# IEC 61215-2

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# INTERNATIONAL STANDARD

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inside

## Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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# CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

## Part 2: Test procedures

## 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.
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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 61215-2:2016. 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 61215-2 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This second edition of IEC 61215-2 cancels and replaces the first edition of IEC 61215-2 issued in 2016; it constitutes a technical revision.

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

a) Addition of cyclic (dynamic) mechanical load testing (MQT 20).
b) Addition of a test for detection of potential-induced degradation (MQT 21).
c) Addition of test methods required for bifacial PV modules.
d) Addition of test methods required for flexible modules. This includes the addition of the bending test (MQT 22).
e) Revision of simulator requirements to ensure uncertainty is both well-defined and minimized.
f) Correction to the hot spot endurance test, where the procedure for monolithically integrated (MLI) thin film technologies (MQT 09.2) previously included two sections describing a procedure only appropriate for silicon modules.
g) Selection of three diodes, rather than all, for testing in the bypass diode thermal test (MQT 18).
h) Removal of the nominal module operating test (NMOT), and associated test of performance at NMOT, from the IEC 61215 series.

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 |
|---|---|
| 82/1829/FDIS | 82/1853/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,
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- 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.**

# 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 2: Test procedures

## 1 Scope ~~and object~~

~~This International Standard series lays down IEC requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open-air climates, as defined in IEC 60721-2-1. This part of IEC 61215 is intended to apply to all terrestrial flat plate module materials such as crystalline silicon module types as well as thin-film modules.~~

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[1]. 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.

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 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 general open-air climates. 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

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[1] Information on 98th percentile operating temperature as a function of system location and mounting configuration is included in IEC TS 63126.

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, 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, *International Electrotechnical Vocabulary* (available at http://www.electropedia.org)~~

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-21, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

~~IEC 60721-2-1, *Classification of environmental conditions – Part 2-1: Environmental conditions appearing in nature – Temperature and humidity*~~

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

IEC 60904-1, *Photovoltaic devices – Part 1: Measurements of photovoltaic current-voltage characteristics*

IEC 60904-1-1, *Photovoltaic devices – Part 1-1: Measurement of current-voltage characteristics of multi-junction photovoltaic (PV) devices*

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

IEC 60904-2, *Photovoltaic devices – Part 2: Requirements for photovoltaic reference devices*

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

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

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IEC 60904-9:2020, *Photovoltaic devices – Part 9: Classification of solar simulator ~~performance requirements~~ characteristics*

IEC 60904-10, *Photovoltaic devices – Part 10: Methods of linearity measurement*

IEC TR 60904-14: *Photovoltaic devices – Part 14: Guidelines for production line measurements of single-junction PV module maximum power output and reporting at standard test conditions*

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

IEC 61215-1:2021, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements*

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

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

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

IEC TS 62804-1:2015, *Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Crystalline silicon*

IEC TS 63163: –[3] *Terrestrial photovoltaic (PV) modules for consumer products – Design qualification and type approval*

~~ISO 868, *Plastics and ebonite – Determination of indentation hardness by means of a durometer (Shore hardness)*~~

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~~[2] To be published.~~

[3] Under preparation. Stage at the time of publication: ADTS.

# IEC 61215-2

Edition 2.0 2021-02

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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inside

## Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures

## Modules photovoltaïques (PV) pour applications terrestres – Qualification de la conception et homologation – Partie 2: Procédures d'essai

IEC 61215-2:2021-02(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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## Part 2: Test procedures

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

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

# SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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

## Partie 2: Procédures 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.

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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 61215-2 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 61215-2 annule et remplace la première édition de l'IEC 61215-2 parue en 2016; elle constitue une révision technique.

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

a) Ajout de l'essai de charge mécanique cyclique (dynamique) (MQT 20 - Module Quality Test, essai de qualité du module).

b) Ajout d'un essai de détection de la dégradation induite par le potentiel (MQT 21).

c) Ajout de méthodes d’essai exigées pour les modules PV bifaces.

d) Ajout de méthodes d’essai exigées pour les modules flexibles. Cette disposition inclut l’ajout de l’essai de flexion (MQT 22).

e) Révision des exigences du simulateur pour assurer à la fois la définition appropriée et la réduction le plus possible de l’incertitude.

f) Correction de l’essai de tenue à l’échauffement localisé, dont la procédure pour les technologies à couches minces à intégration monolithique (MLI - monolithic integration) (MQT 09.2) comprenait précédemment deux sections décrivant une méthode uniquement adaptée aux modules en silicium.

g) Choix de trois diodes, plutôt que de toutes les diodes d’essai, pour l’essai thermique de la diode de dérivation (MQT 18).

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 A informative de l’IEC 61215-1:2021, explique le contexte et la justification qui sous-tendent certaines des modifications les plus significatives apportées à la série IEC 61215 lors du passage de l’édition 1 à l’édition 2.

Le texte de cette norme est issu des documents suivants:

| FDIS | Rapport de vote |
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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.

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# INTRODUCTION

Alors que la Partie 1 de la présente série de normes décrit les exigences (de manière générale 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 2: Procédures 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[1]. 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 TS 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.

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.

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'essais accélérés 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’essais accélérés 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 de l’IEC 61215-1:2021. A l’inverse, les procédures d'essai décrites dans cette série sont effectuées sur des modules dans l’IEC 61215-2.

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[1] L’IEC TS 63126 donne des informations relatives aux températures de fonctionnement du 98e centile en fonction de l’emplacement du système et de la configuration du montage.

## 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 60068-1, *Essais d'environnement – Partie 1: Généralités et lignes directrices*

IEC 60068-2-21, *Essais d'environnement – Partie 2-21: Essais – Essai U: Robustesse des sorties et des dispositifs de montage incorporés*

IEC 60068-2-78:2012, *Essais d'environnement – Partie 2-78: Essais – Essai Cab: Chaleur humide, essai continu*

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 60904-1-1, *Dispositifs photovoltaïques – Partie 1-1: Mesurage des caractéristiques courant-tension des dispositifs photovoltaïques (PV) multijonctions*

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

IEC 60904-2, *Dispositifs photovoltaïques – Partie 2: Exigences applicables aux dispositifs photovoltaïques de référence*

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

IEC 60904-7, *Dispositifs photovoltaïques – Partie 7: Calcul de la correction de désadaptation des réponses spectrales dans les mesures de dispositifs photovoltaïques*

IEC 60904-8, *Dispositifs photovoltaïques – Partie 8: Mesure de la sensibilité spectrale d'un dispositif photovoltaïque (PV)*

IEC 60904-9:2020, *Dispositifs photovoltaïques – Partie 9: Classification des caractéristiques des simulateurs solaires*

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

IEC TR 60904-14 *Photovoltaic devices – Part 14: Guidelines for production line measurements of single-junction PV module maximum power output and reporting at standard test conditions* (disponible en anglais seulement)

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

IEC 61215-1:2021, *Modules photovoltaïques (PV) pour applications terrestres – Qualification de la conception et homologation – Partie -1: Exigences d'essai*

IEC 61215-1-1, *Modules photovoltaïques (PV) pour applications terrestres – Qualification de la conception et homologation - Partie 1-1: Exigences particulières d'essai des modules photovoltaïques (PV) au silicium cristallin*

IEC 61730-1:2016, *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 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 62804-1:2015, *Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Crystalline silicon* (disponible en anglais seulement)

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

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[2] En cours d'élaboration. Stade au moment de la publication: ADTS.