

# 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 61730-1:2004

<https://standards.iteh.ai/catalog/standards/iec/86a4fb22-38b5-4620-aa0b-e0f04b6c9f0b/iec-61730-1-2004>



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### PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION –

#### Part 1: Requirements for construction

#### FOREWORD

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**This consolidated version of IEC 61730-1 consists of the first edition (2004) [documents 82/356/FDIS and 82/365/RVD], its amendment 1 (2011) [documents 82/659A/FDIS and 82/677/RVD] and its amendment 2 (2013) [documents 82/754/FDIS and 82/762/RVD]. It bears the edition number 1.2.**

**The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2. Additions and deletions are displayed in red, with deletions being struck through.**

International Standard IEC 61730-1 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 1: Requirements for construction

### 1 Scope and object

This part of IEC 61730 describes the fundamental construction 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. This part of IEC 61730 pertains to the particular requirements of construction. IEC 61730-2 outlines the requirements of testing.

This standard attempts to define the basic requirements for various application classes of PV 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 coordinate 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 object of this document is to provide basic guidance in certifying the fundamental construction of photovoltaic modules presented for safety approval by testing under IEC 61730-2. These requirements are intended to minimise the misapplication and misuse of modules or the breakdown of internal components which would result in fire, electric shock and personal injury. The standard defines the basic safety construction requirements and additional tests that are a function of the module end-use applications.

Component requirements are intended to provide evidence of performance of that component appropriate to its application in the module construction and environment.

NOTE The additional construction 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 60065, *Audio, video and similar electronic apparatus – Safety requirements***

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

~~IEC 60130 (all parts), *Connectors for frequencies below 3 MHz*~~

IEC 60189-2, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 2: Cables in pairs, triples, quads and quintuples for inside installations*

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

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



IEC 60364-5-51, *Electrical installations of buildings – Part 5-51: Selection and erection of electrical equipment – Common rules*

IEC 60417-DB:2002<sup>1</sup>, *Graphical symbols for use on equipment*

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

IEC 60587, *Electrical insulating materials used under severe ambient conditions – Test methods for evaluating resistance to tracking and erosion*

IEC 60695-1-1, *Fire hazard testing – Part 1-1: Guidance for assessing the fire hazard of electrotechnical products – General guidelines*

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

IEC 60695-2-20, *Fire hazard testing – Part 2-20: Glowing/hot wire based test methods – Hot-wire coil ignitability – Apparatus, test method and guidance<sup>2</sup>*

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

IEC 60695-11-20, *Fire hazard testing – Part 11-20: Test flames – 500 W flame test methods*

IEC 60947-1, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 61140:2001, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61215, *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*

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

IEC 61721, *Susceptibility of a photovoltaic (PV) module to accidental impact damage (resistance to impact test)*

IEC 61730-2:2004, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

IEC 61984, *Connectors – Safety requirements and tests*

ISO 261, *ISO general purpose metric screw threads – General plan*

ISO 262, *ISO general purpose metric screw threads – Selected sizes for screws, bolts, and nuts*

ANSI/UL 746C, *Standard for Polymeric Materials – Use in Electrical Equipment Evaluation*

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

ASTM D2303-97, *Standard Test Methods for Liquid-Contaminant, Inclined-Plane Tracking and Erosion of Insulating Materials*

ASTM E162-02a, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*

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<sup>1</sup> “DB” refers to the IEC on-line database.

<sup>2</sup> The 2004 edition of this publication was withdrawn in 2007. A new edition is currently under consideration.



### 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 this part of IEC 61730 and IEC 61730-2 and 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 this part of IEC 61730 and IEC 61730-2 within this application class are considered to meet the requirements for safety class III.

NOTE Safety classes are defined within IEC 61140.

### 4 Construction requirements

#### 4.1 General requirements

4.1.1 All modules shall be able to operate under environmental condition type AB8 according to IEC 60364-5-51.

4.1.2 A module shall be completely assembled when shipped from the factory, or shall be provided in subassemblies, provided assembly of the product does not involve any action that is likely to affect compliance with the requirements of the IEC 61730 series.

4.1.3 An assembly part, such as a terminal compartment cover, need not be affixed to the module at the factory. Incorporation of a module into the final assembly shall not require any alteration of the module from its originally evaluated form, unless specific details describing necessary modification(s) are provided in the installation instructions.

4.1.4 If a module must bear a definite relationship to another module for the intended installation and operation (for example, to allow connectors to mate), it shall be constructed to permit incorporation into the final assembly without the need for alteration.

4.1.5 The construction of a module shall be such that ground continuity is not interrupted by installation.

**4.1.6** Parts shall be prevented from loosening or turning if such loosening or turning may result in a risk of fire, electric shock, or injury to persons.

**4.1.7** Friction between surfaces, such as simple spring pressure, is not acceptable as the sole means to inhibit the turning or loosening of a part.

**4.1.8** Any adjustable or movable structural part shall be provided with a locking device to reduce the likelihood of unintentional movement, if any such movement may result in a risk of fire, electric shock, or injury to persons.

## 4.2 Metal parts

**4.2.1** Metals used in locations that are exposed to moisture shall not be employed alone or in combinations that could result in deterioration, such that the product would not comply with the requirements in this standard.

**4.2.2** Iron or mild steel serving as a necessary part of the product but not exposed to the weather shall be plated, painted, or enamelled for protection against corrosion.

**4.2.3** Simple sheared or cut edges and punched holes are not required to be additionally protected.

## 5 Polymeric materials

### 5.1 General

All polymeric materials shall have a minimum relative thermal endurance index (electrical and mechanical as defined by IEC 60216-5) of 20 °C above the maximum measured operating temperature of said material in application, as measured during the temperature test (IEC 61730-2, MST 21).

**NOTE** ~~Polymers serving as a superstrate or substrate have additional requirements, as specified in 5.3. and 5.4.~~

Polymers are classified into ~~four~~ **five** operational categories:

- polymers serving as an enclosure for live metal parts (such as a junction box) **shall meet requirements as specified in 5.2;**
- polymers serving as a support of live metal parts (such as integrated terminals) **shall meet the requirements of 5.3;**
- polymers serving as the outer surface for the module (such as a frontsheet and backsheet) which do not provide the major mechanical strength for the module **shall meet the requirements of 5.4;**
- polymers serving as ~~the outer surface for the module (such as the~~ a superstrate or a substrate) **which provide rigid reinforcement or serve as the carrier for the active cells;**
  - If the superstrate or substrate polymers are intended for contact with active cells they shall meet requirements as specified in 5.3.
  - If the superstrate or substrate polymers are intended for use as an outer surface they shall meet requirements as specified in 5.4.
  - If superstrate or substrate polymers are intended for both contact with active cells or other circuit elements and for use as the outer surface they shall meet requirements as specified in both 5.3 and 5.4.
- barriers **shall meet the requirements of 5.5.**

Exception: Encapsulation materials are not required to meet these requirements.

## 5.2 Polymers serving as an enclosure for live parts

A polymeric material serving as the enclosure of a part involving a risk of fire or electric shock shall comply with the following requirements:

- a) 5-V flammability rating (IEC 60695-11-20), either by material test or testing in the end-product ~~design component (IEC 60695-1-1)~~;
- b) 5-V flammability rating ~~either by material test or testing the end-product design (IEC 60695-11-20)~~, after the water immersion and exposure ~~test of the end-product (IEC 60695-1-1)~~;
- c) ultraviolet radiation resistance (if exposed to direct sunlight in the application), as determined in accordance with ANSI/UL 746C or ISO 4892-2. ~~Test condition defined by Xenon cycle 1 at 0,35 W/m<sup>2</sup>/nm or 41 W/m<sup>2</sup> (in the wavelength range from 300 nm to 400 nm), test duration 1 000 h; equivalent pass/fail-criteria as in UL 746C shall be applied,~~ and
- d) a minimum resistance to hot wire ignition rating of 30 (IEC ~~60695-1-1~~ 60695-2-20).

## 5.3 Polymers serving to support live parts

A polymeric material serving as the support or insulation of a part involving a risk of fire or electric shock shall:

- a) have a flammability classification of HB, V-2, V-1, or V-0 ~~in accordance with IEC 60695-11-10~~ and have a minimum high-current arc ignition rating determined in accordance with ~~IEC 60695-1-1~~ ANSI/UL 746C, as shown in Table 1,

Table 1 – High arc ignition rating for given flammability classification

Flammability classification	High-current arc ignition rating
HB	60
V-2	30
V-1	30
V-0	15

- b) have a Comparative Tracking Index (CTI) of 250 ~~V~~ or more, if the system voltage rating is 600 V or less, as determined in accordance with IEC 60112,

NOTE 1 Polymeric materials having a CTI of 250 or more are within material group IIIa of IEC 60664-1.

- c) have an inclined plane tracking rating of 1 h using the time to track method at 2,5 kV according to ~~ASTM D2303~~ IEC 60587, if the maximum system operating voltage rating is in the 601 V – 1 500 V range, and
- d) comply with the requirements for exposure to ultraviolet light as determined in accordance with the ANSI/UL 746C or ISO 4892-2, if exposed to direct sunlight during normal operation of the product. ~~Test conditions defined by Xenon cycle 1 at 0,35 W/m<sup>2</sup>/nm or 41 W/m<sup>2</sup> (in the wavelength range from 300 nm to 400 nm), test duration 1 000 h; equivalent pass/fail-criteria as in UL 746C shall be applied.~~

NOTE 2 Polymeric materials that are exposed to direct sunlight but are protected by glass, or other transparent medium, may be tested with an equivalent layer of that medium attenuating the ultraviolet light exposure during the test.

## 5.4 Polymers serving as an outer surface

5.4.1 A polymeric substrate or superstrate shall have a **relative thermal endurance** index, both electrical and mechanical, as determined in accordance with IEC 60216-5 of at least 90°C. In addition, the **relative thermal endurance** index shall be at least 20 °C above the maximum measured operating temperature of the material as measured during the temperature test given in IEC 61730-2, MST 21.

**5.4.2** Polymeric materials that serve as the outer enclosure for a module that (1) is intended to be installed in a multi-module or -panel system or (2) has an exposed surface area greater than 1 m<sup>2</sup> or a single dimension larger than 2 m, shall have a maximum flame spread index of 100 as determined under ASTM E162-02a.

NOTE Materials that serve as the wiring enclosure for a module, in accordance with 6.1.1, need not comply.

**5.4.3** If exposed to direct sunlight in the application, the polymeric material shall have been evaluated for ultraviolet (UV) radiation resistance as determined in accordance with ANSI/UL 746C or ISO 4892-2. Test condition defined by Xenon cycle 1 at 0,35 W/m<sup>2</sup>/nm or 41 W/m<sup>2</sup> (in the wavelength range from 300 nm to 400 nm), test duration 1 000 h; equivalent pass/fail-criteria as in UL 746C shall be applied.

**5.4.4** Polymeric materials intended for use as a superstrate or substrate, without appropriate IEC insulation pre-qualification, shall comply with the requirements of the partial discharge test, IEC 61730-2, MST 15.

## 5.5 Barriers

A barrier of polymeric insulating material providing the sole insulation between a live part and an accessible metal part or between uninsulated live parts not of the same potential shall be of adequate thickness and of a material appropriate for the application, as defined by IEC 61140. The barrier or liner shall be held in place and shall not be adversely affected to the extent that its necessary properties fall below the minimum acceptable values for the application.

## 5.6 Structural glazing materials

All structural glazing materials used as superstrates or substrates in the construction of modules shall comply with the requirements for safety glazing as described in ANSI Z97.1-93 by material certification or by testing in accordance with MST 32.

## 6 Internal wiring and current-carrying parts

A current-carrying part and wiring shall have the mechanical strength and current-carrying capacity necessary for its application.

### 6.1 Internal wiring

**6.1.1** Wiring used within a module shall have an insulation rated for a minimum of 90°C, with a gauge and voltage rating acceptable for the application as defined by the requirements of IEC 60189-2, as applicable.

**6.1.2** The wiring of a module shall be located so that after installation of the product in the intended manner, the insulation will not be exposed to the degrading effects of direct sunlight.

Exception: The requirement does not apply to wiring with insulation rated "sunlight resistant".

### 6.2 Splices

A splice shall be considered acceptable with insulation equivalent to that required for the wiring involved.

### 6.3 Mechanical securement