

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**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**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2021 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



IEC 61215-2

Edition 2.0 2021-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**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**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.160

ISBN 978-2-8322-9394-2

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

| | |
|---|----|
| FOREWORD..... | 6 |
| INTRODUCTION..... | 8 |
| 1 Scope..... | 9 |
| 2 Normative references | 9 |
| 3 Terms and definitions | 11 |
| 4 Test procedures | 12 |
| 4.1 Visual inspection (MQT 01)..... | 12 |
| 4.1.1 Purpose..... | 12 |
| 4.1.2 Procedure..... | 12 |
| 4.1.3 Requirements | 12 |
| 4.2 Maximum power determination (MQT 02)..... | 12 |
| 4.2.1 Purpose..... | 12 |
| 4.2.2 Apparatus..... | 12 |
| 4.2.3 Procedure..... | 13 |
| 4.3 Insulation test (MQT 03) | 13 |
| 4.3.1 Purpose..... | 13 |
| 4.3.2 Apparatus..... | 14 |
| 4.3.3 Test conditions | 14 |
| 4.3.4 Procedure..... | 14 |
| 4.3.5 Test requirements..... | 15 |
| 4.4 Measurement of temperature coefficients (MQT 04)..... | 15 |
| 4.5 Placeholder section, formerly NMOT | 15 |
| 4.6 Performance at STC (MQT 06.1)..... | 15 |
| 4.6.1 Purpose..... | 15 |
| 4.6.2 Apparatus..... | 15 |
| 4.6.3 Procedure for measuring at STC (MQT 06.1)..... | 16 |
| 4.7 Performance at low irradiance (MQT 07)..... | 16 |
| 4.7.1 Purpose..... | 16 |
| 4.7.2 Apparatus..... | 16 |
| 4.7.3 Procedure..... | 17 |
| 4.8 Outdoor exposure test (MQT 08)..... | 17 |
| 4.8.1 Purpose..... | 17 |
| 4.8.2 Apparatus..... | 17 |
| 4.8.3 Procedure..... | 17 |
| 4.8.4 Final measurements | 18 |
| 4.8.5 Requirements | 18 |
| 4.9 Hot-spot endurance test (MQT 09)..... | 18 |
| 4.9.1 Purpose..... | 18 |
| 4.9.2 Hot-spot effect..... | 18 |
| 4.9.3 Classification of cell interconnection | 19 |
| 4.9.4 Apparatus..... | 20 |
| 4.9.5 Procedure..... | 21 |
| 4.9.6 Final measurements | 28 |
| 4.9.7 Requirements | 28 |
| 4.10 UV preconditioning test (MQT 10)..... | 28 |
| 4.10.1 Purpose..... | 28 |

| | | |
|--------|--|----|
| 4.10.2 | Apparatus | 28 |
| 4.10.3 | Procedure..... | 29 |
| 4.10.4 | Final measurements | 29 |
| 4.10.5 | Requirements | 29 |
| 4.11 | Thermal cycling test (MQT 11) | 29 |
| 4.11.1 | Purpose | 29 |
| 4.11.2 | Apparatus | 29 |
| 4.11.3 | Procedure..... | 30 |
| 4.11.4 | Final measurements | 31 |
| 4.11.5 | Requirements | 31 |
| 4.12 | Humidity-freeze test (MQT 12) | 32 |
| 4.12.1 | Purpose | 32 |
| 4.12.2 | Apparatus | 32 |
| 4.12.3 | Procedure..... | 32 |
| 4.12.4 | Final measurements | 32 |
| 4.12.5 | Requirements | 32 |
| 4.13 | Damp heat test (MQT 13)..... | 33 |
| 4.13.1 | Purpose | 33 |
| 4.13.2 | Apparatus | 33 |
| 4.13.3 | Procedure..... | 33 |
| 4.13.4 | Final measurements | 34 |
| 4.13.5 | Requirements | 34 |
| 4.14 | Robustness of terminations (MQT 14) | 34 |
| 4.14.1 | Purpose | 34 |
| 4.14.2 | Retention of junction box on mounting surface (MQT 14.1) | 34 |
| 4.14.3 | Test of cord anchorage (MQT 14.2) | 34 |
| 4.15 | Wet leakage current test (MQT 15) | 35 |
| 4.15.1 | Purpose | 35 |
| 4.15.2 | Apparatus | 35 |
| 4.15.3 | Procedure..... | 35 |
| 4.15.4 | Requirements | 35 |
| 4.16 | Static mechanical load test (MQT 16)..... | 36 |
| 4.16.1 | Purpose | 36 |
| 4.16.2 | Apparatus | 36 |
| 4.16.3 | Procedure..... | 37 |
| 4.16.4 | Final measurements | 37 |
| 4.16.5 | Requirements | 37 |
| 4.17 | Hail test (MQT 17) | 37 |
| 4.17.1 | Purpose | 37 |
| 4.17.2 | Apparatus | 37 |
| 4.17.3 | Procedure..... | 38 |
| 4.17.4 | Final measurements | 39 |
| 4.17.5 | Requirements | 39 |
| 4.18 | Bypass diode testing (MQT 18) | 40 |
| 4.18.1 | Bypass diode thermal test (MQT 18.1) | 40 |
| 4.18.2 | Bypass diode functionality test (MQT 18.2) | 43 |
| 4.19 | Stabilization (MQT 19) | 44 |
| 4.19.1 | General | 44 |
| 4.19.2 | Criterion definition for stabilization..... | 44 |

| | | |
|--|---|----|
| 4.19.3 | Light induced stabilization procedures | 45 |
| 4.19.4 | Other stabilization procedures | 46 |
| 4.19.5 | Initial stabilization (MQT 19.1) | 46 |
| 4.19.6 | Final stabilization (MQT 19.2) | 46 |
| 4.19.7 | Stress-specific stabilization – BO LID (MQT 19.3) | 47 |
| 4.20 | Cyclic (dynamic) mechanical load test (MQT 20) | 47 |
| 4.20.1 | Purpose | 47 |
| 4.20.2 | Procedure | 47 |
| 4.20.3 | Final measurements | 47 |
| 4.20.4 | Requirements | 48 |
| 4.21 | Potential induced degradation test (MQT 21) | 48 |
| 4.21.1 | Purpose | 48 |
| 4.21.2 | Samples | 48 |
| 4.21.3 | Apparatus | 48 |
| 4.21.4 | Procedure | 48 |
| 4.21.5 | Final measurements | 48 |
| 4.21.6 | Requirements | 49 |
| 4.22 | Bending test (MQT 22) | 49 |
| 4.22.1 | Purpose | 49 |
| 4.22.2 | Apparatus | 49 |
| 4.22.3 | Procedure | 49 |
| 4.22.4 | Final measurements | 49 |
| 4.22.5 | Requirements | 49 |
| Annex A (informative) Recommended setup for managing weights during mechanical loading (MQT 16) | | 50 |
| Bibliography | | 54 |
| | | |
| Figure 1 – Case S, series connection with optional bypass diode | | 19 |
| Figure 2 – Case PS, parallel-series connection with optional bypass diode | | 19 |
| Figure 3 – Case SP, series-parallel connection with optional bypass diode | | 20 |
| Figure 4 – Module <i>I-V</i> characteristics with different cells totally shadowed | | 21 |
| Figure 5 – Module <i>I-V</i> characteristics with the test cell shadowed at different levels | | 23 |
| Figure 6 – Hot-spot effect in a MLI thin-film module with serially connected cells | | 24 |
| Figure 7 – Thermal cycling test – Temperature and applied current profile | | 30 |
| Figure 8 – Proper attachment of 5 N weight to junction box for module utilizing a) electrical termination leads, b) or wire for attachment, and c) only one junction box | | 31 |
| Figure 9 – Humidity-freeze cycle – Temperature and humidity profile | | 33 |
| Figure 10 – Hail-test equipment | | 38 |
| Figure 11 – Hail test impact locations: top for wafer/cell based technologies, bottom for monolithic processed thin film technologies | | 40 |
| Figure 12 – Bypass diode thermal test | | 42 |
| Figure A.1 – 3D view (at left of figure), end view (at top right), and side view (at bottom right) of gantry crane over mounting jig and loading jig | | 50 |
| Figure A.2 – 3D close up views of mounting jig (right) and loading jig (left) | | 51 |
| Figure A.3 – 2D view of mounting jig and loading jig | | 52 |
| Figure A.4 – 3D view of loading jig | | 52 |
| Figure A.5 – Close-up view of loading jig | | 53 |

Table 1 – Voltage stress levels 14

Table 2 – Ice-ball masses and test velocities 38

Table 3 – Impact locations 39

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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.
- 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 61215-2 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,
- 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.

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.