FDIS	Report on voting
82/1828A/FDIS	82/1848/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 61215 series, published under the general title *Terrestrial photovoltaic (PV) modules – Design qualification and type approval*, 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.

The contents of the corrigendum of May 2021 have been included in this copy.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Whereas Part 1 of this standards series describes requirements (both in general and specific with respect to device technology), the sub-parts of Part 1 define technology variations and Part 2 defines a set of test procedures necessary for design qualification and type approval. The test procedures described in Part 2 are valid for all device technologies.

TERRESTRIAL PHOTOVOLTAIC (PV) MODULES – DESIGN QUALIFICATION AND TYPE APPROVAL –

Part 1: Test requirements

1 Scope ~~and object~~

~~This part of IEC 61215 lays down IEC requirements for the design qualification and type approval of terrestrial photovoltaic (PV) modules suitable for long-term operation in general open-air climates, as defined in IEC 60721-2-1.~~

This document lays down requirements for the design qualification of terrestrial photovoltaic modules suitable for long-term operation in open-air climates. The useful service life of modules so qualified will depend on their design, their environment and the conditions under which they are operated. Test results are not construed as a quantitative prediction of module lifetime.

In climates where 98th percentile operating temperatures exceed 70 °C, users are recommended to consider testing to higher temperature test conditions as described in IEC TS 63126. Users desiring qualification of PV products with lesser lifetime expectations are recommended to consider testing designed for PV in consumer electronics, as described in IEC TS 63163 (under development). Users wishing to gain confidence that the characteristics tested in IEC 61215 appear consistently in a manufactured product may wish to utilize IEC 62941 regarding quality systems in PV manufacturing.

This document is intended to apply to all terrestrial flat plate module materials such as crystalline silicon module types as well as thin-film modules. It does not apply to systems that are not long-term applications, such as flexible modules installed in awnings or tenting.

This document does not apply to modules used with concentrated sunlight although it may be utilized for low concentrator modules (1 to 3 suns). For low concentration modules, all tests are performed using the irradiance, current, voltage and power levels expected at the design concentration.

This document does not address the particularities of PV modules with integrated electronics. It may however be used as a basis for testing such PV modules.

~~The objective of this test sequence is to determine the electrical and thermal characteristics of the module and to show, as far as possible within reasonable constraints of cost and time, that the module is capable of withstanding prolonged exposure in climates described in the scope. The actual lifetime expectancy of modules so qualified will depend on their design, their environment and the conditions under which they are operated.~~

The objective of this test sequence is to determine the electrical characteristics of the module and to show, as far as possible within reasonable constraints of cost and time, that the module is capable of withstanding prolonged exposure outdoors. Accelerated test conditions are empirically based on those necessary to reproduce selected observed field failures and are applied equally across module types. Acceleration factors may vary with product design, and thus not all degradation mechanisms may manifest. Further general information on accelerated test methods including definitions of terms may be found in IEC 62506.

Some long-term degradation mechanisms can only reasonably be detected via component testing, due to long times required to produce the failure and necessity of stress conditions that are expensive to produce over large areas. Component tests that have reached a

sufficient level of maturity to set pass/fail criteria with high confidence are incorporated into the IEC 61215 series via addition to Table 1. In contrast, the tests procedures described in this series, in IEC 61215-2, are performed on 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 60050 (all parts), *International Electrotechnical Vocabulary* (available at http://www.electropedia.org)~~

IEC 60269-6, *Low-voltage fuses – Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems*

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 TS 60904-1-2:2019, *Photovoltaic devices – Part 1-2: Measurement of current-voltage characteristics of bifacial photovoltaic (PV) devices*

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

IEC 60904-10, *Photovoltaic devices – Part 10: Methods of linear dependence and linearity measurements*

IEC TS 60904-13, *Photovoltaic devices – Part 13: Electroluminescence of photovoltaic modules*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

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

IEC 61730-1, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

IEC 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

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 response, incidence angle, and module operating temperature measurements*[1]~~

IEC TS 62782, *Photovoltaic (PV) modules – Cyclic (dynamic) mechanical load testing*

IEC 62790, *Junction boxes for photovoltaic modules – Safety requirements and tests*

IEC TS 62804-1, *Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Crystalline silicon*

IEC 62852, *Connectors for DC-application in photovoltaic systems – Safety requirements and tests*

IEC TS 62915, *Photovoltaic (PV) modules – Type approval, design and safety qualification – Retesting*

IEC 62941, *Terrestrial photovoltaic (PV) modules – Quality system for PV module manufacturing*

IEC TS 63163: –[2] *Terrestrial photovoltaic (PV) modules for consumer products – Design qualification and type approval*

~~ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*~~

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

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions in ~~IEC 60050 and~~ IEC TS 61836 apply, as well as the following.

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
bins of power classes
power (typically maximum power) sorting criteria from the PV module manufacturer

3.2
tolerances <on label>
value range of electrical parameters on the label of the PV module as given by the manufacturer

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~~1 To be published.~~

2 Under preparation. Stage at the time of publication: ADTS.

3.3
MQT
Module Quality Test

3.4
type approval
conformity test made on one or more items representative of the production

[SOURCE: IEC 60050-581:2008, 581-21-08 – Type test]

3.5
reproducibility <of measurements>
closeness of agreement between the results of measurements of the same value of a quantity, when the individual measurements are made under different conditions of measurement:

– principle of measurement,
– method of measurement,
– observer,
– measuring instruments,
– reference standards,
– laboratory,
– under conditions of use of the instruments, different from those customarily used,

after intervals of time relatively long compared with the duration of a single measurement. [consistent with the International Vocabulary of Metrology (VIM), 3.7]

Note 1 to entry: The concepts of "principle of measurement" and "method of measurement" are respectively defined in VIM 2.3 and 2.4.

Note 2 to entry: The term "reproducibility" also applies to the instance where only certain of the above conditions are taken into account, provided that these are stated.

Note 3 to entry: It is recommended that laboratories determine their reproducibility according to the formulas and principles in ISO 5725-2.

[SOURCE: IEC 60050-311:2001, 311-06-07]

3.6
flexible module
PV module that exhibits a radius of curvature of 500 mm or less in at least one direction according to the manufacturer's specification and is capable of bending to conform to a flat or curved surface

Note 1 to entry: A curved module with a rigid shape is not considered a flexible module.

Note 2 to entry: Radius of curvature is defined as shown in Figure 1. During testing, the applied radius of curvature is no smaller than that specified by the manufacturer.

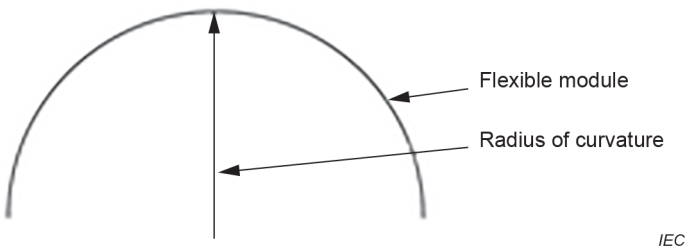

Figure 1 – Geometry that shows radius of curvature of a flexible module

3.7
representative sample
sample that includes all the components of the module, except some repeated parts

Note 1 to entry: The representative samples shall use all key materials and subassemblies, as detailed in Clause 4.

3.8
very large module
module that exceeds the size of standard 2,2 m × 1,5 m commercially-available simulators

Note 1 to entry: A very large module exceeds 2,2 m in length or width, or exceeds 1,5 m in both dimensions. Thus a 3 m × 0,3 m module is considered very large, as is a 2,2 m × 2,2 m module.

Note 2 to entry: Very large modules are exempt from class A simulator spatial irradiance uniformity requirements, as detailed in IEC 61215-2 MQT 02.

Note 3 to entry: During test sequences representative samples may be substituted for very large modules, within the limits described in Clause 4.

Note 4 to entry: In future editions, the size threshold to be considered a very large module will likely increase to larger dimensions.

3.9
bifacial PV modules
modules that can convert irradiation received on both the front-side and rear-side into electric energy by means of the photovoltaic effect

3.10
bifaciality coefficients
ratios between the *I-V* characteristics of the rear-side and the front-side of a bifacial module each measured under Standard Test Conditions (STC – IEC TS 61836), namely the short-circuit current bifaciality coefficient φ_{Isc}, the open-circuit voltage bifaciality coefficient φ_{Voc} and the maximum power bifaciality coefficient φ_{Pmax}

Note 1 to entry: Bifaciality coefficients are fully defined in IEC TS 60904-1-2:2019, 6.2.

3.11
bifacial nameplate irradiance
BNPI
higher irradiance at which nameplate verification is performed for bifacial modules, corresponding to 1 000 W/m^2 on the module front and 135 W/m^2 on the module rear, applied in any method allowed by IEC TS 60904-1-2

3.12
bifacial stress irradiance
BSI
higher irradiance at which currents for stress are measured on bifacial modules, corresponding to 1 000 W/m^2 on the module front and 300 W/m^2 on the module rear, applied by any method allowed in IEC TS 60904-1-2, *I-V* characteristic at which may be extrapolated from lower irradiances

4 Test samples

The PV module samples shall have been manufactured from specified materials and components in accordance with the relevant drawings and process sheets and have been subjected to the manufacturer's normal inspection, quality control and production acceptance procedures. The PV modules shall be complete in every detail and shall be accompanied by the manufacturer's handling, mounting, and connection instructions. When the PV modules to be tested are prototypes of a new design and not from production, this fact shall be noted in the test report (see Clause 9).

The number of test samples required is derived from the applicable test sequences (see Clause 11).

Special test samples may be required for tests such as the bypass diode test MQT 18 (see IEC 61215-2).

For qualification of multiple bins of power classes within the boundaries given in ~~future~~ IEC TS 62915 at least 2 modules each, from the lower end, median and higher end power class shall be used for testing. If median power class does not exist the next higher class shall be used. If qualification of a single power class shall be extended to further bins of power classes within the boundaries given in IEC TS 62915 then at least 2 modules each, from the lower end~~, median~~ and higher end power class shall be used for label verification (see Gate No.1 in 7.2.1). If a power class is extended only towards higher (or lower) bins, then modules only from the higher (or lower) bins, respectively, shall be used for verification of rated label values.

Qualification to multiple bins of power classes does not increase the minimum requirement of one control sample used in 7.2.3.

It is advisable to provide additional spare samples meeting the same output power requirements.

If applicable, the test samples shall be used to represent a group or family of products, or variations in the materials, or production processes used to produce the modules. The additional samples required for the test programme are then derived from IEC TS 62915.

For very large modules (as defined in 3.8), representative samples (as defined in 3.7) may be used for all qualification tests given in Clause 11 and IEC 61215-2. During the design and manufacturing of the representative samples, attention should be paid to reach the maximum similarity to the full-size product in all electrical, mechanical, and thermal characteristics related to quality and reliability. The cell, encapsulation methods, interconnects, terminations, clearance and creepage distances around all edges, and distance through solid insulation (relied upon insulation and cemented joints) shall be the same as on the actual full-size products. Limits are placed on how much one may reduce the dimensions of a very large module in making representative samples for qualification testing. The reduced dimension(s) shall be no less than one half the dimensions that define a very large module. In other words, when reducing the shorter dimension, the representative sample shall be at least 0,75 m wide. In reducing the longer dimension, the representative sample shall be at least 1,1 m long. If representative samples are used for any test, the test report shall include a table listing the dimensions of the product being qualified, and for each MQT, the dimensions of the samples tested. The table shall contain the statement, "Smaller samples were used for some tests as noted above. Use of smaller samples may affect test results." For determination of maximum power degradation during testing (7.2.3) on a representative sample, P_{max}(Lab_GateNo.1) refers to the representative sample's initial stabilized measured power output. However, for verification of rated label values (7.2.2) a standard production product shall be measured, either at the test facility or utilizing a test at the manufacturer monitored by the testing entity.

If representative samples are utilized in Sequence E, then one extra module, full-sized, is required, and shall be subjected only to MQT 16 (static mechanical load test) and the requirements therein.

Any representative sample used for MQT 09 (hot-spot endurance test) shall contain the same number of cells per bypass diode (i.e. the same substring size) as the full-size product.