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CONSOLIDATED VERSION

INTERNATIONAL STANDARD

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Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1-4: Special requirements for testing of thin-film Cu(In,GA)(S,Se)$_2$ based photovoltaic (PV) modules

Modules photovoltaïques (PV) pour applications terrestres – Qualification de la conception et homologation –
Partie 1-4: Exigences particulières d'essai des modules photovoltaïques (PV) au Cu(In,GA)(S,Se)$_2$ à couches minces

IEC 61215-1-4:2021-02+AMD1:2022-03 CSV(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Part 1-4: Special requirements for testing of thin-film Cu(In,Ga)(S,Se)$_2$ based photovoltaic (PV) modules

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IEC 61215-1-4 edition 2.1 contains the second edition (2021-02) [documents 82/1827/FDIS and 82/1852/RVD] and its amendment 1 (2022-03) [documents 82/1998/FDIS and 82/2022/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 61215-1-4 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This second edition constitutes a technical revision.

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

a) A cyclic (dynamic) mechanical load test (MQT 20) added.

b) A test for detection of potential-induced degradation (MQT 21) added.

c) A bending test (MQT 22) for flexible modules added.

Informative Annex A of 61215-1:2021 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.

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

This standard is to be read in conjunction with IEC 61215-1:2021 and IEC 61215-2:2021.

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 the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under webstore.iec.ch in the data related to the specific publication. At this date, the publication will be

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

Part 1-4: Special requirements for testing of thin-film $Cu(In,Ga)(S,Se)_2$ based photovoltaic (PV) modules

1 Scope

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 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 thin-film $Cu(In,Ga)(S,Se)_2$ based terrestrial flat plate modules. As such it addresses special requirements for testing of this technology supplementing IEC 61215-1:2021 and IEC 61215-2:2021 requirements for testing.

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.

The object 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 IEC 61215-1. In contrast, the tests procedures described in this series, in IEC 61215-2, are performed on modules.

This document defines PV technology dependent modifications to the testing procedures and requirements per IEC 61215-1:2021 and IEC 61215-2:2021.

2 Normative references

The normative references of IEC 61215-1:2021 and IEC 61215-2:2021 are applicable without modifications.

3 Terms and definitions

This clause of IEC 61215-1:2021 is applicable ~~without~~ with the following modifications.

Add the following new terms:

3.13
reduced mechanical load module
module where the test load in MQT 16 is less than 2 400 Pa

Note 1 to entry: 2 400 Pa was required in earlier versions of the IEC 61215 series for all technologies (e.g. IEC 61215-2:2021).

3.14
restricted access area
area accessible only to electrically skilled persons and electrically instructed persons with the proper authorization

EXAMPLE Utility-scale PV installations which are protected against public access by fences, location, etc., and where only persons skilled, trained or instructed in electrical safety have access.

[SOURCE: IEC 60050-195:1998, 195-04-04, modified – The example has been added]

4 Test samples

This clause of IEC 61215-1:2021 is applicable without modifications.

5 Marking and documentation

This clause of IEC 61215-1:2021 is applicable ~~without~~ with the following modifications.

5.1 Name plate

Each module shall include the following clear and indelible markings:

Add the following new items:

l) For modules with reduced mechanical load: the range of positive and negative design loads [Pa] the module manufacturer's recommended mounting configurations will allow, preceded by the phrase, "reduced mechanical design load" and followed by the phrases "Not for roof mount. For ground mounted installations with restricted access only. May only be used in systems designed by a licensed professional engineer."

EXAMPLE:
Reduced mechanical design load: ± 800 Pa.
Not for roof mount. For ground mounted installations with restricted access only. May only be used in systems designed by a licensed professional engineer.

m) For modules with reduced mechanical load: Type or model number designation shall contain a unique identification that it is used for reduced mechanical load.

EXAMPLE:
Regular mechanical load module type designation: M300W.
Reduced mechanical load module type designation: M300W-X.
Where -X can be e.g. a combination of letters or numbers.

5.2 Documentation

5.2.2 Information to be given in the documentation

Add the following new item:

r) For modules with reduced mechanical load, the documentation shall contain the following: "When PV modules are intended to be installed in an engineered scenario by qualified personnel such as in a ground mounted utility scale application with restricted access, they may be designed for lower loads. The test load may be lower than 2 400 Pa but greater than 1 200 Pa (or any load in between) with a safety factor of 1,5; corresponding to design loads of 1 600 Pa and 800 Pa (or any load in between), respectively, for the down (positive) pressures and uplift (negative) pressures. These modules may be used in array locations where the module mounting and structure in combination are designed to meet a specific design load by the installer. Alternatively, modules having a higher minimum test load compatible to the required site-specific loads may be used. The reduced load modules cannot be used on a rooftop."

NOTE Many large PV installations of today are designed, engineered, and installed by qualified experts in the electrical, mechanical and structural fields per the prevailing local codes. Designers utilize allowances in building codes to target certain locations in the array to handle higher loading than other areas. The manufacturer mounting configurations, stated design loads and test safety factors are utilized in the overall system design approach.

6 Testing

This clause of IEC 61215-1:2021 is applicable with the following modifications:

Special care has to be taken for stabilizing the power output of the module using MQT 19 procedure with specific requirements stated in 11.19 below.

7 Pass criteria

This clause of IEC 61215-1:2021 is applicable with the following modifications.

The maximum allowable value of reproducibility is set to r = 2,0 %.

The maximum allowable value of measurement uncertainty is set to m_1 = 4,0 % for modules containing single-junction cells, and m_1 = 5,0 % for modules containing multi-junction cells.

8 Major visual defects

This clause of IEC 61215-1:2021 is applicable without modifications.

9 Report

This clause of IEC 61215-1:2021 is applicable without modifications.

10 Modifications

This clause of IEC 61215-1:2021 is applicable without modifications.

11 Test flow and procedures

The test flow from IEC 61215-1:2021 is applicable with the following modifications.

Table 3 – Summary of test levels

Replace:

Test	Section in IEC 61215-2 Ed.2	Title	Test conditions
MQT 16	4.16	Static mechanical load test	Three cycles of uniform load specified by the manufacturer, applied for 1 h to front and back surfaces in turn. Minimum test load: 2 400 Pa

by:

Test	Subclause in IEC 61215-2 Ed.2	Title	Test conditions
MQT 16	4.16	Static mechanical load test	Three cycles of uniform load specified by the manufacturer, applied for 1 h to front and back surfaces in turn. Minimum test load: ≥ 1 200 Pa as defined by the manufacturer (for modules with "reduced design load" marking); 2 400 Pa (for modules without additional marking)

11.1 Visual inspection (MQT 01)

This test of IEC 61215-2:2021 is applicable without modifications.

11.2 Maximum power determination (MQT 02)

This test of IEC 61215-2:2021 is applicable without modifications.

11.3 Insulation test (MQT 03)

This test of IEC 61215-2:2021 is applicable without modifications.

11.4 Measurement of temperature coefficients (MQT 04)

This test of IEC 61215-2:2021 is applicable without modifications.

11.5 Placeholder section, formerly NMOT

This subclause of IEC 61215-2:2021 does not require technology-specific modifications.

11.6 Performance at STC (MQT 06.1)

This test of IEC 61215-2:2021 is applicable without modifications.

11.7 Performance at low irradiance (MQT 07)

This test of IEC 61215-2:2021 is applicable without modifications.

11.8 Outdoor exposure test (MQT 08)

This test of IEC 61215-2:2021 is applicable without modifications.

11.9 Hot-spot endurance test (MQT 09)

This test of IEC 61215-2:2021 is applicable with the following modifications:

$Cu(In,Ga)(S,Se)_2$ thin-film modules may exhibit performance changes with extended time in storage without light exposure (the “dark soak” effect). In order to minimize the influence of this dark soak effect, limit the time delay between the outdoor exposure or stabilization and the hot spot procedure to within 2 to 3 days. During the first hour after the hot-spot procedure is complete, no additional heating or light beyond room ambient shall be applied. If the time delay is to exceed 1 h, the modules are to be stored in the dark at ≤ 25 °C.

11.9.1 Purpose

This subclause of IEC 61215-2:2021, test MQT 09, is applicable without modifications.

11.9.2 Hot-spot effect

This subclause of IEC 61215-2:2021, test MQT 09, is applicable without modifications.

11.9.3 Classification of cell interconnection

This subclause of IEC 61215-2:2021, test MQT 09, is applicable without modifications.

11.9.4 Apparatus

This subclause of IEC 61215-2:2021, test MQT 09, is applicable without modifications.

11.9.5 Procedure

MQT 09.2 of IEC 61215-2:2021 shall be performed for any monolithically integrated (MLI) module design.

If the module is constructed by interconnection of cell-like substructures, MQT 09.1 of IEC 61215-2:2021 may be applicable.

11.9.6 Final measurements

This subclause of IEC 61215-2:2021, test MQT 09, is applicable without modifications.

11.9.7 Requirements

This subclause of IEC 61215-2:2021, test MQT 09, is applicable without modifications.

11.10 UV preconditioning test (MQT 10)

This test of IEC 61215-2:2021 is applicable without modifications.

11.11 Thermal cycling test (MQT 11)

This test of IEC 61215-2:2021 is applicable with the following modifications:

MQT 11 of IEC 61215-2:2021 can be conducted according to the following methods:

Method A) Perform MQT 11 as defined in IEC 61215-2:2021, with the technology specific current equal to 0,1 × STC peak power current. If 0,1 × STC peak power current is less than 100 mA, then 100 mA may be applied instead.

Method B) Perform MQT 11 as defined in IEC 61215-2:2021 with the following modifications:

During the thermal cycling test, set the continuous current flow during the heat up cycle to the technology specified current noted below at temperature from 0 °C to 85 °C. Maintain current flow during high temperature dwell and cool down cycle until the module temperature is below

0 °C. As necessary, adjust the chamber temperature to maintain module temperature below 85 °C.

The technology specific current which needs to be applied according to MQT11 of IEC 61215-2 shall be a forward bias current of 0,1 × STC peak power current to 0,3 × STC peak power current. If 0,1 × STC peak power current is less than 100 mA, then 100 mA may be applied instead.

The current flow applied during Method B is shown superimposed on the temperature cycle in Figure 1.

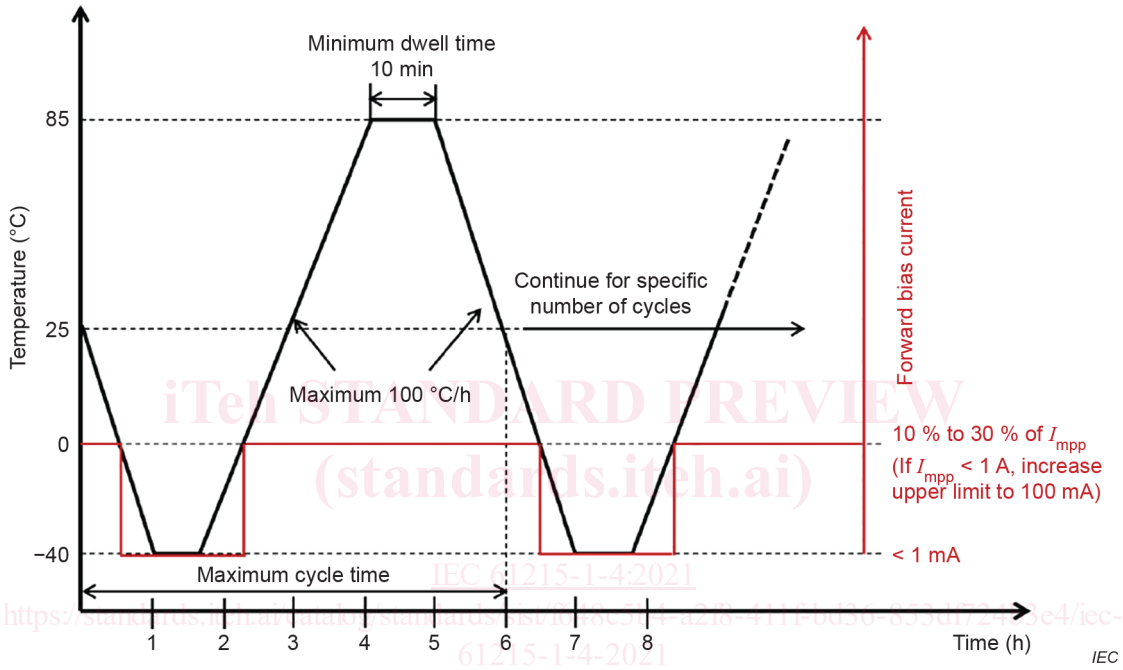

Figure 1 – Current flow using MQT 11 Method B

11.12 Humidity-freeze test (MQT 12)

This test of IEC 61215-2:2021 is applicable with the following modifications:

MQT 12 of IEC 61215-2:2021 can be conducted according to the following methods:

Method A) Perform MQT 12 as defined in IEC 61215-2:2021.

Method B) Perform MQT 12 as defined in IEC 61215-2:2021 with the following modifications:

During the humidity freeze test, set the continuous current flow during the heat up cycle to the technology specified current noted below at temperature from 0 °C to 85 °C. Maintain current flow during high temperature dwell and cool down cycle until module temperature has reached 0 °C. As necessary, adjust the chamber temperature to maintain module temperature below 85 °C.

The technology specific current which needs to be applied according to MQT12 of IEC 61215-2 in Method B shall be a forward bias current of 0,1 × STC peak power current to 0,3 × STC peak power current, with a minimum of 100 mA.

The current flow applied during Method B is shown superimposed on the humidity-freeze cycle in Figure 2.