

INTERNATIONAL STANDARD



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

*itehStandards
(<https://standards.iteh.ai>)
Document Preview*

IEC 61730-2:2023

<https://standards.iteh.ai/catalog/standards/iec/bfa0252e-8e55-490f-a821-2ef5162a51f7/iec-61730-2-2023>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2023 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.

IEC Secretariat
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 It also gives information on projects, replaced and withdrawn publications.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 Products & Services Portal - products.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 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

International
Standards.iteh.ai
Document Preview

[IEC 61730-2:2023](https://standards.iteh.ai/catalog/standards/iec/bfa0252e-8e55-490f-a821-2ef5162a51f7/iec-61730-2-2023)

<https://standards.iteh.ai/catalog/standards/iec/bfa0252e-8e55-490f-a821-2ef5162a51f7/iec-61730-2-2023>



IEC 61730-2

Edition 3.0 2023-09
REDLINE VERSION

INTERNATIONAL STANDARD



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

iteh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 61730-2:2023](#)

<https://standards.iteh.ai/catalog/standards/iec/bfa0252e-8e55-490f-a821-2ef5162a51f7/iec-61730-2-2023>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160

ISBN 978-2-8322-7536-8

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

CONTENTS

FOREWORD.....	7
1 Scope.....	10
2 Normative references	10
3 Terms and definitions	12
4 Test categories.....	12
4.1 General.....	12
4.2 Environmental stress tests	13
4.3 General inspection tests	13
4.4 Electrical shock hazard tests.....	13
4.5 Fire hazard tests.....	14
4.6 Mechanical stress tests.....	14
5 Classes and their necessary test procedures.....	14
6 Sampling	16
7 Test report.....	16
8 Testing	17
9 Pass criteria	21
10 Test procedures	21
10.1 General.....	21
10.2 Visual inspection MST 01.....	21
10.2.1 Purpose.....	21
10.2.2 Procedure.....	21
10.2.3 Pass criteria	21
10.3 Performance at STC MST 02	25
10.3.1 Purpose.....	25
10.3.2 Procedure.....	25
10.3.3 Pass criteria	25
10.4 Maximum power determination MST 03.....	25
10.4.1 Purpose.....	25
10.4.2 Procedure.....	25
10.4.3 Pass criteria	25
10.5 Insulation thickness test MST 04.....	25
10.5.1 Purpose.....	25
10.5.2 Procedure.....	25
10.5.3 Pass criteria	26
10.6 Durability of markings MST 05	26
10.7 Sharp edge test MST 06	26
10.7.1 Purpose.....	26
10.7.2 Apparatus.....	27
10.7.3 Procedure.....	28
10.7.4 Final measurements	29
10.7.5 Pass criteria	29
10.8 Bypass diode functionality test MST 07.....	29
10.9 Accessibility test MST 11	29
10.9.1 Purpose.....	29
10.9.2 Apparatus.....	29
10.9.3 Procedure.....	29

10.9.4	Final measurements	29
10.9.5	Pass criteria	29
10.10	Cut susceptibility test MST 12	30
10.10.1	Purpose	30
10.10.2	Apparatus	30
10.10.3	Procedure	30
10.10.4	Final measurements	30
10.10.5	Pass criteria	30
10.11	Continuity test of equipotential bonding MST 13	31
10.11.1	Purpose	31
10.11.2	Apparatus	31
10.11.3	Procedure	32
10.11.4	Final measurements	32
10.11.5	Pass criteria	32
10.12	Impulse voltage test MST 14	32
10.12.1	Purpose	32
10.12.2	Apparatus	32
10.12.3	Procedure	34
10.12.4	Final measurement	34
10.12.5	Pass criteria	34
10.13	Insulation test MST 16	35
10.3.1	Purpose	35
10.3.2	Procedure	35
10.3.3	Pass criteria	35
10.14	Wet leakage current test MST 17	35
10.15	Placeholder section, formerly Temperature test MST 21	35
10.15.1	Purpose	35
10.15.2	Outdoor method	35
10.15.3	Solar simulator method	35
10.15.4	Pass criteria	35
10.16	Hot-spot endurance test MST 22	39
10.17	Fire test MST 23	39
10.17.1	Purpose	39
10.18	Ignitability test MST 24	39
10.18.1	Purpose	39
10.18.2	Apparatus	40
10.18.3	Test specimen	40
10.18.4	Conditioning	41
10.18.5	Procedure	41
10.18.6	Duration of test	44
10.18.7	Observations Expression of results	44
10.18.8	Pass criteria	44
10.19	Bypass diode thermal test MST 25	44
10.20	Reverse current overload test MST 26	44
10.20.1	Purpose	44
10.20.2	Apparatus	44
10.20.3	Procedure	45
10.20.4	Pass criteria	46
10.21	Module breakage test MST 32	46

10.21.1	Purpose.....	46
10.21.2	Apparatus.....	46
10.21.3	Procedure.....	46
10.21.4	Pass criteria	47
10.22	Screw connections test MST 33.....	50
10.22.1	Test for general screw connections MST 33a.....	50
10.22.2	Test for locking screws MST 33b	52
10.23	Static mechanical load test MST 34	52
10.23.1	General	52
10.23.2	Pass criteria	52
10.24	Peel test MST 35	52
10.24.1	Purpose.....	52
10.24.2	Sample requirements.....	52
10.24.3	Apparatus.....	53
10.24.4	Procedure.....	53
10.24.5	Pass criteria	56
10.25	Lap shear strength test MST 36	56
10.25.1	Purpose.....	56
10.25.2	Test samples	56
10.25.3	Apparatus.....	57
10.25.4	Procedure.....	57
10.25.5	Pass criteria	59
10.26	Materials creep test MST 37	60
10.26.1	Purpose.....	60
10.26.2	Apparatus.....	60
10.26.3	Procedure.....	60
10.26.4	Final measurements	60
10.26.5	Pass criteria	60
10.27	Robustness of terminations test MST 42	61
10.28	Thermal cycling test MST 51	61
10.29	Humidity freeze test MST 52	61
10.30	Damp heat test MST 53	61
10.31	UV test MST 54	61
10.32	Cold conditioning test MST 55	62
10.32.1	Purpose.....	62
10.32.2	Apparatus.....	62
10.32.3	Procedure.....	62
10.32.4	Pass criteria	62
10.33	Dry heat conditioning test MST 56	62
10.33.1	Purpose.....	62
10.33.2	Apparatus.....	62
10.33.3	Procedure.....	62
10.33.4	Pass criteria	63
10.34	Evaluation of insulation coordination MST 57	63
10.34.1	Purpose.....	63
10.34.2	Apparatus.....	63
10.34.3	Procedure.....	63
10.34.4	Pass criteria	66
Annex A (informative) Recommendations for testing of PV modules from production		67

A.1	General.....	67
A.2	Module output power	67
A.3	Wet insulation test	67
A.4	Visual inspection.....	68
A.5	Bypass diodes	68
A.6	Continuity test of equipotential bonding	68
Annex B (informative) Fire tests, spread-of-flame and burning-brand tests for PV modules.....		69
B.1	General.....	69
B.2	Fire test for PV modules based on ENV 1187.....	69
B.2.1	General	69
B.2.2	External fire exposure to roofs	69
B.2.3	Classification according to ISO EN 13501-5.....	71
B.3	Fire test for PV modules based on ANSI/UL 1703 61730-2	71
Annex C (normative) Usage of representative samples for very large modules.....		72
Bibliography.....		75
Figure 1 – Test sequences – Pass criteria		20
Figure 2 – Assessment of bubbles in edge seals for cemented joints		24
Figure 2 – Assessment of bubbles for evaluation of clearances and creepage distances, or distance through insulation		24
Figure 3 – Test apparatus MST 06.....		27
Figure 4 – Position of test apparatus.....		28
Figure 5 – Cut susceptibility test.....		31
Figure 6 – Waveform of the impulse voltage following IEC 60060-1		33
Figure 7 – Application of burner for multilayer products		43
Figure 8 – Impactor.....		48
Figure 9 – Impact test frame 1		49
Figure 10 – Impact test frame 2		50
Figure 11 – Sample preparation of cemented joints ≤ 10 mm using a release sheet		53
Figure 12 – PV module with positions for peel samples on frontsheet or backsheet		54
Figure 13 – Typical peel-off measurement curves		55
Figure 14 – Lap shear test sample for proving cemented joint.....		57
Figure 15 – Lap-shear test flow.....		59
Figure B.1 – Example of test set-up for fire test		70
Figure C.1 – Example for a possible break.....		74
Table 1 – Environmental stress tests		13
Table 2 – General inspection tests.....		13
Table 3 – Electrical shock hazard tests		13
Table 4 – Fire hazard tests		14
Table 5 – Mechanical stress tests		14
Table 6 – Required tests, depending on the Class		15
Table 7 – Tapes for test finger		28
Table 8 – Torque tests on screws per IEC 60598-1:2014, Table 4.1.....		51

Table 9 – Altitude correction factor for test voltage for operating (installation) altitudes higher than 2 000 m	64
Table 10 – Altitude correction factor for test voltage for testing (laboratory) altitudes lower than 2 000 m	64
Table 11 – Rated impulse voltages	65
Table C.1 – Overview of tests	73

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 61730-2:2023](#)

<https://standards.iteh.ai/catalog/standards/iec/bfa0252e-8e55-490f-a821-2ef5162a51f7/iec-61730-2-2023>

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.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 61730-2:2016. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 61730-2 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems. It is an International Standard.

This third edition cancels and replaces the second edition published in 2016. This edition constitutes a technical revision.

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

- a) MST 06: Sharp edge test revised.
- b) MST 14: Impulse voltage test contains technical corrections to Figure 4.
- c) MST 21: Temperature test has been removed from this standard because modules tested individually in unrestricted mounting systems in open-air climates below 40 °C operate at or below a 98th-percentile operating temperature of 70 °C. As a result, the existing IEC 61730-1 requirement for a minimum RTI/RTE/TI of 90 °C is adequate. To address modules operating at higher temperatures, IEC TS 63126 includes an informative annex to describe tests and analysis techniques suitable for estimating the 98th-percentile operating temperature. This covers system effects such as mounting methods that restrict airflow and result in a 98th-percentile module operating temperature in excess of 70 °C.
- d) MST 24: Ignitability test revised.
- e) MST 26: Reverse current overload test revised.
- f) MST 32: Module breakage test is no longer required for Class 0 modules.
- g) MST 54: Instead of sequential test with one module now one module for sequence B shall be irradiated from the front side and another module from the backside during the 60 kWh/m² cycle.
- h) MST 57: Evaluation of insulation coordination added.
- i) All MQT references updated to revised IEC 61215 series Ed.2.0 2021.
- j) Bifacial modules: Requirements updated for MST 02 Performance at STC, MST 07 Bypass diode functionality test, MST 22 Hot-spot endurance test, MST 25 Bypass diode thermal test and MST 51 Thermal cycling (TC200).
- k) Term “Very large module” defined and Annex C (normative) “Usage of representative samples for very large modules” added.

The text of this International Standard is based on the following documents:

Draft	Report on voting
82/2122/FDIS	82/2166/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61730 series, published under the general title *Photovoltaic (PV) module safety qualification*, 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 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 document 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.

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 61730-2:2023](#)

<https://standards.iteh.ai/catalog/standards/iec/bfa0252e-8e55-490f-a821-2ef5162a51f7/iec-61730-2-2023>

PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –

Part 2: Requirements for testing

1 Scope

The scope of IEC 61730-1 is also applicable to this part of IEC 61730. While IEC 61730-1 outlines the requirements of construction, this document lists the tests a PV module is required to fulfill for safety qualification. This document applies for safety qualification only in conjunction with IEC 61730-1.

The sequence of tests required in this document may not test for all possible safety aspects associated with the use of PV modules in all possible applications. This document utilizes the best sequence of tests available at the time of its writing. ~~There are some issues – such as the potential danger of electric shock posed by a broken PV module in a high voltage system – that should be addressed by the system design, location, restrictions on access and maintenance procedures.~~

The objective of this document is to provide the testing sequence intended to verify the safety of PV modules whose construction has been assessed by IEC 61730-1. The test sequence and pass criteria are designed to detect the potential breakdown of internal and external components of PV modules that would result in fire, electric shock, and/or personal injury. This document defines the basic safety test requirements and additional tests that are a function of the PV module end-use applications. Test categories include general inspection, electrical shock hazard, fire hazard, mechanical stress, and environmental stress.

The additional testing requirements outlined in relevant ISO documents, or the national or local codes which govern the installation and use of these PV modules in their intended locations, ~~should be~~ are considered in addition to the requirements contained within this document.

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 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-3-5, *Environmental testing – Part 3-5: Supporting documentation and guidance – Confirmation of the performance of temperature chambers*

IEC 60598-1:2014, *Luminaires – Part 1: General requirements and tests*

IEC 60664-1:2007, *Insulation co-ordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-2-10, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

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

~~IEC 60904-9, Photovoltaic devices – Part 9: Solar simulator performance requirements~~

IEC 60950-1:2005, Information technology equipment – Safety – Part 1: General requirements

IEC 60950-1:2005/AMD1:2009

IEC 60950-1:2005/AMD2:2013

IEC 61010-1, Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements

IEC 61032:1997, Protection of persons and equipment by enclosures – Probes for verification

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

IEC 61215 (all parts), Terrestrial photovoltaic (PV) modules – Design qualification and type approval

IEC 61215-2, Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures

IEC 61730-1:2016/2023, Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction

IEC TS 61836, Solar photovoltaic energy systems – Terms, definitions and symbols

IEC 62788-2-1:2023, Measurement procedures for materials used in photovoltaic modules – Part 2-1: Polymeric materials – Frontsheet and backsheet – Safety requirements

IEC 62790:2020, Junction boxes for photovoltaic modules – Safety requirements and tests

IEC TS 62915, Photovoltaic (PV) modules – Type approval, design and safety qualification – Retesting

~~ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories~~

ISO 813, Rubber, vulcanized or thermoplastic – Determination of adhesion to a rigid substrate – 90 degree peel method

~~ISO 4046-4, Paper, board, pulps and related terms – Vocabulary – Part 4: Paper and board grades and converted products~~

ISO 4587:2003, Adhesives – Determination of tensile lap-shear strength of rigid-to-rigid bonded assemblies

ISO 5893, Rubber and plastics test equipment – Tensile, flexural and compression types (constant rate of traverse) – Specification

~~ISO 8124-1, Safety of toys – Part 1: Safety aspects related to mechanical and physical properties~~

ISO 11925-2:2010/2020, Reaction to fire tests – Ignitability of products subjected to direct impingement of flame – Part 2: Single-flame source test

ISO 23529, *Rubber – General procedures for preparing and conditioning test pieces for physical test methods*

ANSI/UL 1703:2015, *Flat-plate photovoltaic modules and panels*

ANSI Z97.1:2009, *Standard – Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test*

3 Terms and definitions

~~The Clause of Part 1 applies.~~

For the purposes of this document, the terms and definitions in IEC 61730-1 and IEC TS 61836, as well as the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

representative sample

sample that includes all the components of the module, except some repeated parts

3.2

very large module

module that exceeds 2,2 m in any dimension or exceeds 1,5 m in both dimensions

EXAMPLE: a 2,3 m × 0,3 m module is considered very large, as is a 1,6 m × 1,6 m module.

<https://standards.iteh.ai/standards/iec/bfa0252e-8e55-490f-a821-2ef5162a51f7/iec-61730-2-2023>

<https://standards.iteh.ai/standards/iec/bfa0252e-8e55-490f-a821-2ef5162a51f7/iec-61730-2-2023>

4 Test categories

4.1 General

The hazards described in the following subclause might influence the safety of PV modules. In accordance with these hazards, test procedures and criteria are described. The specific tests to which a PV module will be subjected will depend on the end-use application for which the minimum tests are specified in Clause 5.

NOTE PV module safety tests are labelled MST.

Table 1 through Table 5 show the origin of the required tests. For some tests the third column lists the origin of the tests for information only; the appropriate test requirements are given in 10.1 through 10.34. The other tests are based on or are identical to the ~~module qualification tests~~ ~~MQT~~ ~~tests~~ ~~MQT~~ tests defined in the IEC 61215 series. References to the relevant tests are given in the last column. Some of the IEC 61215-based tests were modified for IEC 61730-2 and are included in 10.1 through 10.34.