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

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

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STANDARD PREVIEW
(standards.iteh.ai)

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PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –

Part 2: Requirements for testing

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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 cm² instead of 6,5 cm²).
- 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.

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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 part of the standard lists the tests a PV module is required to fulfill for safety qualification. IEC 61730-2 is applied for safety qualification only in conjunction with IEC 61730-1.

The sequence of tests required in this standard may not test for all possible safety aspects associated with the use of PV modules in all possible applications. This standard 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 standard 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. The standard 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 standards, or the national or local codes which govern the installation and use of these PV modules in their intended locations, should be considered in addition to the requirements contained within this standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *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 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, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

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

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

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

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

3 Terms and definitions

The Clause of Part 1 applies.

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.

Tables 1 to 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 10.32. The other tests are based on or are identical to the module qualification tests MQT 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 10.32.

4.2 Environmental stress tests

Table 1 – Environmental stress tests
 (standards.iteh.ai)

Test	Title	Referenced standards	Based on
			IEC 61215-2
MST 51	Thermal cycling (TC50 or TC200)	IEC 61730-2:2016	MQT 11
MST 52	Humidity freeze (HF10)	ce6337698065/iec-61730-2-2016	MQT 12
MST 53	Damp heat (DH1000)	–	MQT 13
MST 54	UV preconditioning	–	MQT 10
MST 55	Cold conditioning	IEC 60068-2-1	–
MST 56	Dry hot conditioning	IEC 60068-2-2	–

4.3 General inspection

Table 2 – General inspection test

Test	Title	Referenced standards	Based on
			IEC 61215-2
MST 01	Visual inspection	–	MQT 01
MST 02	Performance at STC	–	MQT 6.1
MST 03	Maximum power determination	–	MQT 02
MST 04	Insulation thickness	–	–
MST 05	Durability of markings	IEC 60950-1	–
MST 06	Sharp edge test	ISO 8124-1	–
MST 07	Bypass diode functionality test	–	–

4.4 Electrical shock hazard tests

These tests are designed to assess the risk to persons due to shock or injury from contact with parts of a PV module that are electrically energised as a result of design, construction, or faults caused by environment or operation.

Table 3 – Electrical shock hazard tests

Test	Title	Referenced standards	Based on
			IEC 61215-2
MST 11	Accessibility test	IEC 61032	–
MST 12	Cut susceptibility test	ANSI/UL 1703:2015	–
MST 13	Continuity test for equipotential bonding	ANSI/UL 1703:2015	–
MST 14	Impulse voltage test	IEC 60664-1	–
MST 16	Insulation test	–	MQT 03
MST 17	Wet leakage current test	–	MQT 15
MST 42	Robustness of terminations test	IEC 62790	MQT 14

4.5 Fire hazard tests

These tests assess the potential fire hazard due to the operation of a PV module or failure of its components.

Table 4 – Fire hazard tests

Test	Title	Referenced standards	Based on
			IEC 61215-2
MST 21	Temperature test	ANSI/UL 1703:2015	–
MST 22	Hot-spot endurance test	–	MQT 09
MST 23*	Fire test	–	National/Local code
MST 24	Ignitability test	ISO 11925-2	–
MST 25	Bypass diode thermal test	–	MQT 18
MST 26	Reverse current overload test	ANSI/UL 1703:2015	–
* Fire tests are locally regulated and typically only required for building integrated or building added products, typically to verify their ability to resist fire from external sources.			

4.6 Mechanical stress tests

These tests are to minimise potential injury due to mechanical failure.

Table 5 – Mechanical stress tests

Test	Title	Referenced standards	Based on
			IEC 61215-2
MST 32	Module breakage test	ANSI Z97.1	–
MST 33	Screw connection test	IEC 60598-1	–
MST 34	Mechanical load test	–	MQT 16
MST 35	Peel test	ISO 5893	–
MST 36	Lap shear strength test	ISO 4587:2003	–
MST 37	Materials creep test	–	–
MST 42	Robustness of terminations test		MQT 14

5 Classes and their necessary test procedures

The specific tests to which a PV module will be subjected, depending on the Class defined in IEC 61730-1 referring to IEC 61140, are described in Table 6. The order in which the tests are carried out shall be in accordance with Figure 1. Some tests shall be carried out as preconditioning tests.

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Table 6 – Required tests, depending on the Class

Class according to IEC 61140			Tests
II	0	III	
			Environmental stress tests:
X	X	X	MST 51 Thermal cycling (T50 or T200)
X	X	X	MST 52 Humidity freeze (HF10)
X	X	X	MST 53 Damp heat (DH200 or DH1000)
X	X	X	MST 54 UV pre-conditioning (15 kWh/m ² or 60 kWh/m ²)
X ¹	X ¹	X ¹	MST 55 Cold conditioning
X ¹	X ¹	X ¹	MST 56 Dry hot conditioning
			General inspection test:
X	X	X	MST 01 Visual Inspection
X	X	X	MST 02 Performance at STC
X	X	X	MST 03 Maximum power determination
X	X	-	MST 04 Insulation thickness
X	X	X	MST 05 Durability of markings
X	X	X	MST 06 Sharp edge test
			Electrical shock hazard tests:
X	X	-	MST 11 Accessibility test
X	X	-	MST 12 Cut susceptibility test
X	X	-	MST 13 Continuity test for equipotential bonding
X	X	-	MST 14 Impulse voltage test
X	X	X	MST 16 Insulation test
X	X	-	MST 17 Wet leakage current test
X	X	X	MST 42 Robustness of terminations test
			Fire hazard tests:
X	X	X	MST 21 Temperature test
X	X	X	MST 22 Hot-spot endurance test
X ²	X ²	X ²	MST 23 Fire test
X	X	X	MST 24 Ignitability test
X	X	X	MST 25 Bypass diode thermal test
X	X	-	MST 26 Reverse current overload test
			Mechanical stress tests:
X	X	X	MST 32 Module breakage test
X	X	X	MST 33 Screw connection test
X	X	X	MST 34 Mechanical load test
X ^{3,5}	X ^{3,5}	X ^{3,5}	MST 35 Peel test
X ^{4,5}	X ^{4,5}	X ^{4,5}	MST 36 Lap shear strength test
X	X	X	MST 37 Materials creep test
<p>X Test required.</p> <p>- Test does not need to be carried out.</p> <p>¹ Only required to prove reduction of Pollution Degree PD=2 to PD=1.</p> <p>² Fire tests are nationally regulated and typically only required for building integrated or building added products. Hence, the applicability of a fire test does not depend on the Class, but on the mounting location.</p> <p>³ This test is not applicable to rigid-to-rigid bonded assemblies (e.g. glass/glass PV modules).</p> <p>⁴ This test is not applicable to rigid-to-flexible or flexible-to-flexible bonded assemblies.</p> <p>⁵ Only required for proof of cemented joints around the PV module edges.</p>			