

AS/NZS 61730.1:2024



Australian/New Zealand Standard™

Photovoltaic (PV) module safety qualification

Part 1: Requirements for construction (IEC 61730-1:2023 (ED. 3.0), MOD)



AS/NZS 61730.1:2024

This Joint Australian/New Zealand Standard™ was prepared by Joint Technical Committee EL-042, Renewable Energy Power Supply Systems & Equipment. It was approved on behalf of Standards Australia's Standards Development and Accreditation Committee on 04 June 2024 and by the New Zealand Standards Approval Board on 05 June 2024.

This Standard was published on 21 June 2024.

The following are represented on Committee EL-042:

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Australian PV Institute
Better Regulation Division (Fair Trading, SafeWork NSW, TestSafe)
Clean Energy Council
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This Standard was issued in draft form for comment as DR AS/NZS 61730.1:2024.

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ISBN 978 1 76139 677 9

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**Part 1: Requirements for construction (IEC
61730-1:2023 (ED. 3.0), MOD)**

First published as AS/NZS 61730.1:2024.



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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-042, Renewable Energy Power Supply Systems and Equipment.

The objective of this document is to specify and describe 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. AS/NZS 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 is designed to coordinate with the test sequences in the AS/NZS 61215 series, so that a single set of samples can be used to perform both the safety and design qualification of a PV module.

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 AS/NZS 61730 series and IEC TS 62915.

This document is identical with national modifications, and has been reproduced from IEC 61730-1:2023, *Photovoltaic (PV) module safety qualification — Part 1: Requirements for construction*.

The modifications are additional requirements and are set out in Appendix ZZ, which has been added at the end of the source text.

Appendix ZZ lists the modifications to IEC 61730-1:2023 for the application of this document in Australia and New Zealand.

As this document has been reproduced from an International document, a full point substitutes for a comma when referring to a decimal marker.

Australian or Australian/New Zealand Standards that are identical adoptions of international normative references may be used interchangeably. Refer to the online catalogue for information on specific Standards.

The terms “normative” and “informative” are used in Standards to define the application of the appendices or annexes to which they apply. A “normative” appendix or annex is an integral part of a Standard, whereas an “informative” appendix or annex is only for information and guidance.

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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) frontsheets/backsheets 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 $> 70 \text{ }^\circ\text{C}$ 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.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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NOTES

Australian/New Zealand Standard

Photovoltaic (PV) module safety qualification

Part 1: Requirements for construction (IEC 61730-1:2023 (ED. 3.0), MOD)

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)*

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]

3.4.4

electric insulation

insulation

(electricity) part of an electrotechnical product which separates conducting parts at different electric potentials during operation or insulates such parts from the surroundings

[SOURCE: IEC 60050-212:2010, 212-11-07, modified - The admitted term has been added as synonym and the domain has been specified.]

3.4.5

basic insulation

insulation that provides basic protection against electric shock

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes.

[SOURCE: IEC 60050-195:2021, 195-06-06, modified - In the definition, "against electric shock" has been added.]

3.4.6

double insulation

insulation comprising both *basic insulation* ([3.4.5](#)) and *supplementary insulation* ([3.4.9](#))

[SOURCE: IEC 60050-195:2021, 195-06-08]

3.4.7

functional insulation

insulation between conductive parts, necessary for the proper functioning of the equipment

Note 1 to entry: Functional insulation by definition does not protect against electric shock. It can, however, reduce the likelihood of ignition and fire.

[SOURCE: IEC 60050-195:2021, 195-02-41, modified - Note 1 to entry has been added.]

3.4.8

reinforced insulation

insulation of hazardous-live parts (3.4.2) that provides a degree of protection against electric shock equivalent to *double insulation* (3.4.6)

Note 1 to entry: Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation.

[SOURCE: IEC 60050-195:2021, 195-06-09, modified - In the definition, "hazardous-live parts" has been added.]

3.4.9

supplementary insulation

independent insulation applied in addition to *basic insulation* (3.4.5), that provides fault protection

EXAMPLE It can be used in order to reduce the risk of electric shock in the event of a failure of the basic insulation.

[SOURCE: IEC 60050-195:2021, 195-06-07, modified - The example has been added.]

3.4.10

solid insulation

solid insulating material, or a combination of solid insulating materials, placed between two conductive parts or between a conductive part and a body part

Note 1 to entry: It includes both thin films and cemented joints, with related but different testing and dimensioning requirements.

[SOURCE: IEC 60050-903:2015, 903-04-14, modified - The example has been deleted and Note 1 to entry has been added.]

3.4.11

cemented joint

joint comprised of two insulating materials where the interface has been demonstrated to be cemented, and thus considered as *solid insulation* (3.4.10) with no interface for creepage

3.4.12

relied upon insulation

RUI

solid insulation (3.4.10) system providing protection against electric shock in the final application, with material's requirements for thickness, thermal endurance and resistance against environmental stress factors

Note 1 to entry: Thin films used as polymeric backsheet or frontsheet can consist of *RUI* plus additional layers that have other functions, e.g. they protect the polymeric materials from UV radiation.

3.4.13

breakdown voltage

V_{B-DC}

DC voltage at which electric breakdown occurs under prescribed test conditions, or in use

Note 1 to entry: Breakdown voltage testing in context of PV modules and components materials applies direct current (DC).

[SOURCE: IEC 60050-212:2010, 212-11-34, modified - The symbol and Note 1 to entry have been added.]

3.4.14

material group

category of insulation materials according to IEC 60664-1

3.4.15

comparative tracking index

CTI

numerical index value related to the maximum voltage that a material can withstand without formation of a permanent and electrically conductive carbon (tracking) path and without occurrence of a persistent flame, when evaluated under specified test conditions defined in IEC 60112

Note 1 to entry: The mentioned maximum test voltage is not in conjunction with any system or operational voltage, but it is used for evaluation of material groups.

[SOURCE: IEC 60050-212:2010, 212-11-59, modified - The definition has been rephrased by also clarifying that CTI is an index value to evaluate material groups according to IEC 60112. Note 1 to entry has also been added.]

3.4.16

clearance

cl

shortest distance in air, between two conductive parts or between a conductive part and an accessible surface

[SOURCE: IEC 60050-581:2008, 581-27-76, modified - The definition has been extended by "or between a conductive part and an accessible surface".]

3.4.17

creepage distance

cr

shortest distance along the surface of a solid insulating material between two conductive parts or between conductive *live parts* ([3.4.2](#)) and *accessible parts* ([3.4.1](#))

[SOURCE: IEC 60050-581:2008, 581-21-23, modified - The abbreviation has been added. In the definition, a second pair of parts has been added.]

3.4.18

distance through insulation

DTI

thickness of relied upon insulation (*RUI*) in a PV module, with the minimum allowable value defined by the maximum working voltage

3.4.19

distance through solid insulation

shortest distance through solid insulation between two conductive parts

[SOURCE: IEC 60050-426:2020, 426-04-14]

3.4.20

distance through functional insulation

shortest distance through material not qualified as relied upon insulation between two conductive parts

3.5 Ratings

3.5.1

rated value

value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system

[SOURCE: IEC 60050-151:2001, 151-16-08]

3.5.2

rating

set of rated values and operating conditions

[SOURCE: IEC 60050-151:2001, 151-16-11]

3.5.3

rated current of overcurrent protection device

current rating of fuse or circuit breaker according to IEC 60269-6

3.5.4

pollution degree

numeric classification characteristic of the expected pollution of the micro-environment

[SOURCE: IEC 60050-581:2008, 581-21-07, modified - In the definition, "numeral characterizing" has been changed to "numeric classification characteristic of".]

3.5.5

maximum rated altitude

maximum altitude at which the module is rated to be deployed at the rated system voltage in the nameplate

Note 1 to entry: This implies the module has either been designed with larger clearance distances ([Table 5](#)) or tested for the applicable higher impulse voltage rating at a given fixed clearance spacing to qualify for that altitude.

3.5.6

maximum rated operating temperature

$[T_{98}]_{\max}$

maximum 98th percentile module operating temperature at which the module is rated to be deployed at the rated temperature on the nameplate

3.6 Temperatures

3.6.1

environmental temperature

air temperature defined in degrees Celsius and measured and documented by meteorological services for the installation's geographic location

3.6.2

temperature index

TI

numerical value of the Celsius temperature expressed in degrees Celsius characterizing the thermal capability of an insulating material or an insulation system

[SOURCE: IEC 60050-212:2010, 212-12-11, modified - Notes have been removed.]

3.6.3

relative temperature index

RTI

temperature index of an insulating material or system obtained from the time which corresponds to the known temperature index of a reference material or system when both are subjected to the same ageing and diagnostic procedures in a comparative test

[SOURCE: IEC 60050-212:2010, 212-12-12]

3.6.4 relative thermal endurance index RTE

numerical value of the Celsius temperature expressed in degrees Celsius at which the estimated time to endpoint of an insulating material is the same as the estimated time to endpoint of a control material at a temperature equal to its assessed thermal endurance

[SOURCE: IEC 60050-212:2010, 212-12-14, modified - Notes have been removed.]

3.6.5 98th percentile module operating temperature

temperature at which a module is operating below more than 98 % of the time when deployed in a PV system

Note 1 to entry: The 98th percentile module operating temperature is calculated by ranking measured or calculated module temperature data taken at hourly (or more frequent) time intervals for a typical calendar year.

Note 2 to entry: For a standard year, the 98th percentile module operating temperature is met or exceeded for 175,2 h.

3.7 Voltages

3.7.1 rated system voltage

$[V_{\text{sys}}]_{\text{max}}$
maximum voltage between any *live part* (3.4.2) and *accessible part* (3.4.1) or earth against which the *electric insulation* (3.4.4) of the PV module is designed to stand under operating conditions as specified by the manufacturer

3.7.2 working voltage

highest RMS value of the DC voltage across any particular insulation which can occur when the equipment is operated at rated voltage

[SOURCE: IEC 60050-581:2008, 581-21-19, modified - The definition has been limited to DC and "supplied" has been replaced by "operated".]

3.8 Bifacial photovoltaics

3.8.1 bifacial PV module

module that can generate electric power by converting UV-VIS-IR radiation received on both front and rear sides by means of the photovoltaic effect

3.8.2 bifaciality coefficient

ratio between the main characteristics of the rear side and the front side of a bifacial PV device

Note 1 to entry: Usually bifacial coefficients are referred to Standard Test Conditions (STC).

Note 2 to entry: Three types of coefficient are defined in IEC TS 60904-1-2. They are:

- bifaciality coefficient for short-circuit current, $\phi_{I_{sc}}$;
- bifaciality coefficient for open-circuit voltage, $\phi_{V_{oc}}$;
- bifaciality coefficient for maximum power point, $\phi_{P_{max}}$.

3.8.3**bifacial nameplate irradiance****BNPI**

irradiance at which currents are measured on bifacial modules, corresponding to 1 000 W/m² on the module front and 135 W/m² on the module rear, applied by any method allowed in IEC TS 60904-1-2

3.8.4**bifacial stress irradiance****BSI**

higher irradiance at which currents for stress are measured on bifacial modules, corresponding to 1 000 W/m² on the module front and 300 W/m² on the module rear, applied by any method allowed in IEC TS 60904-1-2

3.8.5**applied bifacial stress irradiance****aBSI**

irradiance corresponding to the combination of 1 000 W/m² on the front side of the module with the value that is greater of 300 W/m² or the manufacturer's claimed irradiance value for the rear side of the module

4 Symbols and abbreviated terms

$I_{SC-BNPI}$	short-circuit current for bifacial PV modules at BNPI
I_{SC-BSI}	short-circuit current for bifacial PV modules at BSI
I_{mp-BSI}	current at maximum power point of bifacial PV modules exposed to BSI
$I_{SC-aBSI}$	short-circuit current for bifacial PV modules under aBSI conditions of irradiance
$I_{mp-aBSI}$	current at maximum power point of bifacial PV modules exposed to aBSI conditions of irradiance

5 Classification, applications and intended use**5.1 General**

Protection against electric shock will be achieved by combinations of constructional measures used to build the module together with how the module is installed.

The degree of protection that the PV modules achieve shall be classified according to the descriptions provided in [Table 1](#), based on requirements in IEC 61140. Each PV module shall be classified for protection against electric shock by attributing to it the same class to which it complies according to IEC 61140. The use of the protections in the different classes for the PV modules is described in [5.2](#) to [5.4](#). PV modules complying with Class I of IEC 61140 are not covered in this document.

EXAMPLE A PV module that satisfies the requirements for protection against electric shock as identified by Class II of IEC 61140 is classified as a Class II PV module.

In relation to this, the PV modules shall be marked in accordance with [6.2.2](#).

Table 1 — Classes for protection against electric shock

Class (as defined in IEC 61140)	Application in this document
0	Application in restricted access area
II	Application in non-restricted access area
III	Basic protection by limitation of voltage (ELV)

5.2 PV modules of Class 0

5.2.1 General

Class 0 PV modules have individual and/or system level electrical outputs at hazardous levels of voltage, current and power.

5.2.2 Insulation

These PV modules are provided with basic insulation only as provision for basic protection and with no provisions for fault protection. All conductive components that are not separated from hazardous live parts by at least basic insulation shall be treated as if they are hazardous live parts.

5.2.3 Application

Class 0 PV modules are intended for use in restricted access areas that are protected from public access by fences or other measures of the location that prevent general access. Such PV modules are only to be accessed by persons knowledgeable of the inherent hazards associated with their use and failure modes.

5.3 PV modules of Class II

5.3.1 General

Class II PV modules have individual and/or system level electrical outputs at hazardous levels of voltage, current and power.

5.3.2 Insulation

These PV modules are provided with:

- basic insulation as basic protection, and
 - supplementary insulation as precaution for fault protection,
- or
- double insulation as basic and supplementary insulation, or reinforced insulation.

Accessible conductive parts and accessible surfaces of insulation material shall be:

- separated from hazardous live parts by double or reinforced insulation,
- or
- designed with constructional measures which provide comparable protection.

All conductive parts which are separated from hazardous live parts only by basic insulation or by constructional design means which provide comparable protection shall be separated from accessible surfaces by supplementary insulation. All conductive parts which are not separated from hazardous live parts at least by basic insulation shall be considered as hazardous live parts.

5.3.3 Application

These PV modules are intended for installations where non-restricted access to the PV module and contact to insulated live parts can occur.

5.4 PV modules of Class III

5.4.1 General

Class III PV modules shall not have electrical ratings larger than:

- 240 W for the maximum power point,
- 35 V DC for the open-circuit voltage, and
- 8 A for the short-circuit current,

when tested under STC. The three maximum rating conditions shall apply concurrently.

5.4.2 Insulation

Class III PV modules have inherently limited capability of electrical output. Therefore, their use, misuse and failure are unlikely to result in a risk of electric shock or fire. Based upon these electrical output limitations, no requirements for construction or insulation are given beyond functional insulation.

5.4.3 Application

These PV modules are intended for installations where non-restricted access to the PV module and contact to uninsulated live parts can occur, e.g. in consumer electronics. Class III PV modules shall not be combined in series strings operating at more than 35 V in V_{OC} and shall not have a system voltage rating above 35 V. These PV modules are not intended for use in parallel with other PV modules or energy sources unless their combination provides protection from reverse current and from overvoltage protection.

5.5 Rating categories and special applications

PV modules can be installed in many different applications and system configurations.

Modules are intended for use in the temperature range from a lower environmental temperature of $-40\text{ }^{\circ}\text{C}$ to the upper-limit set by a 98th percentile module operating temperature of $70\text{ }^{\circ}\text{C}$, unless tested according to IEC TS 63126.

Modules qualified for a 98th percentile module operating temperature equal to or less than $70\text{ }^{\circ}\text{C}$ will allow for use in PV arrays designed with unrestricted airflow to the back of the module anywhere in the world. Systems designed with restricted airflow in very hot locations may result in a 98th percentile module operating temperature greater than $70\text{ }^{\circ}\text{C}$, and require modules tested to higher temperature conditions as provided in IEC TS 63126.

System design and installation factors which can affect the module operating temperature include (but are not limited to): site specific environmental conditions (irradiance, temperature, wind speed), and mounting distance, array size, array spacing, anti-nesting features which could reduce airflow. Installers must consider these factors in design of systems. Refer to IEC TS 63126 for more information.

NOTE 1 Specific geographic restrictions can apply; maps in IEC TS 63126 provide examples.

NOTE 2 An IEC document describing a method for calculating the 98th percentile module operating temperature for different mounting and geographical combinations is in progress.

For special applications, such as the examples listed below, additional requirements can apply:

- Building attached PV (BAPV).
- Building integrated PV (BIPV, see IEC 63092-1).