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**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**

IEC 61730-2:2004

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PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –

Part 2: Requirements for testing

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This consolidated version of IEC 61730-2 consists of the first edition (2004) [documents 82/357/FDIS and 82/366/RVD] and its amendment 1 (2011) [documents 82/660/FDIS and 82/678/RVD]. It bears the edition number 1.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

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

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

IEC 61730 consists of the following parts, under the general title *Photovoltaic (PV) module safety qualification*:

Part 1: Requirements for construction

Part 2: Requirements for testing

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

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PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –

Part 2: Requirements for testing

1 Scope and object

This part of IEC 61730 describes the testing requirements for photovoltaic (PV) modules in order to provide safe electrical and mechanical operation during their expected lifetime. Specific topics are provided to assess the prevention of electrical shock, fire hazards, and personal injury due to mechanical and environmental stresses. IEC 61730-1 pertains to the particular requirements of construction. This part of IEC 61730 outlines the requirements of testing.

This standard attempts to define the basic requirements for various application classes of photovoltaic modules, but it cannot be considered to encompass all national or regional building codes. The specific requirements for marine and vehicle applications are not covered. This standard is not applicable to modules with integrated AC inverters (AC modules).

This standard is designed so that its test sequence can co-ordinate with those of IEC 61215 or IEC 61646, so that a single set of samples may be used to perform both the safety and performance evaluation of a photovoltaic module design.

The test-sequences of this standard are arranged in an optimal way so that tests of IEC 61215 or IEC 61646 can be used as basic preconditioning tests.

NOTE 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 module in a high voltage system, that should be addressed by the systems design, location, restrictions on access and maintenance procedures.

The object 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 personal injury. The standard defines the basic safety test requirements and additional tests that are a function of the module end-use applications.

Test categories include general inspection, electrical shock hazard, fire hazard, mechanical stress, and environmental stress.

NOTE 2 The additional testing requirements outlined in relevant ISO standards, or the national or local codes which govern the installation and use of these modules in their intended locations, should be considered in addition to the requirements contained within this document.

2 Normative references

The following referenced documents are indispensable for the application 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 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60410, *Sampling plans and procedures for inspection by attributes*

IEC 60664-1:~~1992~~, *Insulation co-ordination for equipment within low-voltage systems – Part 1 Principles, requirements and tests*
Amendment 2 (2002)

IEC 60904-2, *Photovoltaic devices – Part 2: Requirements for reference solar ~~cells~~ devices*

~~IEC 60904-6, Photovoltaic devices – Part 6: Requirements for reference solar modules~~

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:~~2004~~, *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61646:~~1996~~, *Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61730-1:~~2004~~, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

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

ANSI/UL 514C, *Non-metallic outlet boxes, flush device boxes and covers*

ANSI/UL 790, *Tests for Fire Resistance of Roof Covering Materials*

ANSI/UL 1703, *Flat – Plate Photovoltaic Modules and Panels*

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

3 Application classes

3.1 General

Photovoltaic modules may be installed in many different applications. Therefore, it is important to evaluate the potential hazards associated with those applications and to evaluate the construction of the module accordingly.

Relevant safety requirements and necessary tests shall be performed to verify the conformance to the requirements of that application class. This clause defines those application classes and construction qualities required for each class.

Application classes for PV-modules are defined as follows:

3.2 Class A: General access, hazardous voltage, hazardous power applications

Modules rated for use in this application class may be used in systems operating at greater than 50 V DC or 240 W, where general contact access is anticipated. Modules qualified for safety through IEC 61730-1 and this part of IEC 61730 within this application class are considered to meet the requirements for safety class II.

3.3 Class B: Restricted access, hazardous voltage, hazardous power applications

Modules rated for use in this application class are restricted to systems protected from public access by fences, location, etc. Modules evaluated within this application class provide protection by basic insulation, are considered to meet the requirements for safety class 0.

3.4 Class C: Limited voltage, limited power applications

Modules rated for use in this application class are restricted to systems operating at less than 50 V DC and 240 W, where general contact access is anticipated. Modules qualified for safety through IEC 61730-1 and this part of IEC 61730 within this application class are considered to meet the requirements for safety class III.

NOTE Safety classes are defined within IEC 61140.

4 Test categories

4.1 General

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

NOTE Module safety tests are labelled MST.

Tables 1 to 6 show the origin of the required tests. For some tests, the third column shows for information the origin of the tests, but the appropriate test requirements are given in Clauses 10 and 11. The rest of the tests are based on or identical to IEC 61215/IEC 61646, and references to the relevant Clauses are given in the last two columns. Some of the IEC 61215/IEC 61646-based tests were modified for IEC 61730-2 and are included in Clauses 10 and 11.

4.2 Preconditioning tests

Table 1 – Preconditioning tests

Test	Title	References in Standards	According to	
			IEC 61215	IEC 61646
MST 51	Thermal cycling (TC50 or TC200)		10.11	10.11
MST 52	Humidity freeze (HF10)		10.12	10.12
MST 53	Damp heat (DH1000)		10.13	10.13
MST 54	UV preconditioning test		10.10	10.10

4.3 General inspection

Table 2 – General inspection test

Test	Title	References in Standards	According to	
			IEC 61215	IEC 61646
MST 01	Visual inspection		10.1	10.1

4.4 Electrical shock hazard tests

These tests are designed to assess the risk to personnel due to shock or injury because of contact with parts of a 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	References in Standards	According to	
			IEC 61215	IEC 61646
MST 11	Accessibility test	ANSI/UL 1703		
MST 12	Cut susceptibility test (not required for glass surfaces)	ANSI/UL 1703		
MST 13	Ground continuity test (not required unless metal framed)	ANSI/UL 1703		
MST 14	Impulse voltage test	IEC 60664-1		
MST 16	Dielectric withstand test		10.3*	10.3*
MST 17	Wet leakage current test		10.15	10.20
MST 42	Robustness of terminations test		10.14	10.14

* The pass/fail criteria differ from those given in IEC 61215 and IEC 61646.

4.5 Fire hazard tests

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

Table 4 – Fire hazard tests

Test	Title	References in Standards	According to	
			IEC 61215	IEC 61646
MST 21	Temperature test	ANSI/UL 1703		
MST 22	Hot-spot test		10.9	10.9
MST 23	Fire test	ANSI/UL 790		
MST 25	Bypass diode thermal test		10.18	10.18
MST 26	Reverse current overload test	ANSI/UL 1703		

4.6 Mechanical stress tests

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

Table 5 – Mechanical stress tests

Test	Title	References in Standards	According to	
			IEC 61215	IEC 61646
MST 32	Module breakage test	ANSI Z97.1		
MST 34	Mechanical load test		10.16	10.16

4.7 Component tests

Table 6 – Component tests

Test	Title	References in Standards	According to	
			IEC 61215	IEC 61646
MST 15	Partial discharge test	IEC 60664-1		
MST 33	Conduit bending	ANSI/UL 514C		
MST 44	Terminal box knock out test	ANSI/UL 514C		

5 Application classes and their necessary test procedures

The specific tests to which a module will be subjected, depending on the application class defined in IEC 61730-1, is described in Table 7. 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.

NOTE This test sequence has been designed so that IEC 61730-2 can be performed in conjunction with IEC 61215 or IEC 61646. In this way, the environmental stress tests in IEC 61215 or IEC 61646 can serve as the preconditioning tests for IEC 61730-2.

Table 7 – Required tests, depending on the application class

Application class			Tests
A	B	C	
			Preconditioning tests:
X	X	X	MST 51 Thermal cycling (T50 or T200)
X	X	X	MST 52 Humidity freeze (10HF)
X	X	X	MST 53 Damp heat (DH1000)
X	X	X	MST 54 UV resistance pre-conditioning
			General inspection test:
X	X	X	MST 01 Visual inspection
			Electrical shock hazard tests:
X	X	-	MST 11 Accessibility test
X	X	-	MST 12 Cut susceptibility test
X	X	X	MST 13 Ground continuity test
X	X*	-	MST 14 Impulse voltage test
X	X*	-	MST 16 Dielectric withstand 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 test
X**	-	-	MST 23 Fire test
X	X	-	MST 26 Reverse current overload test
			Mechanical stress tests:
X	-	X	MST 32 Module breakage test
X	X	X	MST 34 Mechanical load test
			Component tests:
X	-	-	MST 15 Partial discharge test
X	X	-	MST 33 Conduit bending
X	X	X	MST 44 Terminal box knockout test
<p>X Test required.</p> <p>- Test needs not be carried out.</p> <p>* Different test levels for application classes A and B.</p> <p>** Minimum fire resistance class C is necessary for building roof-mounted modules.</p>			

6 Sampling

Six modules and a laminate¹ (a module without frame) for safety testing (plus spares as desired) and additional modules as required for the fire-test shall be taken at random from a production batch or batches, in accordance with the procedure given in IEC 60410. The modules shall have been manufactured from specified materials and components in accordance with the relevant drawings and process sheets and have been subjected to the manufacturer's normal inspection, quality control and production acceptance procedures. The modules shall be complete in every detail and shall be accompanied by the manufacturer's handling, mounting and connection instructions, including the maximum permissible system voltage.

When the modules to be tested are prototypes of a new design and not from production, this fact shall be noted in the test report (see Clause 7).

7 Test report

The results shall be laid down in a test report according to ISO/IEC 17025. The results shall be reported, normally in a test report and shall include all the information requested by the client and necessary to the interpretation of the test and all information required by the method used:

- a) a title;
- b) name and address of the test laboratory and location where the tests were carried out;
- c) unique identification of the certification or report and of each page;
- d) name and address of client, where appropriate;
- e) description and identification of the item tested;
- f) characterization and condition of the test item;
- g) date of receipt of test item and date(s) of test, where appropriate;
- h) identification of test method used;
- i) reference to sampling procedure, where relevant;
- j) any deviations from, additions to or exclusions from the test method, and any other information relevant to a specific tests, such as environmental conditions;
- k) measurements, examinations and derived results supported by tables, graphs, sketches and photographs as appropriate including maximum systems voltage, safety class, mounting technique and any failures observed;
- l) a statement indicating whether the impulse voltage test was performed on module or laminate;
- m) a statement of the estimated uncertainty of the test results (where relevant);
- n) a signature and title, or equivalent identification of the person(s) accepting responsibility for the content of the certificate or report, and the date of issue;
- o) where relevant, a statement to the effect that the results relate only to the items tested;
- p) a statement that the certificate or report shall not be reproduced except in full, without the written approval of the laboratory.

A copy of this report shall be kept by the manufacturer for reference purposes.

¹ If the module is only used with frame and the frame is an essential part to fulfil the isolation requirement, the laminate can be replaced by a module.