



# UL 61215-1-1

## STANDARD FOR SAFETY

Terrestrial Photovoltaic (PV) Modules –  
Design Qualification and Type Approval  
– Part 1-1: Special Requirements for  
Testing of Crystalline Silicon  
Photovoltaic (PV) Modules

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UL Standard for Safety for Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval – Part 1-1: Special Requirements for Testing of Crystalline Silicon Photovoltaic (PV) Modules, UL 61215-1-1

Second Edition, Dated July 28, 2021

### **Summary of Topics**

***UL 61215-1-1 is an adoption of IEC 61215-1-1, Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval – Part 1-1: Special Requirements for Testing of Crystalline Silicon Photovoltaic (PV) Modules (Second Edition, issued February 2021). Please note that there are no National Differences.***

The requirements are substantially in accordance with Proposal(s) on this subject dated May 21, 2021.

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UL 61215-1-1

**Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type  
Approval – Part 1-1: Special Requirements for Testing of Crystalline Silicon  
Photovoltaic (PV) Modules**

First Edition – February, 2017

**Second Edition**

**July 28, 2021**

This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 61215-1-1 as an American National Standard (ANSI) occurred on July 7, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or Preface. The IEC Foreword is also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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## PREFACE

This UL Standard is based on IEC Publication IEC 61215-1-1: Second edition Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval – Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules. IEC publication IEC 61215-1-1 is copyrighted by the IEC.

This edition has been issued to satisfy UL Standards policy.

This UL Standard 61215-1-1 Standard for Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval – Part 1-1: Special Requirements for Testing of Crystalline Silicon Photovoltaic (PV) Modules, is to be used in conjunction with the second edition of UL 61215-1 and the second edition of UL 61215-2.

Requirements of this Standard, where stated, amend the requirements of UL 61215-1 and UL 61215-2.

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Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

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## FOREWORD

### INTERNATIONAL ELECTROTECHNICAL COMMISSION

#### **TERRESTRIAL PHOTOVOLTAIC (PV) MODULES – DESIGN QUALIFICATION AND TYPE APPROVAL – Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules**

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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9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

This second edition cancels and replaces the first edition of IEC 61215-1-1, issued in 2016, and 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.

d) A procedure for stress specific stabilization – BO LID (MQT 19.3) added.

e) A final stabilization procedure for modules undergoing PID testing added.

Informative Annex A of IEC 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.

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

FDIS	Report on voting
82/1824/FDIS	82/1849/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 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 this publication will remain unchanged until the stability date indicated on the IEC web site 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.

**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.**

# **TERRESTRIAL PHOTOVOLTAIC (PV) MODULES – DESIGN QUALIFICATION AND TYPE APPROVAL – Part 1-1: Special requirements for testing of crystalline silicon 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 98<sup>th</sup> 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 crystalline silicon terrestrial flat plate modules.

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 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 IEC 61215-1:2021. In contrast, the tests procedures described in this series, in IEC 61215-2:2021, 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, definitions and abbreviated terms

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

### 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 modifications.

### 6 Testing

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

### 7 Pass criteria

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

The maximum allowable value of reproducibility is set to  $r = 1,0 \%$ .

The maximum allowable value of measurement uncertainty is set to  $m_1 = 3,0 \%$ .

### 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.

#### 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)**

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

##### **11.9.1 Purpose**

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

##### **11.9.2 Classification of cell interconnection**

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

##### **11.9.3 Apparatus**

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

##### **11.9.4 Procedure**

MQT 09.1 shall be performed in accordance to IEC 61215-2:2021.

##### **11.9.5 Final measurements**

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

##### **11.9.6 Requirements**

The relevant 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 without modifications.

For monofacial modules, the technology specific current which needs to be applied according to test MQT 11 of IEC 61215-2:2021, shall be equal to the STC peak power current. For bifacial modules, the technology specific current which needs to be applied according to test MQT 11 of IEC 61215-2:2021, shall be equal to the peak power current at the elevated irradiance level BSI, as defined in IEC 61215-1,3.12. The peak power current at irradiance BSI ( $I_{mp-BSI}$ ) may be determined either by a measurement (MQT 06.1) at irradiance BSI, or by assuming linearity of peak power current with irradiance. Assuming linearity allows one to calculate  $I_{mp-BSI}$ , using  $I_{mp}$  values measured for Gate No. 1 ( $I_{mp-STC}$  and  $I_{mp-BNPI}$ ), and the relevant equivalent irradiances:  $1\ 000\ Wm^{-2}$ ,  $G_{BNPI}$ , and  $G_{BSI}$ . To extrapolate  $I_{mp-BSI}$ , these quantities are combined as follows:

$$I_{mp-BSI} = I_{mp-BNPI} + \frac{(I_{mp-BNPI} - I_{mp-STC})}{G_{BNPI} - 1000\ Wm^{-2}} \times (G_{BSI} - G_{BNPI})$$

In the above formula, equivalent irradiance is calculated as in IEC TS 60904-1-2, specifically:

$$G_{BNPI} = 1000\ Wm^{-2} + \varphi \times 135\ Wm^{-2}$$

$$G_{BSI} = 1000\ Wm^{-2} + \varphi \times 300\ Wm^{-2}$$

$$\varphi = \text{Min}(\varphi_{ISC}, \varphi_{Pmax})$$

### 11.12 Humidity-freeze test (MQT 12)

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

### 11.13 Damp heat test (MQT 13)

This test of IEC 61215-2:2021 shall be performed without modifications. Modules shall be subject to the requirements in MQT 19.2 prior to evaluation of gate No. 2.

### 11.14 Robustness of terminations (MQT 14)

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

### 11.15 Wet leakage current test (MQT 15)

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

### 11.16 Static mechanical load test (MQT 16)

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

### 11.17 Hail test (MQT 17)

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