

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Photovoltaic (PV) module safety qualification –
Part 1: Requirements for construction**

**Qualification pour la sûreté de fonctionnement des modules
photovoltaïques (PV) –**

Partie 1: Exigences pour la construction

[IEC 61730-1:2023 ED3](#)

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CONTENTS

FOREWORD.....	5
1 Scope.....	8
2 Normative references	8
3 Terms, definitions, symbols and abbreviated terms.....	10
3.1 General terms and definitions	11
3.2 Components	11
3.3 Installation and application.....	12
3.4 Insulation concepts	13
3.5 Ratings	16
3.6 Temperatures	17
3.7 Voltages	17
3.8 Bifacial photovoltaics	18
4 Symbols and abbreviated terms.....	19
5 Classification, applications and intended use.....	19
5.1 General.....	19
5.2 PV modules of Class 0.....	19
5.2.1 General	19
5.2.2 Insulation.....	19
5.2.3 Application.....	19
5.3 PV modules of Class II.....	20
5.3.1 General	20
5.3.2 Insulation.....	20
5.3.3 Application.....	20
5.4 PV modules of Class III.....	20
5.4.1 General	20
5.4.2 Insulation.....	20
5.4.3 Application.....	20
5.5 Rating categories and special applications.....	21
6 Requirements for design and construction	22
6.1 General.....	22
6.2 Marking and documentation	23
6.2.1 General	23
6.2.2 Marking	23
6.2.3 Documentation	27
6.3 Electrical components and insulation	30
6.3.1 General	30
6.3.2 Internal wiring.....	30
6.3.3 External wiring and cables.....	30
6.3.4 Module overcurrent protection rating	30
6.3.5 Connectors.....	30
6.3.6 Junction boxes	30
6.3.7 Frontsheets and backsheets.....	31
6.3.8 Insulation barriers.....	31
6.3.9 Electrical connections.....	31
6.3.10 Encapsulants.....	32
6.3.11 Bypass diodes	32

6.4	Mechanical and electromechanical connections	32
6.4.1	General	32
6.4.2	Screw connections.....	33
6.4.3	Rivets	34
6.4.4	Thread-cutting screws	34
6.4.5	Form/press/tight fit	34
6.4.6	Connections by adhesives	34
6.4.7	Other connections	35
6.5	Materials.....	35
6.5.1	General	35
6.5.2	Polymeric materials	35
6.5.3	Metallic materials.....	38
6.5.4	Adhesives.....	38
6.6	Protection against electric shock.....	38
6.6.1	General	38
6.6.2	Protection against accessibility to hazardous live parts.....	39
6.6.3	Insulation coordination.....	40
6.6.4	Distance through functional and relied upon insulation	47
Annex A (normative) Symbol "Do not disconnect under load"		50
Annex B (normative) Basis for insulation coordination dimensions		51
B.1	General.....	51
B.2	Influencing factors	51
B.2.1	General	51
B.2.2	Overvoltage category and rated impulse voltage.....	51
B.2.3	Working voltage.....	52
B.2.4	Pollution degree	52
B.2.5	Insulating material – material groups	53
B.3	Clearances	53
B.4	Creepage distances	54
B.4.1	General	54
B.4.2	Enclosed parts.....	54
B.5	Distance through insulation.....	55
B.5.1	Cemented joints.....	55
B.5.2	Insulation in thin layers (DTI).....	55
B.5.3	Distance through functional insulation (DTFI)	56
Annex C (informative) Specific use cases		57
C.1	Modules	57
C.1.1	General	57
C.1.2	Insulation coordination diagrams	57
C.2	Insulation coordination after mounting of components	64
C.2.1	General	64
C.2.2	Backsheets.....	65
C.2.3	Junction box	66
Bibliography.....		68
Figure 1 – IEC 60417-5021:2002-10		26
Figure 2 – IEC 60417-5017:2006-08		26
Figure 3 – IEC 60417-5018:2011-07		26

Figure A.1 – Symbol "DO NOT DISCONNECT UNDER LOAD"	50
Figure A.2 – Symbol IEC 60417-6070:2011-06: "Do not disconnect under load"	50
Figure C.1 – General case for clearance, creepage distances and DTI	58
Figure C.2 – Location of highest potential difference within the module	59
Figure C.3 – Examples of spacing requirements between live parts of different potential within a module	60
Figure C.4 – Clearance and creepage distance between internal live parts and outer accessible surfaces	62
Figure C.5 – Effect of frame tape or edge adhesive on clearance and creepage distance	62
Figure C.6 – Distance between internal live parts and outer accessible surfaces with a cemented joint	63
Figure C.7 – Backsheet with aluminium layer	64
Figure C.8 – Spacing requirements between the junction box ribbon and aluminium layer of backsheet	66
Figure C.9 – Considerations for clearances and creepage distances between live parts and outer accessible surfaces after installation and termination of junction box (J-box)	67
Figure C.10 – Possible critical points due to improper installation	67
Table 1 – Classes for protection against electric shock	19
Table 2 – Required type of insulation	40
Table 3 – Minimum clearances (cl), creepage distances (cr) and distances through solid insulation for Class II PV modules	41
Table 4 – Minimum clearances (cl), creepage distances (cr) and distances through solid insulation for Class 0 PV modules	43
Table 5 – Multiplication factors for clearances of equipment rated for operation at altitudes greater than 2 000 m above sea level	47
Table B.1 – Rated impulse voltage	52
Table B.2 – Minimum clearances for an inhomogeneous field	54
Table B.3 – Minimum spacings for thin layers	55
Table C.1 – Distance between parts of different potential within a PV module (values for Class II modules with working voltage of ≤ 35 V)	59
Table C.2 – Spacing between live parts and outer accessible surfaces (values for Class II modules with rated system voltage of 1 500 V)	61

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PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –**Part 1: Requirements for construction**

FOREWORD

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IEC 61730-1 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) Revision of Clauses 2 and 3.
- b) Addition of requirements for qualification of specific components according to their standard documents (junction box, connectors, frontsheets/backsheets).
- c) Significant changes to the definition and testing of relied upon insulation materials (RUI). These requirements are described in the pre-qualification document for frontsheets and backsheets (IEC 62788-2-1). This includes:
 - 1) clarifications on the concept and measurement of DTI, and related materials test requirements;

- 2) frontsheet/backsheet weathering requirements.
- d) Removal of all reference to "open rack", with updates according to an intended use for applications according to the application's 98th percentile module operating temperature.
- e) Modules meeting Class 0 for use in restricted access areas are not required to pass the breakage test, (MST 32).
- f) Marking and documentation subclauses have been revised and aligned with the IEC 61215 series.
- g) Electronic copies are now allowed instead of paper copies of required safety documentation.
- h) Requirements for bifacial modules:
 - 1) addition of new term, aBSI;
 - 2) relevant tests have been changed to account for higher current of bifacial modules;
 - 3) for bifacial modules, marking that indicates which side is designed as the front side, or if both are designed for prolonged exposure to direct sunlight ($> 300 \text{ W/m}^2$);
 - 4) relevant parameters for installing bifacial modules clarified;
 - 5) overprotection rating;
 - 6) documentation has been modified.
- i) In 6.2, marking requirements for connectors have been added.
- j) Related to the intended use temperature range:
 - 1) Clause 5 and 6.2 have been modified to include temperature ratings, with $> 70 \text{ °C}$ 98th percentile module operating temperature as the default maximum. Guidance for factors which could impact the module operating temperature for a system design/location are provided, and responsibility for proper installation is placed upon the installer.
 - 2) Changes to insulation coordination sections (6.6, Annex B and Annex C).
 - 3) Subclauses on insulation coordination (6.6.3) and distance through solid insulation (6.6.4) have been updated to clearly state the insulation coordination requirements, and are aligned with Annex B.
 - 4) Annex B has been revised to show the basis for the dimensioning related to insulation coordination and is aligned with 6.6.3 and 6.6.4.
 - 5) Annex C has been created to show specific use cases and describe how changes to materials or use of additional testing can modify the required dimensioning. Diagrams have been updated.
 - 6) A new term, distance through functional insulation (DTFI), has been defined to describe the spacing between fully encapsulated live parts of different potential (the larger of creepage and clearance for the relevant voltage).
 - 7) Testing requirements to verify a clearance value less than the listed value (but not below the creepage distance) are defined.
 - 8) Requirements for junction boxes, cables and connectors, and polymeric frontsheets/backsheets have been removed (these are now covered in their respective standards).
 - 9) In Table 2, functional insulation is required for insulation between live parts of different potential inside a PV module for all module types.
 - 10) In Table 3 and Table 4:
 - i) lines related to pollution degree 3 have been removed, since this is not applicable to module laminates passing the requirements of IEC 61730-2;
 - ii) the minimum values for DTI have been increased to include the minimum 0,030 mm thickness (pinhole considerations);
 - iii) lines related to reinforced insulation have been combined;
 - iv) lines related to basic insulation have been combined, and functional insulation included on those lines;

v) lines for DTFI have been added.

11) Insulation coordination requirements for Class III modules have been removed from Table 4, and functional insulation requirements are included in text (no DTI thickness requirement).

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

Draft	Report on voting
82/2140/FDIS	82/2165/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.

A list of all parts in the IEC 61730 series, under the general title *Photovoltaic (PV) module safety qualification*, can be found on the IEC website.

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/standardsdev/publications.

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PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –

Part 1: Requirements for construction

1 Scope

This part of IEC 61730 specifies and describes the fundamental construction requirements for photovoltaic (PV) modules in order to provide safe electrical and mechanical operation. Specific topics are provided to assess the prevention of electrical shock, fire hazards, and personal injury due to mechanical and environmental stresses. This document pertains to the particular requirements of construction. IEC 61730-2 defines the requirements for testing. Modules with modified construction are qualified as described in IEC TS 62915.

This document lays down requirements for terrestrial PV modules suitable for long-term operation in open-air climates with 98th percentile module operating temperatures of 70 °C or less. Guidelines for modules to be used at higher operating temperatures are described in IEC TS 63126. The useful service life of modules so qualified will depend on their design, their environment, and the conditions under which they are operated. Therefore, test results are not construed as a quantitative prediction of module lifetime.

This document is intended to apply to all terrestrial flat plate module materials, such as crystalline silicon module types as well as thin-film modules.

PV modules covered by this document are limited to a maximum DC system voltage of 1 500 V.

This document defines the basic requirements for various applications of PV modules, but it cannot be considered to encompass all national or regional codes. Specific requirements, e.g. for building, floating, marine and vehicle applications, are not covered.

This document does not address specific requirements for products that combine a PV module with power conversion equipment, monitoring or control electronics, such as integrated inverters, converters or output disabling functions, which are addressed in IEC 62109-3.

While it is possible that parts of this document are applicable to flat plate PV modules with internally generated low-level concentration below three times, it was not written specifically to address these concerns.

This document is designed to coordinate with the test sequences in the IEC 61215 series, so that a single set of samples can be used to perform both the safety and design qualification of a PV module.

Additional construction 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, can apply in addition to the requirements contained within this document.

Any change to materials, design, or internal spacing are subject to a re-evaluation of the PV module or its component(s), as applicable, according to the IEC 61730 series and IEC TS 62915.

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 60216-1, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*

IEC 60216-2, *Electrical insulating materials – Thermal endurance properties – Part 2: Determination of thermal endurance properties of electrical insulating materials – Choice of test criteria*

IEC 60216-5, *Electrical insulating materials – Thermal endurance properties – Part 5: Determination of relative temperature index (RTE) of an insulating material*

IEC 60243-1:2013, *Electric strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60243-2:2013, *Electric strength of insulating materials – Test methods – Part 2: Additional requirements for tests using direct voltage*

IEC 60269-6, *Low-voltage fuses – Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems*

IEC 60364-7-712, *Low voltage electrical installations – Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems*

IEC 60417, *Graphical symbols for use on equipment*, available at <https://www.graphical-symbols.info/equipment>

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

[https://standards.iteh.ai/catalog/standards/sist/5eef43fe-6c78-41aa-9cf9-b8ae88fdf715/iec-](https://standards.iteh.ai/catalog/standards/sist/5eef43fe-6c78-41aa-9cf9-b8ae88fdf715/iec-60529-2023)

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC TS 60904-1-2, *Photovoltaic devices – Part 1-2: Measurement of current-voltage characteristics of bifacial photovoltaic (PV) devices*

IEC 60950-1:2005, *Information technology equipment – Safety – 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 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

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

IEC 62548, *Photovoltaic (PV) arrays – Design requirements*

IEC 62788-1 (all parts), *Measurement procedures for materials used in photovoltaic modules – Part 1: Encapsulants*

IEC 62788-1-2, *Measurement procedures for materials used in photovoltaic modules – Part 1-2: Encapsulants – Measurement of volume resistivity of photovoltaic encapsulants and other polymeric materials*

IEC TS 62788-2, *Measurement procedures for materials used in photovoltaic modules – Part 2: Polymeric materials – Frontsheets and backsheets*

IEC 62788-2-1, *Measurement procedures for materials used in photovoltaic modules – Part 2-1: Polymeric materials – Frontsheets and backsheets – Safety requirements*

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

IEC 62852, *Connectors for DC-application in photovoltaic systems – Safety requirements and tests*

IEC 62930, *Electric cables for photovoltaic systems with a voltage rating of 1,5 kV DC*

IEC TS 63126, *Guidelines for qualifying PV modules, components and materials for operation at high temperatures*

IEC TR 63225, *Incompatibility of connectors for DC-application in photovoltaic systems*

ISO 1456, *Metallic and other inorganic coatings – Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium*

ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

ISO 2081, *Metallic and other inorganic coatings – Electroplated coatings of zinc with supplementary treatments on iron or steel*

ISO 2093, *Electroplated coatings of tin – Specification and test methods*

ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*, available at <https://www.iso.org/obp>

ISO 9224:2012, *Corrosion of metals and alloys – Corrosivity of atmospheres – Guiding values for the corrosivity categories*

EN 50618, *Electric cables for photovoltaic systems*

UL 746B, *Standard for Polymeric Materials – Long Term Property Evaluations*

IEC/IEEE 82079-1, *Preparation of information for use (instructions for use) of products – Part 1: Principles and general requirements*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 60664-1, IEC TS 60904-1-2, IEC 61140, IEC TS 61836, IEC 61215-1 and 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 General terms and definitions

3.1.1

functional earthing

earthing for purposes other than electrical safety

[SOURCE: IEC 60050-195:2021, 195-01-13]

3.1.2

internal wiring

wiring and electrical connections that are made within the apparatus by its manufacturer

[SOURCE: IEC 60050-426:2020, 426-11-32]

3.1.3

external wiring

wiring that is not *internal wiring* (3.1.2), including, but not limited to, output cables

3.1.4

laminated

product made by bonding together two or more layers of the same or different materials

Note 1 to entry: It includes all components prior to attaching the junction box, frame or rail, and nameplate.

[SOURCE: IEC 60050-212:2010, 212-15-52, modified – Note 1 to entry has been added]

3.1.5

manufacturer

legal entity that manufactures a product, or that has a product designed or manufactured, and that markets the product under its name or trademark

3.1.6

module quality test

MQT

PV module quality test in accordance with IEC 61215-2

3.1.7

module safety test

MST

PV module safety test in accordance with IEC 61730-2

3.2 Components

3.2.1

backsheet

outer layer or combination of outer layers of the PV module, located as substrate on the back of the PV module and providing protection of the inner components of the PV module from external stresses and weather elements, as well as providing electrical insulation

3.2.2

connector

component which terminates conductors for the purpose of providing connection to and disconnection from a suitable mating component

[SOURCE: IEC 60050-581:2008, 581-06-01]

3.2.3 encapsulant

<general> material used between the substrate and superstrate to provide environmental protection for photovoltaic cells in a photovoltaic module

[SOURCE: IEC TS 61836:2016, 3.1.30, modified – Domain has been added.]

3.2.4 enclosure

part of an assembly providing a specified degree of protection of equipment against external influences and a specified degree of protection against approach to or contact with live parts

[SOURCE: IEC 60050-441:1984, 441-13-01, modified – In the definition, the words "and against contact with moving parts" have been deleted.]

3.2.5 frontsheet

outer layer or combination of outer layers of the PV module, located as superstrate on the front of the PV module and providing protection of the inner components of the PV module from external stresses and weather elements, as well as providing electrical insulation

3.2.6 insulation barrier

raised or recessed configuration of an insulator to increase creepage distance between conducting surfaces

[SOURCE: IEC 60050-581:2008, 581-22-15]

3.2.7 junction box

closed or protected enclosure in which circuits are electrically connected

[SOURCE: IEC TS 61836:2016, 3.2.16]

3.2.8 potting

sealing of components and associated conductors with a compound to exclude contaminants

[SOURCE: IEC 60050-581:2008, 581-24-20]

3.2.9 terminal

conductive part of a device, electric circuit or electric network, provided for connecting that device, electric circuit or electric network to one or more external conductors

Note 1 to entry: Can contain one or several contacts and the term therefore includes sockets, connectors, etc.

[SOURCE: IEC 60050-151:2001, 151-12-12, modified – The original Note 1 to entry has been replaced.]

3.3 Installation and application

3.3.1 building attached PV BAPV

system in which the PV modules are mounted on a building envelope and do not fulfil the criteria for *building integrated PV* (3.3.2)

3.3.2 building integrated PV BIPV

system in which the PV modules form a building component providing additional functions as defined in 5.5 b)

3.3.3 installation

<fixed wiring> permanent wiring system such as a raceway or conduit that prevents or reduces wire and cable movement

3.3.4 installation

<non-fixed wiring> unconstrained wiring system that consists of cables or wires able to move freely

3.3.5 non-restricted access area

area to which all persons including those who are not skilled, trained or instructed in electrical safety have general access

EXAMPLE Any PV installations which are not protected against public access by any means.

Note 1 to entry: A building's roof is considered non-restricted access area, unless explicitly marked as restricted area.

3.3.6 restricted access area

area accessible only to electrically skilled persons and electrically instructed persons with the proper authorization

EXAMPLE Utility-scale PV installations which are protected against public access by fences, location, etc., and where only persons skilled, trained or instructed in electrical safety have access.

[SOURCE: IEC 60050-195:2021, 195-04-04, modified – The example has been added.]

3.4 Insulation concepts

3.4.1 accessible part

part which can be touched by means of the standard test finger

Note 1 to entry: The standard test finger is as in Figure 2, test probe B of IEC 61032:1997.

[SOURCE: IEC 60050-442:1998, 442-01-15, modified – Note 1 to entry has been added.]

3.4.2 live part

conductive part intended to be energized under normal operating conditions

[SOURCE: IEC 60050-195:2021, 195-02-19, modified – The second part of the definition has been deleted because not applicable to DC.]

3.4.3 insulation system

insulating material, or an assembly of insulation materials, to be considered in relation with associated conducting parts, as applied to a particular type or size or part of electrical equipment

[SOURCE: IEC 60050-411:2007, 411-39-25]