IEC/TS 62548

Edition 1.0 2013-07

TECHNICAL SPECIFICATION

colour inside

Photovoltaic (PV) arrays – Design requirements

Withdrawn
iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/4f2e30a5-fc15-49f4-8eec-88df1c3c1663/iec-ts-62548-2013

IEC/TS 62548:2013(E)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2013 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.
If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,…).
It also gives information on projects, replaced and withdrawn publications.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

Withdrawn
iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/49e30a5-fc15-49f4-8eec-88df1c3c1663/iec-ts-62548-2013

IEC/TS 62548

Edition 1.0 2013-07

TECHNICAL SPECIFICATION

colour inside

Photovoltaic (PV) arrays – Design requirements

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/4f2e30a5-fc15-49f4-8eec-88df1c3c1663/iec-ts-62548-2013
Withdrawn

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE XA

ICS 27.160

ISBN 978-2-8322-1006-2

Warning! Make sure that you obtained this publication from an authorized distributor.

® Registered trademark of the International Electrotechnical Commission

CONTENTS

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/...-fc15-49f1-8eec-88df1c3c1663/iec-ts-62548-2013
Withdrawn

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/d9e80a5-fc15-49f4-8eec-88df1c3c1663/iec-ts-62548-2013
Withdrawn

Withdrawn
iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/4f2e30a5-fc15-49f4-8eec-88df1c3c1663/iec-ts-62548-2013

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PHOTOVOLTAIC (PV) ARRAYS – DESIGN REQUIREMENTS

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62548, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

Withdrawn

The present Technical Specification is intended to be withdrawn as soon as an International Standard in the IEC 60364 series, under joint development by IEC technical committees 64 and 82, will be published.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/746/DTS	82/765A/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International Standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

Withdrawn
iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/7b0e0a5-fe15-49f1-8cee-88df1e3e1663/iec-ts

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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 – DESIGN REQUIREMENTS

1 Scope and object

This Technical Specification sets out design requirements for photovoltaic (PV) arrays including d.c. array wiring, electrical protection devices, switching and earthing provisions. The scope includes all parts of the PV array up to but not including energy storage devices, power conversion equipment or loads.

The object of this Technical Specification 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 a.c. power systems, including the ability to produce and sustain electrical arcs with currents that are not greater than normal operating currents.

In grid connected systems the safety requirements of this Technical Specification are however critically dependent on the inverters associated with PV arrays complying with the requirements of IEC 62109-1 and IEC 62109-2.

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

PV arrays of less than 100 W and less than 35 V d.c. open circuit voltage at STC are not covered by this Technical Specification.

Attention is drawn to Annex D describing arc fault detection and interruption in PV arrays. It is expected that requirements for the use of this type of equipment will be included in this Technical Specification when reliable commercial equipment for detection of arcs in PV systems is available.

NOTE 1 This Technical Specification covers the protection requirements of PV arrays which develop as a result of the use of batteries in PV systems.

NOTE 2 Additional requirements may be needed for more specialized installations e.g. concentrating systems, tracking systems or building integrated PV.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60228:2004, *Conductors of insulated cables*

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

IEC 60287 (all parts), *Electric cables – Calculation of the current rating*

IEC 60332-1-2:2004, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

Withdrawn
iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013

IEC 60364 (all parts), *Low-voltage electrical installations*

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

IEC 60364-5-54:2011, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

IEC 60364-7-712:2002, *Electrical installations of buildings – Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems*

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 a.c. and d.c. operation*

IEC 60947-1, *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 61215:2005, *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 61730-1:2004, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

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

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

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

IEC 62305-4, *Protection against lightning – Part 4: Electrical and electronic systems within structures*

IEC 62446, *Grid connected photovoltaic systems – Minimum requirements for system documentation, commissioning tests and inspection*

EN 50521, *Connectors for photovoltaic systems – Safety requirements and tests*

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/4f9e90a5-fc15-49f4-8eec-88df1e3c1663/iec-ts-62548-2013
Withdrawn

3 Terms and definitions, symbols and abbreviations

3.1 Terms, definitions and symbols

For the purposes of this document, the following terms and definitions apply.

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
bonding conductor
conductor provided for functional or protective equipotential bonding

3.1.3
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

3.1.4
cable
assembly of one or more conductors and/or optical fibres, with a protective covering and possibly filling, insulating and protective material

[SOURCE: IEC 60050-151:2001,151-12-38]

3.1.5
cable core
the conductor with its insulation but not including any mechanical protective covering

3.1.6
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 d.c. or 240 W, where general contact access is anticipated. Modules qualified for safety through IEC 61730-1 and IEC 61730-2 within this application class are considered to meet the requirements for safety class II.

[SOURCE: IEC 61730-1:2004]

3.1.7
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.

[SOURCE: IEC 61730-1:2004]

3.1.8
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 d.c. and 240 W, where general contact access is anticipated. Modules qualified for safety through IEC 61730-1 and IEC 61730-2 within this application class are considered to meet the requirements for safety class III.

Note 1 to entry: Safety classes are defined in IEC 61140.

Withdrawn
iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/ef0e10a5-fc15-49f4-8eec-88df1c3c1663/iec-ts-62548-2013

[SOURCE: IEC 61730-1:2004]

3.1.9
competent person
a person, who has acquired, through training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the required task correctly

3.1.10
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. Refer also to switch-disconnector.

3.1.11
double insulation
insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEC 60050-195:1998, 195-06-08]

3.1.12
extraneous conductive part
a conductive part liable to introduce a potential, generally earth potential, and not forming part of the electrical installation

3.1.13
functionally earthed PV array
a PV array that has one conductor intentionally connected to earth for purposes other than safety, by means not complying with the requirements for protective bonding

Note 1 to entry: Such a system is not considered to be an earthed array.

Note 2 to entry: Examples of functional array earthing include earthing one conductor through an impedance, or only temporarily earthing the array for functional or performance reasons.

Note 3 to entry: In an inverter intended for an array not connected to a functional earth that uses a resistive measurement network to measure the array impedance to earth, that measurement network is not considered a form of functional earth.

3.1.14
independent manual operation
independent manual operation of a mechanical switching device
switching action using stored energy operation where the energy originates from manual power, stored and released in one continuous operation (e.g. spring release), such that the speed and force of the operation are independent of the action of the operator

[SOURCE: IEC 60050-441:1984, 441-16-16, modified]

3.1.15
irradiance
G (Unit: W/m^2)

electromagnetic radiated solar power per unit of area

[SOURCE: IEC 61836:2007, modified]

Withdrawn
IECNORM.COM : Click to view the full PDF of IEC TS 62548:2013
Withdrawn
IECNORM.COM : Click to view the full PDF of IEC TS 62548:2013
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/iec/3c1663/iec-ts-62548-2013

3.1.16
$I_{MOD\_MAX\_OCPR}$
the PV module maximum overcurrent protection rating determined by IEC 61730-2

Note 1 to entry: This is often specified by module manufacturers as the maximum series fuse rating.

3.1.17
I_n
the nominal rating of an overcurrent protection device

3.1.18
$I_{SC\ ARRAY}$
the short circuit current of the PV array at Standard Test Conditions (STC), and is equal to:

$$I_{SC\ ARRAY} = I_{SC\ MOD} \times S_A$$

where S_A is the total number of parallel-connected PV strings in the PV array

3.1.19
$I_{SC\ MOD}$
the short circuit current of a PV module or PV string at Standard Test Conditions (STC), as specified by the manufacturer in the product specification plate

Note 1 to entry: As PV strings are a group of PV modules connected in series, the short circuit current of a string is equal to $I_{SC\ MOD}$.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.1.20
$I_{SC\ S\text{-}ARRAY}$
the short circuit current of a PV sub-array at Standard Test Conditions (STC), and equal to:

$$I_{SC\ S\text{-}ARRAY} = I_{SC\ MOD} \times S_{SA}$$

where S_{SA} is the number of parallel-connected PV strings in the PV sub-array

3.1.21
isolated PCE
a PCE with at least simple separation between the main power output circuits and PV circuits and having leakage currents less than the limits required to be classified as an isolated PCE.

Note 1 to entry: Inverter requirements are as set out in IEC 62109-2. The separation/isolation may be either integral to the PCE or provided externally e.g. an inverter with an external isolation transformer. If the isolation is provided externally there must be no other equipment connected to the same circuit as the PCE.

Note 2 to entry: In a PCE with more than two external circuits, there may be isolation between some pairs of circuits and no isolation between others. For example, an inverter with PV, battery, and mains circuits may provide isolation between the mains circuit and the PV circuit, but no isolation between the PV and battery circuits. In this Technical Specification, the term isolated PCE is used as defined above in general – referring to isolation between the main power output circuit and the PV circuits.

Note 3 to entry: For a PCE that does not have internal isolation between the main power output circuit and PV circuits, but is required to be used with a dedicated isolation means, with no other equipment connected to the PCE side of that isolation means, the combination may be treated as an isolated PCE.

Note 4 to entry: In the case of an inverter required to be used with a dedicated external isolation transformer, the requirement to have no other equipment connected between the inverter and the inverter-side winding allows designs having more than one inverter connected to the same transformer, as long as each inverter is connected to a separate transformer winding. If more than one inverter is intended to be connected to a single winding, the inverters must be treated as non-isolated inverters.

3.1.22
junction box
closed or protected connecting device allowing making of one or several junctions

[SOURCE: IEC 60050-442:1998, 442-08-03]

Withdrawn

3.1.23
live part
conductor or conductive part intended to be energized in normal operation, including a neutral conductor, but by convention not a PEN conductor or PEM conductor or PEL conductor

Note 1 to entry: This concept does not necessarily imply a risk of electric shock.

3.1.24
low voltage
voltage exceeding DVC-A, but not exceeding 1 000 V a.c. or 1 500 V d.c.

3.1.25
main earthing terminal
the terminal or bar provided for the connection of the main protective earthing conductor, bonding conductors and, if provided, the conductor for functional earthing

3.1.26
maximum power point tracking
MPPT
control strategy whereby PV array operation is always at or near the point on a PV device's current-voltage characteristic where the product of electric current and voltage yields the maximum electrical power under specified operating conditions

3.1.27
non-isolated PCE
a PCE without the minimum separation between the main power output and PV circuits or with leakage currents greater than the requirements for an isolated PCE

3.1.28
PEL conductor
conductor combining the functions of both a protective earthing conductor and a line conductor

[SOURCE: IEC 60050-195:1998,195-02-14]

3.1.29
PEM conductor
conductor combining the functions of both a protective earthing conductor and a midpoint conductor

[SOURCE: IEC 60050-195:1998, 195-02-13]

3.1.30
PEN conductor
conductor combining the functions of both a protective earthing conductor and a neutral conductor

[SOURCE: IEC 60050-195:1998, 195-02-12]

3.1.31
power conversion equipment
PCE
a system that converts the electrical power delivered by the PV array into the appropriate frequency and/or voltage values to be delivered to the load, or stored in a battery or injected into the electricity grid (see Figure 2 to Figure 4)

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/41e30a5-4e15-4914-8cee-88dffe3e1665/iec-ts-62548-2013
Withdrawn

3.1.32
protective earthing
earthing of a point in an equipment or in a system for safety reasons

3.1.33
PV array
assembly of electrically interconnected PV modules, PV strings or PV sub-arrays.

Note 1 to entry: For the purposes of this Technical Specification a PV array is all components up to the d.c. input terminals of the inverter or other power conversion equipment or d.c. loads.

A PV array does not include its foundation, tracking apparatus, thermal control, and other such components.

Note 2 to entry: A PV array may consist of a single PV module, a single PV string, or several parallel-connected strings, or several parallel-connected PV sub-arrays and their associated electrical components (see Figure 2 to Figure 4). For the purposes of this Technical Specification the boundary of a PV array is the output side of the PV array disconnecting device.

3.1.34
PV array cable
the output cable of a PV array that carries the total output current of the array

3.1.35
PV cell
the most elementary device that exhibits the photovoltaic effect, i.e the direct non-thermal conversion of radiant energy into electrical energy

Note 1 to entry: The preferred term is "solar photovoltaic cell" or "photovoltaic cell", colloquially referred to as a "solar cell".

[SOURCE: IEC 61836:2007, 3.1.43, modified]

3.1.36
PV array combiner box
a junction box where PV sub-arrays are connected and which may also contain overcurrent protection and/or switch-disconnection devices

Note 1 to entry: Small arrays generally do not contain sub-arrays but are simply made up of strings whereas large arrays are generally made up of multiple sub-arrays.

3.1.37
PV array maximum voltage
$V_{OC\ ARRAY}$ corrected for the worst-case conditions of ambient temperature. Refer to 7.2.

3.1.38
PV module
the smallest complete environmentally protected assembly of interconnected cells

[SOURCE: IEC 60904-3:2008]

3.1.39
PV string
a circuit of one or more series-connected modules

[SOURCE: IEC 61836:2007]

3.1.40
PV string cable
a cable interconnecting the modules in a PV string, or connecting the string to a, combiner box, PCE or other d.c. loads (see Figure 2 to Figure 4)

Withdrawn
iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TS 62548:2013
https://standards.iteh.ai/catalog/standards/sist/4f2e30a5-fc15-49f4-8eec-88df1c3c1663/iec-ts-