



IEC 61215-1

Edition 2.0 2021-02
REDLINE VERSION

INTERNATIONAL STANDARD



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160

ISBN 978-2-8322-9491-8

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	4
INTRODUCTION	2
1 Scope and object	7
2 Normative references	7
3 Terms, definitions and abbreviated terms	9
4 Test samples	11
5 Marking and documentation	13
5.1 Name plate	13
5.2 Documentation	14
5.2.1 Minimum requirements	14
5.2.2 Information to be given in the documentation	14
5.2.3 Assembly instructions	15
6 Testing	15
7 Pass criteria	20
7.1 General	20
7.2 Power output and electric circuitry	20
7.2.1 Identification of rated values and tolerances	21
7.2.2 Verification of rated label values → Gate No. 1	21
7.2.3 Maximum power degradation during type approval testing → Gate No. 2	27
7.2.4 Electrical circuitry	27
7.3 Visual defects	27
7.4 Electrical safety	27
8 Major visual defects	28
9 Report	28
10 Modifications	29
11 Test flow and procedures	30
Annex A (informative) Changes from previous edition	34
A.1 General	34
A.2 Procedures for bifacial modules	34
A.3 Use of representative samples	36
A.4 Addition of dynamic mechanical load test	37
A.5 Addition of test for potential induced degradation	37
A.6 Simulator requirements	39
A.6.1 General	39
A.6.2 Rationale for changes to spectral requirements	40
A.6.3 Rationale for changes to uniformity requirements	41
A.7 References to retest guidelines	42
A.8 Weight on junction boxes	42
A.9 Correction to monolithically-integrated hot-spot endurance test	42
A.10 Number of modules in sequence	44
A.11 Removal of nominal module operating temperature (NMOT)	45
A.12 Very low currents during thin-film tests	46
A.13 Limit bypass diode testing to three diodes	46
A.14 Revert the insulation test to 2005 version	46
A.15 Bending test	47

A.16 Stabilization option for boron oxygen LID (MQT 19.3) 47

Bibliography..... 48

Figure 1 – Geometry that shows radius of curvature of a flexible module 10

Figure 2 – Full test flow for design qualification and type approval of photovoltaic modules 19

Figure 3 – Examples of hypothetical partial nameplates (left column), datasheets (center column), and derived rated values and tolerances (right column) 23

Figure A.1 – Derived temperature coefficients (α) for nine different mc-Si products types..... 44

Table 1 – Required component tests 20

Table 2 – Summary of Gate No. 1 requirements..... 20

Table 3 – Summary of test levels 31

Table A.1 – Published uncertainty values as a function of simulator uniformity class 41

Table A.2 – Summary of foil placement during insulation test in three different versions..... 46

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 1: Test requirements

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 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.

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 measurements¹~~

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: –²Terrestrial 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)

¹ ~~To be published.~~

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

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

**Modules photovoltaïques (PV) pour applications terrestres – Qualification de la
conception et homologation –
Partie 1: Exigences d'essai**

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms, definitions and abbreviated terms	9
4 Test samples	11
5 Marking and documentation.....	13
5.1 Name plate	13
5.2 Documentation.....	13
5.2.1 Minimum requirements	13
5.2.2 Information to be given in the documentation.....	13
5.2.3 Assembly instructions	15
6 Testing.....	15
7 Pass criteria	17
7.1 General.....	17
7.2 Power output and electric circuitry	18
7.2.1 Identification of rated values and tolerances	18
7.2.2 Verification of rated label values → Gate No. 1.....	20
7.2.3 Maximum power degradation during type approval testing → Gate No. 2.....	23
7.2.4 Electrical circuitry	23
7.3 Visual defects	23
7.4 Electrical safety	23
8 Major visual defects.....	24
9 Report	24
10 Modifications	25
11 Test flow and procedures	26
Annex A (informative) Changes from previous edition	28
A.1 General.....	28
A.2 Procedures for bifacial modules	28
A.3 Use of representative samples	30
A.4 Addition of dynamic mechanical load test.....	31
A.5 Addition of test for potential induced degradation.....	31
A.6 Simulator requirements	33
A.6.1 General	33
A.6.2 Rationale for changes to spectral requirements	34
A.6.3 Rationale for changes to uniformity requirements	35
A.7 References to retest guidelines.....	36
A.8 Weight on junction boxes	36
A.9 Correction to monolithically-integrated hot-spot endurance test	36
A.10 Number of modules in sequence	38
A.11 Removal of nominal module operating temperature (NMOT)	39
A.12 Very low currents during thin-film tests	40
A.13 Limit bypass diode testing to three diodes.....	40
A.14 Revert the insulation test to 2005 version	40
A.15 Bending test.....	41

A.16 Stabilization option for boron oxygen LID (MQT 19.3) 41

Bibliography..... 42

Figure 1 – Geometry that shows radius of curvature of a flexible module 10

Figure 2 – Full test flow for design qualification and type approval of photovoltaic modules 16

Figure 3 – Examples of hypothetical partial nameplates (left column), datasheets (center column), and derived rated values and tolerances (right column) 20

Figure A.1 – Derived temperature coefficients (α) for nine different mc-Si products types..... 38

Table 1 – Required component tests 17

Table 2 – Summary of Gate No. 1 requirements..... 17

Table 3 – Summary of test levels 26

Table A.1 – Published uncertainty values as a function of simulator uniformity class 35

Table A.2 – Summary of foil placement during insulation test in three different versions..... 40

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 1: Test requirements

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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 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 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

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 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 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 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: –¹*Terrestrial photovoltaic (PV) modules for consumer products – Design qualification and type approval*

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

¹ Under preparation. Stage at the time of publication: ADTS.

SOMMAIRE

AVANT-PROPOS.....	50
INTRODUCTION.....	52
1 Domaine d'application	53
2 Références normatives	54
3 Termes, définitions et termes abrégés	55
4 Échantillons d'essai	58
5 Marquage et documentation	59
5.1 Plaque signalétique	59
5.2 Documentation.....	60
5.2.1 Exigences minimales	60
5.2.2 Informations à inclure dans la documentation	60
5.2.3 Instructions d'assemblage	61
6 Essais	62
7 Critères d'acceptation.....	64
7.1 Généralités	64
7.2 Puissance de sortie et circuits électriques.....	65
7.2.1 Identification des valeurs et des tolérances assignées.....	65
7.2.2 Vérification des valeurs d'étiquette assignées → Point 1	67
7.2.3 Dégradation de la puissance maximale pendant l'essai d'homologation → Point 2	70
7.2.4 Circuits électriques	70
7.3 Défauts visuels	70
7.4 Sécurité électrique.....	71
8 Défauts visuels majeurs.....	71
9 Rapport	71
10 Modifications	73
11 Série et procédures d'essai	73
Annexe A (informative) Modifications par rapport à l'édition précédente.....	75
A.1 Généralités	75
A.2 Procédures applicables aux modules bifaces	75
A.3 Utilisation d'échantillons représentatifs	77
A.4 Ajout de l'essai de charge mécanique dynamique	78
A.5 Ajout de l'essai de la dégradation induite du potentiel.....	79
A.6 Exigences concernant les simulateurs	81
A.6.1 Généralités.....	81
A.6.2 Justifications des modifications apportées aux exigences spectrales	82
A.6.3 Justifications des modifications apportées aux exigences d'uniformité	83
A.7 Références aux lignes directrices pour un contre-essai.....	84
A.8 Poids appliqué aux boîtes de jonction	84
A.9 Correction de l'essai de tenue à l'échauffement localisé à intégration monolithique	84
A.10 Nombre de modules dans une séquence d'essais	86
A.11 Suppression de la température nominale de fonctionnement du module (NMOT).....	87
A.12 Courants très faibles pendant les essais sur couches minces	88

A.13	Limitation de l'essai de diodes de dérivation à trois diodes	89
A.14	Retour de l'essai diélectrique à la version de 2005.....	89
A.15	Essai de flexion	90
A.16	Option de stabilisation pour la dégradation bore-oxygène induite par la lumière (MQT 19.3).....	90
Bibliographie.....		91
Figure 1	– Représentation géométrique du rayon de courbure d'un module flexible	56
Figure 2	– Série d'essais complète pour la qualification de la conception et l'homologation des modules photovoltaïques	64
Figure 3	– Exemples de plaques signalétiques (colonne de gauche), fiches techniques (colonne du milieu) et valeurs et tolérances assignées déduites (colonne de droite) partielles hypothétiques	67
Figure A.1	– Coefficients de température dérivés (α) pour neuf types de produits mc-Si différents	87
Tableau 1	– Essais de composants exigés.....	64
Tableau 2	– Synthèse des exigences du point 1.....	64
Tableau 3	– Synthèse des niveaux d'essai.....	73
Tableau A.1	– Valeurs d'incertitude publiées en fonction de la classe d'uniformité du simulateur.....	83
Tableau A.2	– Synthèse de positionnement de la feuille pendant l'essai diélectrique (trois versions différentes)	89

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

MODULES PHOTOVOLTAÏQUES (PV) POUR APPLICATIONS TERRESTRES – QUALIFICATION DE LA CONCEPTION ET HOMOLOGATION –

Partie 1: Exigences d'essai

AVANT-PROPOS

- 1) La Commission Électrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. À cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
- 2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
- 3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
- 4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
- 5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
- 6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
- 7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
- 8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
- 9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 61215-1 a été établie par le comité d'études 82 de l'IEC: Systèmes de conversion photovoltaïque de l'énergie solaire.

Cette deuxième édition de l'IEC 61215-1 annule et remplace la première édition de l'IEC 61215-1 parue en 2016, dont elle constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) Ajout d'un essai issu de l'IEC TS 62782.
- b) Ajout d'un essai issu de l'IEC TS 62804-1.

- c) Ajout de méthodes d'essai exigées pour les modules flexibles. Cette disposition inclut l'ajout de l'essai de flexion (MQT 22).
- d) Ajout de définitions, références et instructions concernant le mode de réalisation de la qualification de la conception et de l'homologation IEC 61215 des modules photovoltaïques bifaces.
- e) Clarification des exigences relatives aux mesurages de la puissance de sortie.
- f) Ajout de poids à la boîte de jonction pendant 200 cycles thermiques.
- g) Exigence stipulant de réaliser un contre-essai conformément à l'IEC TS 62915.
- h) Suppression de l'essai nominal de fonctionnement du module (NMOT - *nominal module operating test*), et de l'essai associé de performances à la température nominale de fonctionnement du module (NMOT - *nominal module operating temperature*), issus de la série IEC 61215.

L'Annexe informative A explique le contexte et le raisonnement qui justifie certaines modifications les plus importantes apportées à la série IEC 61215 dans l'évolution de l'édition 1 à l'édition 2.

Le texte de cette Norme internationale est issu des documents suivants:

FDIS	Rapport de vote
82/1828A/FDIS	82/1848/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette Norme internationale.

La version française de la norme n'a pas été soumise au vote.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 61215, publiées sous le titre général *Modules photovoltaïques (PV) pour applications terrestres – Qualification de la conception et homologation*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "<http://webstore.iec.ch>" dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

Le contenu du corrigendum de mai 2021 ne s'applique qu'à la version anglaise.

IMPORTANT – Le logo "colour inside" qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer ce document en utilisant une imprimante couleur.

INTRODUCTION

Alors que la Partie 1 de la présente série de normes décrit les exigences (en termes généraux et spécifiques par rapport à la technologie du dispositif), les sous-parties de la Partie 1 définissent les variations technologiques, tandis que la Partie 2 définit un ensemble de procédures d'essai nécessaires pour la qualification de la conception et l'homologation. Les procédures d'essai décrites dans la Partie 2 sont valides pour toutes les technologies de dispositifs.

MODULES PHOTOVOLTAÏQUES (PV) POUR APPLICATIONS TERRESTRES – QUALIFICATION DE LA CONCEPTION ET HOMOLOGATION –

Partie 1: Exigences d'essai

1 Domaine d'application

Le présent document établit les exigences concernant la qualification de conception des modules photovoltaïques terrestres appropriés à un fonctionnement de longue durée dans des climats à l'air libre. La durée de vie utile des modules ainsi qualifiés dépend de leur conception, de leur environnement et de leurs conditions de fonctionnement. Les résultats d'essai ne sont pas une prévision quantitative de la durée de vie des modules.

Sous des climats pour lesquels les températures de fonctionnement du 98^e centile dépassent 70 °C, il est recommandé que les utilisateurs tiennent compte des essais dans des conditions d'essai à des températures plus élevées telles qu'elles sont décrites dans l'IEC TS 63126. Il est recommandé que les utilisateurs qui recherchent la qualification de produits PV dont la durée de vie prévue est inférieure tiennent compte des essais conçus pour les PV de l'électronique grand public, tels qu'ils sont décrits dans l'IEC 63163 (en cours d'élaboration). Les utilisateurs qui souhaitent avoir l'assurance que les caractéristiques soumises à l'essai dans l'IEC 61215 apparaissent de manière constante dans un produit fabriqué peuvent souhaiter utiliser l'IEC 62941 pour ce qui concerne les systèmes de qualité pour la fabrication des modules photovoltaïques.

Le présent document est destiné à s'appliquer à tous les matériaux de modules à plaque plane pour applications terrestres, tels que les types de modules au silicium cristallin et les modules à couches minces. Il ne s'applique pas aux systèmes qui ne constituent pas des applications de longue durée, comme les modules flexibles installés dans des auvents ou des tentes.

Le présent document ne s'applique pas aux modules utilisés avec un ensoleillement intense, même s'il peut être utilisé pour les modules à faible concentration (ensoleillement 1 à 3). Pour les modules à faible concentration, tous les essais sont réalisés en utilisant les niveaux d'éclairement, de courant, de tension et de puissance prévus à la concentration théorique.

Le présent document ne traite pas des particularités des modules PV à électronique intégrée. Toutefois, il peut être utilisé comme fondement pour soumettre à l'essai de tels modules PV.

L'objet de cette séquence d'essais est de déterminer les caractéristiques électriques du module et d'indiquer, dans la mesure du possible avec des contraintes de coût et de temps raisonnables, que le module est capable de supporter une exposition prolongée en site naturel. Les conditions d'essai accélérées sont fondées de manière empirique sur les conditions nécessaires pour reproduire les défaillances sur le terrain observées sélectionnées et sont appliquées de manière égale aux types de modules. Les facteurs d'accélération peuvent varier avec la conception du produit et ainsi les mécanismes de dégradation peuvent ne pas tous se produire. D'autres informations générales concernant les méthodes d'essai accélérées y compris les définitions des termes peuvent être consultées dans l'IEC 62506.

Certains mécanismes de dégradation à long terme ne peuvent raisonnablement être détectés que par l'intermédiaire d'essais des composants, car une longue période est nécessaire à l'apparition des défaillances et car des conditions de contraintes chères à produire sur des zones étendues sont nécessaires. Les essais de composants qui ont atteint un niveau de maturité suffisant pour établir un degré élevé de confiance des critères d'acceptation/de refus

sont intégrés dans la série IEC 61215 au sein du Tableau 1. À l'inverse, les procédures d'essai décrites dans cette série sont effectuées sur des modules dans l'IEC 61215-2.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60269-6, *Fusibles basse tension – Partie 6: Exigences supplémentaires concernant les éléments de remplacement utilisés pour la protection des systèmes d'énergie solaire photovoltaïque*

IEC 60891, *Dispositifs photovoltaïques – Procédures pour les corrections en fonction de la température et de l'éclairement à appliquer aux caractéristiques I-V mesurées*

IEC 60904-1, *Dispositifs photovoltaïques – Partie 1: Mesurage des caractéristiques courant-tension des dispositifs photovoltaïques*

IEC TS 60904-1-2:2019, *Photovoltaic devices - Part 1: Measurement of current-voltage characteristics of bifacial photovoltaic (PV) devices* (disponible en anglais seulement)

IEC 60904-3, *Dispositifs photovoltaïques – Partie 3: Principes de mesure des dispositifs solaires photovoltaïques (PV) à usage terrestre incluant les données de l'éclairement énergétique spectral de référence*

IEC 60904-10, *Dispositifs photovoltaïques – Partie 10: Méthodes de mesure de la dépendance linéaire et de la linéarité*

IEC TS 60904-13, *Photovoltaic devices – Part 13: Electroluminescence of photovoltaic modules* (disponible en anglais seulement)

IEC 61140, *Protection contre les chocs électriques - Aspects communs aux installations et aux matériels*

IEC 61215-2, *Modules photovoltaïques (PV) pour applications terrestres – Qualification de la conception et homologation – Partie 2: Procédures d'essai*

IEC 61730-1, *Qualification pour la sûreté de fonctionnement des modules photovoltaïques (PV) – Partie 1: Exigences pour la construction*

IEC 61730-2, *Qualification pour la sûreté de fonctionnement des modules photovoltaïques (PV) – Partie 2: Exigences pour les essais*

IEC TS 61836, *Solar photovoltaic energy systems – Terms, definitions and symbols* (disponible en anglais seulement)

IEC 61853-1, *Essais de performance et caractéristiques assignées d'énergie des modules photovoltaïques (PV) – Partie 1: Mesures de performance en fonction de l'éclairement et de la température, et caractéristiques de puissance*

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

IEC 62790, *Boîtes de jonction pour modules photovoltaïques - Exigences de sécurité et essais*

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

IEC 62852, *Connecteurs pour applications en courant continu pour systèmes photovoltaïques – Exigences de sécurité et essais*

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

IEC 62941, *Modules photovoltaïques (PV) pour applications terrestres – Système de qualité pour la fabrication des modules photovoltaïques*

IEC TS 63163 –¹ *Terrestrial photovoltaic (PV) modules for consumer products – Design qualification and type approval* (disponible en anglais seulement)

Guide ISO/IEC 98-3, *Incertitude de mesure – Partie 3: Guide pour l'expression de l'incertitude de mesure (GUM:1995)*

¹ En cours d'élaboration. Stade au moment de la publication: ADTS.