IEC 62548-1

Edition 1.0 2023-12

INTERNATIONAL STANDARD

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Photovoltaic (PV) arrays – Part 1: Design requirements

IEC 62548-1:2023-12en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 27.160

ISBN 978-2-8322-7848-2

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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PHOTOVOLTAIC (PV) ARRAYS – Part 1: DESIGN REQUIREMENTS

FOREWORD

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IEC 62548-1 has been prepared by IEC technical committee 82: Solar photovoltaic energy systems. It is an International Standard.

This first edition cancels and replaces IEC 62548 published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Revised provisions for systems including DC to DC conditioning units.
b) Revision of mounting structure requirements.
c) Revised cable requirements.
d) Revision of Clause 6 on safety issues which includes provisions for protection against electric shock including array insulation monitoring and earth fault detection.
e) Revision of 7.2.7 and 7.3 with respect to isolation means.

f) Provisions for use of bifacial modules and modules mounted in non-optimal orientations.

g) New Annex F containing: K_I factor calculations for bifacial and non-optimally oriented systems; anti-PID equipment and arc flash.

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

Draft	Report on voting
82/2174/FDIS	82/2193/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.

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- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

PHOTOVOLTAIC (PV) ARRAYS – Part 1: DESIGN REQUIREMENTS

1 Scope

This document sets out design requirements for photovoltaic (PV) arrays including DC array wiring, electrical protection devices, switching and earthing provisions. The scope includes all parts of the PV array and final power conversion equipment (PCE), but not including energy storage devices, loads or AC or DC distribution network supplying loads.

The object of this document is to address the design safety requirements arising from the particular characteristics of photovoltaic systems. Direct current systems, and PV arrays in particular, pose some hazards in addition to those derived from conventional AC power systems, including the ability to produce and sustain electrical arcs with currents that are not greater than normal operating currents.

In systems supplying AC loads or circuits, the safety requirements mentioned in this document are however critically dependent on the inverters associated with PV arrays complying with the requirements of IEC 62109-1, IEC 62109-2 and IEC 62109-3.

Installation requirements are also critically dependent on compliance with the IEC 60364 series (see Clause 4).

PV arrays of less than 100 W and less than 35 V DC open circuit voltage at STC are not covered by this document.

PV arrays in grid interconnected systems connected to medium or high voltage systems are not covered in this document, except as required by IEC TS 62738. Variations and additional requirements for large-scale ground mounted PV power plants with restricted access to personnel are addressed in IEC TS 62738.

Additional requirements may be needed for more specialized installations, for example concentrating systems, tracking systems or building integrated PV.

This document also includes extra protection requirements of PV arrays when they are directly connected with batteries at the DC level.

Attention is drawn to the co-existence of IEC 60364-7-712 and IEC 62548. Both standards have been developed in close coordination, respectively by IEC technical committees 64 and 82.

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 60228, *Conductors of insulated cables*

IEC 60269-1, *Low-voltage fuses – Part 1: General requirements*

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

IEC 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-4 (all parts), *Low-voltage electrical installations – Part 4: Protection for safety*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:2017

IEC 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*
IEC 60364-4-44:2007/AMD1:2015
IEC 60364-4-44:2007/AMD2:2018

IEC 60364-5 (all parts), *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment*

IEC 60364-5-52, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60364-5-54, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

IEC 60364-6, *Low-voltage electrical installations – Part 6: Verification*

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

IEC 60898-2, *Circuit-breakers for overcurrent protection for household and similar installations – Part 2: Circuit-breakers for AC and DC operation*

IEC 60898-3, *Circuit-breakers for overcurrent protection for household and similar installations – Part 3: Circuit-breakers for DC operation*

IEC 60947-1:2020, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-2, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 61215 (all parts), *Terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61439-2, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*

IEC 61643-21, *Low-voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods*

IEC 61643-22, *Low-voltage surge protective devices – Part 22: Surge protective devices connected to telecommunications and signalling networks – Selection and application principles*

IEC 61643-31:2018, *Low-voltage surge protective devices – Part 31: Requirements and test methods for SPDs for photovoltaic installations*

IEC 61701, *Photovoltaic (PV) modules – Salt mist corrosion testing*

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

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

IEC TS 61836:2016, *Solar photovoltaic energy systems – Terms, definitions and symbols*

IEC 61984, *Connectors – Safety Requirements and tests*

IEC 62109-1:2010, *Safety of power converters for use in photovoltaic power systems – Part 1: General requirements*

IEC 62109-2, *Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters*

IEC 62109-3, *Safety of power converters for use in photovoltaic power systems – Part 3: Particular requirements for electronic devices in combination with photovoltaic elements*

IEC 62305-2:2010, *Protection against lightning – Part 2: Risk management*

IEC 62305-3, *Protection against lightning – Part 3: Physical damage to structures and life* hazard

IEC 62440:2008, *Electric cables with a rated voltage not exceeding 450/750 V – Guide to use*

IEC 62446-1, *Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 1: Grid connected systems – Documentation, commissioning tests and inspection*

IEC 62446-2, *Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 2: Grid connected systems – Maintenance of PV systems*

IEC 62716, *Photovoltaic (PV) modules – Ammonia corrosion testing*

IEC TS 62738, *Ground-mounted photovoltaic power plants – Design guidelines and recommendations*

IEC TS 62804-1, *Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Crystalline silicon*

IEC 62817, *Photovoltaic systems – Design qualification of solar trackers*

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

IEC 62930:2017, *Electric cables for photovoltaic systems with a voltage rating of 1,5 kV DC*

IEC 62938, *Photovoltaic (PV) modules – Non-uniform snow load testing*

IEC 62941, *Terrestrial photovoltaic (PV) modules – Quality system for PV module manufacturing*

IEC 63027, *Photovoltaic power systems – DC arc detection and interruption*

IEC 63104, *Solar trackers – Safety requirements*

IEC 63112:2021, *Photovoltaic (PV) arrays – Earth fault protection equipment – Safety and safety-related functionality*

IEC TS 63126:2020, *Guideline for qualifying PV modules, components and materials for operation at high temperatures*

IEC TS 63209-1, *Photovoltaic modules – Extended-stress testing – Part 1: Modules*

IEC TR 63226:2021, *Managing risk related to photovoltaic (PV) systems on buildings*

IEC TR 63227, *Lightning and surge voltage protection for photovoltaic (PV) power supply systems*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions in IEC TS 61836 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
blocking diode
diode connected in series with module(s), panel(s), sub-arrays and array(s) to block reverse current into such module(s), panel(s), sub-array(s) and array(s)

3.1.2
bifacial nameplate irradiance
BNPI
higher irradiance at which nameplate verification is performed for bifacial modules. Bifacial nameplate irradiance (BNPI) is that which corresponds to 1 000 W/m^2 on the module front, and 135 W/m^2 on the module rear

Note 1 to entry: BNPI may be applied in any method allowed by IEC TS 60904-1-2.

[SOURCE: IEC 61215-1:2021, 3.11]

3.1.3
bonding conductor
conductor provided for functional or protective equipotential bonding

3.1.4
bypass diode
diode connected across one or more cells in the forward current direction to allow the module current to bypass shaded or broken cells to prevent hot spot or hot cell damage resulting from the reverse voltage biasing from the other cells in that module

3.1.5
charge controller
power conversion equipment used between a battery and a PV array to regulate charge delivered to the battery

3.1.6
DC conditioning units
DCU
DC to DC power conversion equipment connected to individual PV modules or groups of PV modules or PV strings to modify the voltage and or current of the PV output

3.1.7
decisive voltage class
DVC
classification of voltage range used to determine the protective means against electric shock and the requirements of protection between circuits

Note 1 to entry: See decisive voltage class limits in Clause E.1.

[SOURCE: IEC 62477-1:2022,3.15]

3.1.8
disconnector
mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements

Note 1 to entry: A disconnector is capable of opening and closing a circuit when either negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying currents for a specified time under abnormal conditions such as those of short circuit.

[SOURCE: IEC 60050-441:1984, 441-14-05]

3.1.9
double insulation
insulation comprising both basic insulation and supplementary insulation

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

3.1.10
earth fault
ground fault (US)
occurrence of an accidental conductive path between a live part and the Earth

Note 1 to entry: The conductive path can consist of faulty insulation, structures (e.g. poles, scaffoldings, cranes, ladders), or vegetation (e.g. trees, bushes) and can have a significant impedance.

[SOURCE: IEC 60050-195:2021, 195-04-14]