

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Photovoltaic (PV) module safety qualification –  
Part 2: Requirements for testing**

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



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2016 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  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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 corrigenda or an amendment might have been published.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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](http://webstore.iec.ch/justpublished)

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

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://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: [csc@iec.ch](mailto:csc@iec.ch).

#### 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.

#### Catalogue IEC - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

#### Recherche de publications IEC - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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](http://webstore.iec.ch/justpublished)

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

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)

65 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Photovoltaic (PV) module safety qualification –  
Part 2: Requirements for testing**

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

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 27.160

ISBN 978-2-8322-3575-1

**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
1 Scope.....	8
2 Normative references .....	8
3 Terms and definitions .....	10
4 Test categories.....	10
4.1 General.....	10
4.2 Environmental stress tests .....	10
4.3 General inspection .....	10
4.4 Electrical shock hazard tests .....	11
4.5 Fire hazard tests.....	11
4.6 Mechanical stress tests .....	11
5 Classes and their necessary test procedures.....	12
6 Sampling.....	14
7 Test report .....	14
8 Testing.....	15
9 Pass criteria .....	17
10 Test procedures .....	17
10.1 General.....	17
10.2 Visual inspection MST 01 .....	17
10.2.1 Purpose.....	17
10.2.2 Procedure.....	17
10.2.3 Pass criteria.....	17
10.3 Performance at STC MST 02.....	19
10.3.1 Purpose .....	19
10.3.2 Procedure.....	19
10.3.3 Pass criteria.....	19
10.4 Maximum power determination MST 03 .....	19
10.4.1 Purpose.....	19
10.4.2 Procedure.....	19
10.4.3 Pass criteria.....	19
10.5 Insulation thickness test MST 04 .....	19
10.5.1 Purpose.....	19
10.5.2 Procedure.....	20
10.5.3 Pass criteria.....	20
10.6 Durability of markings MST 05.....	20
10.7 Sharp edge test MST 06.....	20
10.8 Bypass diode functionality test MST 07.....	21
10.9 Accessibility test MST 11.....	21
10.9.1 Purpose.....	21
10.9.2 Apparatus .....	21
10.9.3 Procedure.....	21
10.9.4 Final measurements.....	21
10.9.5 Pass criteria.....	21
10.10 Cut susceptibility test MST 12 .....	21
10.10.1 Purpose.....	21
10.10.2 Apparatus .....	22

10.10.3	Procedure .....	22
10.10.4	Final measurements .....	22
10.10.5	Pass criteria .....	22
10.11	Continuity test of equipotential bonding MST 13 .....	23
10.11.1	Purpose .....	23
10.11.2	Apparatus .....	23
10.11.3	Procedure .....	24
10.11.4	Final measurements .....	24
10.11.5	Pass criteria .....	24
10.12	Impulse voltage test MST 14 .....	24
10.12.1	Purpose .....	24
10.12.2	Apparatus .....	24
10.12.3	Procedure .....	25
10.12.4	Final measurement .....	26
10.12.5	Pass criteria .....	26
10.13	Insulation test MST 16 .....	26
10.13.1	Purpose .....	26
10.13.2	Procedure .....	26
10.13.3	Pass criteria .....	26
10.14	Wet leakage current test MST 17 .....	26
10.15	Temperature test MST 21 .....	27
10.15.1	Purpose .....	27
10.15.2	Outdoor method .....	27
10.15.3	Solar simulator method .....	28
10.15.4	Pass criteria .....	30
10.16	Hot-spot endurance test MST 22 .....	30
10.17	Fire test MST 23 .....	30
10.17.1	Purpose .....	30
10.18	Ignitability test MST 24 .....	31
10.18.1	Purpose .....	31
10.18.2	Apparatus .....	31
10.18.3	Test specimen .....	32
10.18.4	Conditioning .....	32
10.18.5	Procedure .....	32
10.18.6	Duration of test .....	33
10.18.7	Observations .....	33
10.18.8	Pass criteria .....	33
10.19	Bypass diode thermal test MST 25 .....	34
10.20	Reverse current overload test MST 26 .....	34
10.20.1	Purpose .....	34
10.20.2	Procedure .....	34
10.20.3	Pass criteria .....	34
10.21	Module breakage test MST 32 .....	35
10.21.1	Purpose .....	35
10.21.2	Apparatus .....	35
10.21.3	Procedure .....	35
10.21.4	Pass criteria .....	35
10.22	Screw connections test MST 33 .....	38
10.22.1	Test for general screw connections MST 33a .....	38

10.22.2	Test for locking screws MST 33b .....	40
10.23	Static mechanical load test MST 34 .....	40
10.24	Peel test MST 35 .....	40
10.24.1	Purpose .....	40
10.24.2	Sample requirements .....	40
10.24.3	Apparatus .....	41
10.24.4	Procedure .....	41
10.24.5	Pass criteria .....	44
10.25	Lap shear strength test MST 36 .....	44
10.25.1	Purpose .....	44
10.25.2	Test samples .....	44
10.25.3	Apparatus .....	45
10.25.4	Procedure .....	45
10.25.5	Pass criteria .....	46
10.26	Materials creep test MST 37 .....	47
10.26.1	Purpose .....	47
10.26.2	Apparatus .....	47
10.26.3	Procedure .....	47
10.26.4	Final measurements .....	47
10.26.5	Pass criteria .....	47
10.27	Robustness of terminations test MST 42 .....	47
10.28	Thermal cycling test MST 51 .....	48
10.29	Humidity freeze test MST 52 .....	48
10.30	Damp heat test MST 53 .....	48
10.31	UV test MST 54 .....	48
10.32	Cold conditioning MST 55 .....	48
10.32.1	Purpose .....	48
10.32.2	Apparatus .....	48
10.32.3	Procedure .....	48
10.32.4	Pass criteria .....	49
10.33	Dry heat conditioning MST 56 .....	49
10.33.1	Purpose .....	49
10.33.2	Apparatus .....	49
10.33.3	Procedure .....	49
10.33.4	Pass criteria .....	49
Annex A (informative)	Recommendations for testing of PV modules from production .....	50
A.1	General .....	50
A.2	Module output power .....	50
A.3	Wet insulation test .....	50
A.4	Visual inspection .....	51
A.5	Bypass diodes .....	51
A.6	Continuity test of equipotential bonding .....	51
Annex B (informative)	Fire tests, spread-of-flame and burning-brand tests for PV modules .....	52
B.1	General .....	52
B.2	Fire test for PV modules based on ENV 1187 .....	52
B.2.1	General .....	52
B.2.2	External fire exposure to roofs .....	52
B.2.3	Classification according to ISO 13501-5 .....	53

B.3	Fire test for PV modules based on ANSI/UL 1703 .....	54
Figure 1	– Test sequences .....	16
Figure 2	– Assessment of bubbles in edge seals for cemented joints.....	18
Figure 3	– Cut susceptibility test .....	23
Figure 4	– Waveform of the impulse voltage following IEC 60060-1.....	25
Figure 5	– Impactor.....	36
Figure 6	– Impact test frame 1 .....	37
Figure 7	– Impact test frame 2 .....	38
Figure 8	– Sample preparation of cemented joints $\leq 10$ mm using a release sheet.....	41
Figure 9	– PV module with positions for peel samples on frontsheet or backsheet.....	42
Figure 10	– Typical peel-off measurement curves .....	43
Figure 11	– Lap shear test sample for proving cemented joint.....	45
Figure 12	– Lap-shear test flow .....	46
Figure B.1	– Example of test set-up for fire test.....	53
Table 1	– Environmental stress tests.....	10
Table 2	– General inspection test.....	10
Table 3	– Electrical shock hazard tests .....	11
Table 4	– Fire hazard tests .....	11
Table 5	– Mechanical stress tests .....	12
Table 6	– Required tests, depending on the Class .....	13
Table 7	– Torque tests on screws per IEC 60598-1:2014, Table 4.1.....	39

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –

## Part 2: Requirements for testing

## 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 61730-2 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This second edition cancels and replaces the first edition of IEC 61730-2, issued in 2004 and its amendment 1 (2011), and constitutes a technical revision.

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

- a) Rearrange test sequences.
- b) MST 01: Visual inspection: added nameplate requirement and modified pass criteria.
- c) Added sharp edge test MST 06.
- d) Added insulation thickness test MST 04.
- e) MST 11: Accessibility test: defined force for test finger.
- f) MST 12: Cut susceptibility test: defined blade radius for cut test.

- g) MST 14: removed preconditioning requirement TC200 from Figure 1.
- h) MST 15: Partial discharge test removed.
- i) Renamed dielectric breakdown test MST 16 to insulation test.
- j) MST 21: Temperature test: rewritten test procedure; removed short circuit mode; allow alternative indoor test method.
- k) MST 23: Fire test: subclause rewritten; fire test requirements related to national building codes; moved optional test description to informative annex.
- l) Added ignitability test MST 24.
- m) MST 26: Reverse current overload test: changed specification of wooden board.
- n) MST 32: Module breakage test: defined new dimensions of impactor to allow other filling compounds; consider variety of mounting techniques for glass breakage test; reduced impact height to only 300 mm; corrected diameter of opening according to referenced standard (65 cm<sup>2</sup> instead of 6,5 cm<sup>2</sup>).
- o) Added screw connection test MST 33.
- p) Added peel test MST 35 for proof of cemented joints.
- q) Added lap shear strength test MST 36 for proof of cemented joints.
- r) Added materials creep test MST 37.
- s) Added PV module test sequence with moisture and UV to stress polymers to Figure 1. The new UV sequence was added as a response to the Kyoto meeting, where it was decided to add a coupon test and a PV module test sequence. As it is not possible to perform the ISO UV test on PV modules (no affordable equipment available) it was decided to rely on already available PV module test equipment. R&D work has shown that cycling UV and HF are best to age polymers in PV modules.
- t) Added new sequence for Pollution Degree (PD) testing (sequence B1).
- u) Added annex: Recommendations for testing of PV modules from production.

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

FDIS	Report on voting
82/1129/FDIS	82/1147/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**