

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Low voltage electrical installations –  
Part 7-712: Requirements for special installations or locations – Solar  
photovoltaic (PV) power supply systems**

**Installations électriques basse tension –  
Partie 7-712: Exigences applicables aux installations ou emplacements  
spéciaux – Installations d'énergie solaire photovoltaïque (PV)**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2017 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.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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 It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

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

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://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](mailto:csc@iec.ch).

---

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Catalogue IEC - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

#### Recherche de publications IEC - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)

65 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [csc@iec.ch](mailto:csc@iec.ch).

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



---

**Low voltage electrical installations –  
Part 7-712: Requirements for special installations or locations – Solar  
photovoltaic (PV) power supply systems**

**Installations électriques basse tension –  
Partie 7-712: Exigences applicables aux installations ou emplacements  
spéciaux – Installations d'énergie solaire photovoltaïque (PV)**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

---

ICS 27.160; 29.020; 91.140.50

ISBN 978-2-8322-4006-9

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
712 Solar photovoltaic (PV) power supply installations .....	8
712.1 Scope .....	8
712.2 Normative references .....	9
712.3 Terms and definitions.....	10
712.31 Purposes, supplies and structure .....	15
712.4 Protection for safety .....	22
712.41 Protection against electric shock.....	22
712.410 Introduction.....	22
712.412 Protective measure: double or reinforced insulation .....	23
712.414 Protective measure: extra-low-voltage provided by SELV and PELV .....	23
712.42 Protection against thermal effects .....	23
712.421 Protection against fire caused by electrical equipment .....	23
712.43 Protection against overcurrent .....	24
712.432 Nature of protective devices.....	25
712.433 Protection against overload current.....	25
712.434 Protection against short-circuit currents .....	29
712.44 Protection against voltage disturbances and electromagnetic disturbances .....	29
712.443 Protection against transient overvoltages of atmospheric origin or due to switching.....	29
712.444 Measures against electromagnetic influences .....	30
712.5 Selection and erection of electrical equipment.....	30
712.51 Common rules.....	30
712.511 Compliance with standards .....	31
712.512 Operational conditions and external influences .....	31
712.513 Accessibility .....	32
712.514 Identification .....	32
712.515 Prevention of mutual detrimental influence .....	34
712.52 Wiring systems.....	35
712.521 Types of wiring systems .....	35
712.522 Selection and erection of wiring systems in relation to external influences .....	37
712.523 Current-carrying capacities .....	38
712.524 Cross-sectional areas of conductors .....	38
712.525 Voltage drop in consumers installations .....	39
712.526 Electrical connections .....	40
712.527 Selection and erection of wiring systems to minimize spread of fire.....	41
712.528 Proximity of wiring systems to other services .....	41
712.529 Selection and erection of wiring systems in relation to maintainability, including cleaning .....	41
712.53 Isolation, switching and control .....	41
712.531 Devices for protection against indirect contact (fault protection) by automatic disconnection of supply.....	41
712.532 Devices for protection against thermal effects .....	44
712.533 Devices for protection against overcurrent .....	45

712.534	Devices for protection against transient overvoltages .....	46
712.536	Isolation and switching .....	48
712.54	Earthing arrangements and protective conductors .....	49
712.542	Earthing arrangements .....	49
712.55	Other equipment .....	50
712.6	Inspection and testing .....	50
Annex A (informative)	PV installation information .....	51
Annex B (normative)	Calculation of $U_{OC\ MAX}$ and $I_{SC\ MAX}$ .....	54
Annex C (informative)	Examples of signs .....	56
Annex D (informative)	Blocking diode .....	57
Annex E (informative)	Arc fault detection and interruption in PV arrays .....	61
Annex F (informative)	List of notes concerning certain countries .....	62
Bibliography	.....	63
Figure 712.1	– General functional configuration of a PV installation .....	15
Figure 712.2	– PV array diagram – single string case .....	16
Figure 712.3	– PV array diagram – multiple parallel string case .....	17
Figure 712.4	– PV array diagram – multiple parallel string case with array divided into subarrays .....	18
Figure 712.5	– PV array using a PCE with multiple MPPT DC inputs .....	19
Figure 712.6	– PV array using a PCE with multiple DC inputs internally connected to a common DC bus .....	20
Figure 712.7	– Example of a PV array diagram where strings are grouped under one overload protective device per group .....	27
Figure 712.8	– Example of an indication showing the presence of a photovoltaic installation on a building .....	33
Figure 712.9	– Examples of cables with reinforced protection .....	36
Figure 712.10	– PV string wiring with minimum loop area .....	37
Figure A.712.1	– Single string PV array .....	51
Figure A.712.2	– Parallel connected multi-string PV array .....	52
Figure A.712.3	– Unearthed PV array connected to the AC side via a PCE with transformer .....	53
Figure A.712.4	– Unearthed PV array connected to the AC side via a PCE without a transformer .....	53
Figure A.721.5	– Earthed PV array connected to the AC side via a PCE with transformer .....	53
Figure A.712.6	– Earthed PV array connected to the AC side via a PCE without a transformer, the transformer being separate .....	53
Figure C.712.1	– Example of sign required on PV array combiner boxes (712.514.102) .....	56
Figure C.712.2	– Example of switchboard sign for identification of PV on a building .....	56
Figure D.712.1	– Effect of blocking diode at short circuit in PV string .....	58
Figure D.712.2	– Effect of blocking diode where there is an insulation fault on a PV installation with earthing on the DC negative side .....	58
Figure D.712.3	– Effect of blocking diode where there is a fault on a PV installation with earthing on the DC positive side .....	59
Figure E.712.1	– Examples of types of arcs in PV arrays .....	61

Table 712.1 – Calculation of the critical length $L_{crit}$ .....	30
Table 712.2 – Minimum current rating of circuits .....	39
Table 712.3 – Requirements for different system types based on PCE isolation and PV array functional earthing .....	42
Table 712.4 – Minimum insulation resistance thresholds for detection of failure of insulation to earth .....	43
Table 712.5 – Response time limits for sudden changes in residual current .....	44
Table 712.6 – Rated current of automatic disconnecting device in the functional earthing conductor .....	45
Table 712.7 – Impulse withstand voltage $U_w$ where no information is available.....	47
Table 712.8 – Disconnection device requirements in PV array installations.....	48
Table A.712.1 – PV DC configurations .....	52

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**LOW VOLTAGE ELECTRICAL INSTALLATIONS –****Part 7-712: Requirements for special installations or locations –  
Solar photovoltaic (PV) power supply systems**

## 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.

International Standard IEC 60364-7-712 has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

This second edition cancels and replaces the first edition, published in 2002. This edition constitutes a technical revision.

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

- a) The technical content has been extensively revised and expanded, taking into account experience gained in the construction and operation of PV installations, and developments made in technology, since the first edition of this standard was published.

The text of this standard is based on the following documents:

FDIS	Report on voting
64/2154/FDIS	64/2163/RVD

Full information on the voting for the approval of this standard 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.

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

A list of all parts in the IEC 60364 series, published under the general title *Low voltage electrical installations*, can be found on the IEC website.

The reader's attention is drawn to the fact that Annex F lists all of the “in-some-country” clauses on differing practices of a less permanent nature relating to the subject of this standard.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

**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.**



## INTRODUCTION

For the purpose of this part of IEC 60364 (IEC 60364-7-712), the requirements of the general parts 1 to 6 of IEC 60364 apply.

The IEC 60364-7-7XX parts of IEC 60364 contain particular requirements for special installations or locations which are based on the requirements of the general parts of IEC 60364 (IEC 60364-1 to IEC 60364-6). These IEC 60364-7-7XX parts are considered in conjunction with the requirements of the general parts.

The particular requirements of this part of IEC 60364 supplement, modify or replace certain of the requirements of the general parts of IEC 60364 being valid at the time of publication of this part. The absence of reference to the exclusion of a part or a clause of a general part means that the corresponding clauses of the general part are applicable (undated reference).

Requirements of other 7XX parts being relevant for installations covered by this part also apply. This part may therefore also supplement, modify or replace certain of these requirements valid at the time of publication of this part.

The clause numbering of this part follows the pattern and corresponding references of IEC 60364. The numbers following the particular number of this part are those of the corresponding parts, or clauses of the other parts of the IEC 60364 series, valid at the time of publication of this part, as indicated in the normative references of this document (dated reference). If requirements or explanations additional to those of the other parts of the IEC 60364 series are needed, the numbering of such items appears as 712.101, 712.102, 712.103, etc.

Numbering of figures and tables takes the number of this part followed by a sequential number. For annexes, the numbering of figures and tables takes the letter of the annex, the number of the part and a sequential number.

In the case where new or amended general parts with modified numbering were published after this part was issued, the clause numbers referring to a general part in this 712 part may no longer align with the latest edition of the general part. Dated references should be observed.

## LOW VOLTAGE ELECTRICAL INSTALLATIONS –

### Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems

#### 712 Solar photovoltaic (PV) power supply installations

NOTE The abbreviation “PV” is used for “Photovoltaic”. Photovoltaic installations are, hereafter, known as PV installations.

##### 712.1 Scope

This part of IEC 60364 applies to the electrical installation of PV systems intended to supply all or part of an installation.

The equipment of a PV installation, like any other item of equipment, is dealt with only so far as its selection and application in the installation is concerned.

A PV installation starts from a PV module or a set of PV modules connected in series with their cables, provided by the PV module manufacturer, up to the user installation or the utility supply point (point of common coupling).

Requirements of this document apply to

- PV installations not connected to a system for distribution of electricity to the public,
- PV installations in parallel with a system for distribution of electricity to the public,
- PV installations as an alternative to a system for distribution of electricity to the public,
- appropriate combinations of the above.

This document does not cover the specific installation requirements for batteries or other energy storage methods.

NOTE 1 Additional requirements for PV installations with battery storage capabilities on the DC side are under consideration.

NOTE 2 This document does cover the protection requirements of PV arrays which develop as a result of the use of batteries in PV installations.

For systems using DC-DC converters, additional requirements regarding voltage and current rating, switching, and protective devices can apply. These requirements are under consideration.

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

In grid connected PV installations the safety requirements of this document are, however, critically dependent on the PCE associated with PV arrays complying with the requirements of IEC 62109-1 and IEC 62109-2.