इंटरनेट मानक

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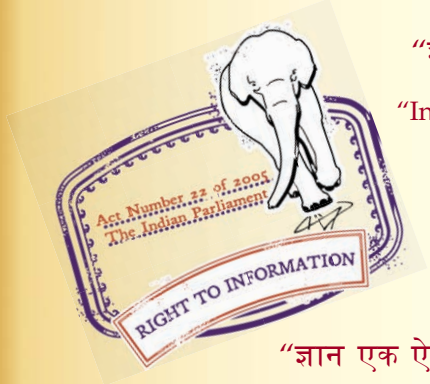
Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS/IEC 61730-1 (2004): Photovoltaic (PV) Module Safety Qualification, Part 1: Requirements for Construction [ETD 28: Solar Photovoltaic Energy Systems]



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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS/IEC 61730-1 : 2004

भारतीय मानक

प्रकाशवोल्टीय (पी वी) मॉडयूल सुरक्षा अर्हता

भाग 1 निर्माण अपेक्षाएँ

Indian Standard

PHOTOVOLTAIC (PV) MODULE SAFETY QUALIFICATION

PART 1 REQUIREMENTS FOR CONSTRUCTION

ICS 27.160

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

January 2010 **Price Group 7**

Solar Photovoltaic Energy Systems Sectional Committee, ETD 28

NATIONAL FOREWORD

This Indian Standard (Part 1) which is identical with IEC 61730-1 : 2004 'Photovoltaic (PV) module safety qualification — Part 1: Requirements for construction' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Solar Photovoltaic Energy Systems Sectional Committee and approval of the Electrotechnical Division Council.

The text of the IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, references appear to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their respective places are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60112 : 2003 Method for the determination of the proof and the comparative tracking indices of solid insulating materials	IS 2824 : 2007 Method for determination of the proof and the comparative tracking indices of solid insulating materials (*second revision*)	Identical
IEC 60130 (all parts) Connectors for frequencies below 3 MHz	IS 9647 : 1986 General requirements and methods of tests for low frequency connectors below 3 MHz including dc (*first revision*) IS 3826 (Part 2) : 1970 Specification for connectors for frequencies below 3 MHz: Part 2 Battery connectors for electronic equipment	Technically Equivalent
IEC 60216-1 Electrical insulating materials — Thermal endurance properties — Part 1: Ageing procedures and evaluation of test results	IS 8504 (Part 1) : 1994 Guide for determination of thermal endurance properties of electrical insulating materials: Part 1 General guidelines for ageing procedures and evaluation of test results (*first revision*)	do
IEC 60364-5-51 Electrical installations of buildings — Part 5-51: Selection and erection of electrical equipment — Common rules	IS 732 : 1989 Code of practice for electrical wiring installations (*third revision*)	do

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60529 Degrees of protection provided by enclosures (IP Code)	IS 12063 : 1987 Classification of degrees of protection provided by enclosures of electrical equipment	Technically Equivalent
IEC 60695-1-1 Fire hazard testing — Part 1-1: Guidance for assessing the fire hazard of electrotechnical products — General guidelines	IS 11000 (Part 1/Sec 1) : 1988 Fire hazard testing: Part 1 Guidance for the preparation of requirements and test specifications for assessing fire hazard of electronic and electrical items, Section 1 General guidance	do
IEC 60947-1 : 1988 Low-voltage switchgear and controlgear — Part 1: General rules	IS 13947 (Part 1) : 1993 Specification for low-voltage switchgear and controlgear: Part 1 General rules	Identical
IEC 61215 : 2005 Crystalline silicon terrestrial photovoltaic (PV) modules — Design qualification and type approval	IS 14286 : 2009 Crystalline silicon terrestrial photovoltaic (PV) modules — Design qualification and type approval (*first revision*)	do
IEC 61730-2 : 2004 Photovoltaic (PV) module safety qualification — Part 2: Requirements for testing	IS/IEC 61730-2 : 2004 Photovoltaic (PV) module safety qualification: Part 2 Requirements for testing	do
ISO 261 : 1998 ISO general purpose metric screw threads — General plan	IS 4218 (Part 2) : 2001 ISO general purpose metric screw threads: Part 2 General plan (*second revision*)	do
ISO 262 : 1998 ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts	IS 4218 (Part 4) : 2007 ISO general purpose: metric screw threads: Part 4 Selected sizes for screws, bolts and nuts (*third revision*)	do

The technical committee has reviewed the provisions of following International Standards referred to in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
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 60216-5	Electrical insulating materials — Thermal endurance properties — Part 5: Determination of relative thermal endurance index (RTE) of an insulating material
IEC 60417-DB : 2002[1)]	Graphical symbols for use on equipment
IEC 61140 : 2001	Protection against electric shock — Common aspects for installation and equipment
IEC 61646 : 1996	Thin-film terrestrial photovoltaic (PV) modules — Design qualification and type approval

[1)] "DB" refers to the IEC on-line database.

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

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Indian Standard

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 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[1], *Graphical symbols for use on equipment*

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

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

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 photovaltaic (PV) module to accidental impact damage (resistance to impact test)*

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

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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[1] "DB" refers to the IEC on-line database.

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

Polymers are classified into four operational categories:

– polymers serving as an enclosure for live metal parts (such as a junction box);
– polymers serving as a support of live metal parts (such as integrated terminals);
– polymers serving as the outer surface for the module (such as the superstrate or substrate);
– barriers.

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

All polymeric materials shall have a minimum relative thermal 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.

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, either by material test or testing in the end-product design (IEC 60695-1-1);

b) 5-V flammability rating, after water immersion and exposure 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, and

d) a minimum resistance to hot wire ignition rating of 30 (IEC 60695-1-1).

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 and have a minimum high-current arc ignition rating determined in accordance with IEC 60695-1-1, 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,

c) have an inclined plane tracking rating of 1 h using the time to track method at 2,5 kV according to ASTM D2303, 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 if exposed to direct sunlight during normal operation of the product.

NOTE 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 thermal index, both electrical and mechanical, as determined in accordance with IEC 60216-5 of at least 90°C. In addition, the thermal 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^2 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.

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

6.3.1 A joint or connection shall be mechanically secure and shall provide electrical contact without strain on connections and terminals. Soldered connections between module interconnections and cell metallizations are considered mechanically secure when held by encapsulation systems.

6.3.2 An uninsulated live part, including a terminal, shall be secured to its supporting surface so that it will be prevented from turning or shifting in position, if such motion may result in reduction of spacings to less than required in Tables 3 and 4.

7 Connections

7.1 Field connections – general requirements

7.1.1 A module shall be provided with wiring terminals, connectors, or leads to accommodate current-carrying conductors of the load circuit.

7.1.2 Field connections shall either be rated for exposure to direct sunlight as defined in Clause 5 or so located that after installation they will not be exposed to the degrading effects of direct sunlight.

7.2 Field wiring terminals

7.2.1 If the module contains a field wiring terminal block, it shall be rated for the appropriate voltage and current for the application and constructed in compliance with the requirements of IEC 60947-1.

7.2.2 If the module alternately contains wiring terminals integral to the construction of the terminal enclosure, they shall comply with the following requirements:

7.2.2.1 Screws and nuts which clamp external conductors shall have a thread conforming with ISO 261 or ISO 262, or a thread comparable in pitch and mechanical strength (e.g. standard threads). The screws and nuts used for field wiring shall not serve to fix any other component. These connections are also permitted to clamp internal conductors provided that the internal conductors are so arranged that they will not be displaced when fitting the external conductors.

7.2.2.2 Terminal screws shall have minimum sizes as shown in Table 2. Stud terminals shall be provided with nuts and washers.

7.2.2.3 Terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damage to the conductor. Terminals shall be so designed or located that the conductor cannot slip out when the clamping screws or nuts are tightened. Terminals shall be so fixed that, when the means of clamping the conductor is tightened or loosened:

a) the terminal itself does not work loose,

b) internal wiring is not subjected to stress,

c) creepage distances and clearances are not reduced below the values specified in Clause 9.

Table 2 – Sizes of terminals for supply conductors

Rated current of equipment A	Minimum nominal thread diameter mm	
	Pillar type or stud type	Screw type
Up to and including 10	3,0	3,5
Over 10 up to and including 16	3,5	4,0
Over 16 up to and including 25	4,0	5,0
Over 25 up to and including 32	4,0	5,0
Over 32 up to and including 40	5,0	5,0

7.3 Connectors

7.3.1 A connector intended for use in the output circuit of a module shall be rated for the appropriate voltage and current, as per the requirements of the IEC 60130 series. In addition, the connector shall comply with the requirements of Clause 5, with respect to flammability, comparative tracking index and relative thermal index for the support of live parts.

7.3.2 Unless a connector is appropriately evaluated for disconnect overload performance, the connector shall be assumed to be suitable for assembly only and not reliable as a disconnect means. See Clause 11.

7.3.3 A connector intended for exposure to the outdoor environment shall be enclosed by material which complies with the following:

a) the requirements of Clause 5, with respect to UV resistance,

b) resistance to inclusion of water, as per IEC 60529, equivalent to IP55,

c) the steel ball impact test, per IEC 61721,

d) the requirements of the accessibility test, IEC 61730-2, MST 11.

7.3.4 Separable multi-pole connectors shall be polarised. If two or more separable connectors are provided, they shall be configured or arranged so that the other and vice-versa will not accept the mating connector for one, if it will result in an improper connection.

7.3.5 For a connector incorporating a grounding member, the grounding member shall be the first to make and the last to break contact with the mating connector.

7.3.6 Connectors that can be separated without the use of a tool shall not have accessible conductive parts, as determined by 10.2 of IEC 61730-2.

7.4 Output lead or cables

Leads extending from the module shall be rated for the appropriate system voltage, ampacity, wet locations, temperature and sunlight resistance.

8 Bonding and grounding

8.1 A module with accessible conductive parts which form a perimeter framing or mounting system, or have a conductive surface area of greater that 10 cm^2 accessible after installation shall have provision for grounding.

8.2 Modules rated as safety class II may be provided with provisions for functional grounding. Such grounding means shall be isolated from live parts by reinforced insulation (7.3.2.2 of IEC 61140).

8.3 Each exposed conductive part of the module that is accessible during normal use shall be bonded together, as verified by 10.4 of IEC 61730-2.

Exception: If conductive materials are used only as fasteners for installation and separated from the conductive components of the module by both appropriate insulation and spacings, they are not required to be bonded.

8.4 Routine maintenance of a module shall not involve breaking or disturbing the bonding path. A bolt, screw, or other part used for bonding purposes within a module or panel shall not be intended for securing the complete device to the supporting surface or frame.

8.5 Bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connections, or welding, soldering or brazing. The bonding connection shall penetrate all non-conductive coatings, such as paint, anodised coatings or vitreous enamel.

8.6 All joints in the bonding path shall be mechanically secure, independently of any soldering.

8.7 If the bonding connection depends upon screw threads, two or more screws or two full threads of a single screw shall engage the metal.

8.8 The diameter of the grounding screw or bolt shall be sized appropriately to the gauge of the bonding conductor, as per Table 2.

8.9 A ferrous metal part in the grounding path shall be protected against corrosion by metallic or non-metallic coatings, such as painting, galvanising, or plating. Stainless steel is acceptable without additional coating.

8.10 A metal-to-metal multiple-bearing pin-type hinge is considered to be an acceptable means for bonding.

8.11 A wiring terminal or bonding location of a module intended to accommodate a field installed equipment-grounding conductor shall be identified with the appropriate symbol (IEC 60417-5019(DB:2002-10)) or shall have a green-coloured part. No other terminal or location shall be identified in this manner.

8.12 If a marking is used to identify an equipment grounding terminal, it shall be located on or adjacent to the terminal, or on a wiring diagram affixed to the module or panel near the terminal.

9 Creepage and clearance distances

9.1 The creepage and clearance distances between uninsulated live parts not of the same potential and between a live part and an accessible metal part, shall not be less than the values specified in Tables 3 and 4.

These spacing requirements do not apply to the inherent spacings of a component. Such spacings shall comply with the requirements for the component in question. These distances also do not apply to solid insulation materials. Those insulation properties can be assessed through the tests outlined in IEC 61730-2.

9.2 Creepage and clearance distances at field wiring terminals are to be judged on module open-circuit voltage (V_{oc}). If additional unmarked terminals exist in the terminal block, or if wiring terminals are marked specifically for grounding, the creepage and clearance distances will be judged on the basis of the maximum system operating voltage.

Table 3 – Minimum acceptable creepage and clearance distances between field wiring terminals

Voltage V	mm
0 – 50	6,5
51 – 300	9,5
301 – 600	12,5
601 – 1 000	16
1 001 – 1 500	25

Table 4 – Minimum acceptable clearance distances between internal current-carrying parts and accessible points

Maximum system voltage V	**Clearance** mm		
	Class C	**Class B**	**Class A**
0 – 50	2	2	2
51 – 300		3,2	6,4
301 – 600		3,2	6,4
601 – 1 000		4,2	8,4
1 001 – 1 500		8	11

NOTE The encapsulant materials used in PV construction cannot be considered totally non-hygroscopic and the lamination process does not provide a truly sealed system. Therefore, creepage and clearance distances specified are based on pollution degree 2, material grade IIIa & IIIb, also case A, impulse voltage 8 kV. Rounding was done upward to promote conservative margins.

9.3 The spacings at a field-wiring terminal are to be measured with and without wire connected to the terminal. The wire shall be connected as it would be in actual use. If the terminal will properly accommodate it, and if the product is not marked to restrict its use, the wire is to be one size larger than that required, otherwise, the wire is to be the size required.

9.4 Surfaces separated by a gap of 0,4 mm or less are considered to be in contact with each other for the purpose of judging creepage distances.

10 Field wiring compartments with covers

10.1 General

Modules designed for the application of a permanently attached wiring system by an installer in the field shall be provided with an enclosed wiring compartment, which provides protection of the conductors and connections from environmental stress, protection from accessibility to live uninsulated parts and strain relief for the attached wiring system.

NOTE The considerations mentioned in Clause 5 apply to non-metallic wiring compartments.

10.2 Wall thickness

A wiring compartment intended for the attachment of a field-applied permanent wiring system shall provide the minimum wall thickness, based on the material used, as specified in Table 5.

Table 5 – Minimum wall thickness for given material

Material	Minimum thickness [a] mm
Sheet steel, uncoated	1,35
Sheet steel, zinc coated	1,42
Sheet aluminium	1,59
Cast iron, aluminium, brass, or bronze	2,4
Polymeric materials	3

[a] If the wall thickness is less than the specified values, acceptability is to be determined from the results of the impact test, the crushing resistance test, the conduit bending tests, and the end-product 5 V flammability tests. For enclosure with conduit, see Table 6.

10.3 Internal volume

A minimum internal volume for each intended conductor, including integral conductors of the module, shall be provided in a wiring compartment, within ±5 % as given in Table 6.

Table 6 – Minimum internal volume/conductor for given conductor size

Conductor size	Minimum internal volume, each conductor cm^3
1,5 mm^2	25
No. 14 AWG	33
2,5 mm^2	40
No. 12 AWG	36,9
4 mm^2	60

In the space comprising the minimum required volume, no enclosure dimension shall be less than 20 mm.

10.4 Openings

All openings shall be provided with appropriate coverings (such as knockouts, plugs, etc.), whose functions comply with the requirements of 5.2.1, the wet leakage test of Subclause 10.20 of IEC 61646 and the accessibility test of Subclause 10.2 of IEC 61730-2, and should only be able to be removed by the use of a tool.

10.5 Gaskets and seals

Gaskets and seals shall not deteriorate beyond limits during accelerated ageing, and shall not be used where they may be subject to flexing during normal operation. See accelerated ageing test, IEC 60216-1.

10.6 Strain relief

Strain relief shall be provided so that stress on a lead intended for field connection, or otherwise likely to be handled in the field, including a flexible cord, is not transmitted to the electrical connection inside the module. Mechanical securement means which comply with 10.14 of IEC 61215 meet this requirement.

10.7 Sharp edges

10.7.1 The enclosure shall be smooth and free from sharp edges, burrs, or the like that may damage insulation or conductors.

Compliance shall be done by inspection.

10.7.2 This requirement also applies to the inner edges of conduit openings and knockouts.

10.8 Conduit applications – Metallic

10.8.1 A threaded hole in a metal wiring compartment intended for the connection of rigid metal conduit shall be reinforced to provide metal not less than 6,4 mm (1/4 in.) thick, and shall be tapered unless a conduit end stop is provided.

10.8.2 If threads for the connection of conduit are tapped all the way through a hole in a compartment wall, or if an equivalent construction is employed, there shall not be less than 3,5 nor more than 5 threads in the metal and the construction shall be such that a conduit bushing can be attached as intended.

10.8.3 If threads for the connection of conduit are not tapped all the way through a hole in a compartment wall, there shall not be less than 5 full threads in the metal and there shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

10.8.4 For a non-threaded opening in a metal wiring compartment intended to accommodate rigid metallic conduit, a flat surface of sufficient area shall be provided around the opening to accept the bearing surfaces of the bushing and lock washer.

10.8.5 Conduit shall comply with the Conduit bending test described in Clause 11 of IEC 61730-2, MST 33.

10.9 Conduit applications – Non-metallic

10.9.1 The sides, end walls, and bottom of a non-metallic wiring enclosure specified for conduit applications shall not have a thickness less than the values specified in Table 7.

Table 7 – Wall thickness of polymeric boxes intended for conduit

Trade size of conduit mm	Minimum wall thickness mm
13 to 25	3
26 to 50	4
51 to 100	5

10.9.2 A non-metallic wiring compartment intended to accommodate non-metallic conduit shall have the following:

a) one or more unthreaded conduit-connection sockets integral with the compartment that comply with the requirements of the conduit system intended;

b) one or more threaded or unthreaded openings for a conduit-connection socket, or one or more knockouts that comply with the requirements of IEC 61730-2, MST 44;

c) compliance with Subclause 11.2 of IEC 61730-2, MST 33, if intended for rigid non-metallic conduit. A module which does not comply with MST 33 shall be marked "For use with non-rigid non-metallic conduit only." Modules which comply with MST 33 may be marked "For use with rigid non-metallic conduit".

10.9.3 A socket for the connection of non-metallic conduit shall provide a positive end stop for the conduit. The socket diameters, the throat diameter at the entrance to the box, the socket depths, and the wall thickness of the socket shall be within the limits specified in the applicable conduit system.

10.9.4 A knockout or opening in a non-metallic wiring compartment intended to accommodate rigid non-metallic conduit shall comply with the dimensional requirements of the applicable conduit system.

11 Marking

11.1 Each module shall include the following clear and indelible markings:

– name, monogram or symbol of manufacturer;
– type or model number;
– serial number;
– polarity of terminals or leads (colour coding is permissible);
– maximum system voltage for which the module is suitable;
– safety class in accordance with IEC 61140, if applicable.

The date and place of manufacture shall be marked on the module or be traceable from the serial number.

NOTE International symbols should be used where applicable.

11.2 These additional markings shall be applied to either the module or placed into the instruction and installation data (required documents). All electrical data should be shown as relative to standard test conditions (1 000 W/m^2 at 25 °C):

– voltage at open-circuit;
– current at short-circuit;
– maximum over-current protection rating, as verified by IEC 61730-2, MST 26;
– recommended maximum series/parallel module configurations;
– application class of product.

11.3 Connectors suitable only for field assembly of modules shall be marked “Do not disconnect under load”.

11.4 For modules with open-circuit voltage in excess of 50 V, and/or modules rated for maximum system voltage in excess of 50 V, a highly visible warning label regarding the shock hazard shall be applied near the means of connection to the module.

12 Requirements for supplied documents

12.1 A module or panel shall be supplied with installation instructions describing the methods of electrical and mechanical installation and the electrical ratings of the module. The instructions shall state the application class under which the module was qualified and any specific limitations required for that application class.

12.2 When the fire rating is dependent on a specific mounting structure, specific spacing, or specific means of attachment to the roof or structure, details of the specific parameter or parameters shall be included in the instructions.

12.3 The electrical installation instructions shall include a detailed description of the wiring method to be used. This description shall include:

– the grounding method to be used;
– the size, type, and temperature rating of the conductors to be used;
– recommended maximum series/parallel module configurations;
– the type of overcurrent protection and diode bypassing to be used;
– the minimum cable diameters when the wiring method is cable;
– any limitations on wiring methods that apply to the wiring compartment or box.

12.4 The mechanical installation instructions for roof mounting shall include:

– a statement indicating the minimum mechanical means for securing the module or panel to the roof;
– for a non-integral module or panel, a statement that the assembly is to be mounted over a fire resistant roof covering rated for the application;
– indication of any slope required for maintaining a fire class rating.

12.5 The installation instructions shall include a statement advising that artificially concentrated sunlight shall not be directed on the module or panel.

12.6 Assembly instructions shall be provided with a product shipped in subassemblies, and shall be detailed and adequate to the degree required to facilitate total assembly of the product.

12.7 To allow for increased output of a module resulting from certain conditions of use, the installation instructions shall include the following statement or the equivalent:

"Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. Accordingly, the values of I_{SC} and V_{OC} marked on this module should be multiplied by a factor of 1,25 when determining component voltage ratings, conductor current ratings, fuse sizes, and size of controls connected to the PV output."

13 Modifications

13.1 Any significant redesign or reconfiguration of the electrical or mechanical elements of a module previously qualified under both this part of IEC 61730 and verified by testing in IEC 61730-2 will require an engineering re-examination in order to determine the effect of those modifications. Based on that re-examination, additional testing under IEC 61730-2 many be deemed necessary.

13.2 Guidance on this can be obtained in the blank detail specifications, IEC 62145 (under consideration).

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