

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Low-voltage surge protective devices –
Part 32: Surge protective devices connected to the d.c. side of photovoltaic
installations – Selection and application principles**

**Parafoudres basse tension –
Partie 32: Parafoudres connectés au côté courant continu des installations
photovoltaïques – Principes de choix et d'application**



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
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

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

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

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

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

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

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

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

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

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

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

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

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

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Low-voltage surge protective devices –
Part 32: Surge protective devices connected to the d.c. side of photovoltaic
installations – Selection and application principles**

**Parafoudres basse tension –
Partie 32: Parafoudres connectés au côté courant continu des installations
photovoltaïques – Principes de choix et d'application**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.240.01; 29.240.10

ISBN 978-2-8322-4583-5

**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.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	8
4 Systems and equipment to be protected	12
5 Overvoltages in a PV installation	12
6 Installation and location of SPDs	13
6.1 General.....	13
6.2 Requirements for different PV installations:.....	15
6.2.1 PV installation without an external LPS.....	15
6.2.2 PV installation with an external LPS when the separation distance (s) is maintained (excluding multi-earthed solar systems, such as PV power plants)	16
6.2.3 PV installation with an external LPS where the separation distance (s) cannot be maintained (including multi-earthed systems, such as PV power plants).....	17
6.2.4 PV installation including communication and signalling circuits	18
7 Equipotential bonding	18
8 Requirements for the installation of surge protective devices (SPDs) in a PV system	19
9 Selection and installation of SPDs in PV installations	19
9.1 Selection of SPDs on the AC side	19
9.1.1 General	19
9.1.2 Selection of SPDs with regard to nominal discharge current I_n and impulse current I_{imp}	19
9.1.3 Selection of SPDs with regard to voltage protection level U_p	20
9.1.4 Installation of SPDs on the AC side	20
9.2 Selection of SPDs installed on the DC side	22
9.2.1 General	22
9.2.2 Selection of SPDs with regard to nominal discharge current I_n and impulse current I_{imp}	22
9.2.3 Selection of U_{CPV} of SPDs on the DC side	22
9.2.4 Selection of SPDs with regard to voltage protection level U_p	22
9.2.5 Installation of SPDs on the DC side	23
9.2.6 Cross-sections of connecting conductors for SPDs on the DC side	24
9.2.7 Internal connection schemes of multipole SPDs or combinations of SPDs with a single mode of protection on the DC side	25
9.2.8 Selection of I_{SCPV} of SPDs on the DC side	26
9.2.9 Coordination of SPDs	27
10 Maintenance	27
Annex A (normative) Determination of the value of I_{imp} or I_n for SPDs according to the simplified approach for different structures protected by an LPS	28
A.1 General.....	28
A.2 Building with a PV installation on the roof according to 6.2.3	29
A.3 Free- field PV power plant.....	32
Annex B (informative) Characteristics of a PV source	35

B.1	PV source characteristics.....	35
B.2	Calculation of $U_{OC\ MAX}$	36
B.3	Calculation of $I_{SC\ MAX}$	37
Annex C (informative)	Additional information to clause 6: Installation and location of SPD and to clause 7: Equipotential bonding.....	38
C.1	PV installation including communication and signalling circuits	38
C.2	PV installation and dimensions of equipotential bonding conductors	40
Annex D (informative)	Exceptions in the USA related to Class I tested SPDs	42
Bibliography.....		43
Figure 1	– Installation of SPDs in the case of a building without an external LPS.....	15
Figure 2	– Installation of SPDs in the case of a PV installation with an external LPS where the separation distance (s) is maintained.....	16
Figure 3	– Installation of SPDs in the case of a PV-installation with an external LPS where the separation distance (s) cannot be maintained	17
Figure 4	– Installation of SPDs on the AC side with a short distance between the origin of the installation and the PV inverter ($E < 10\ m$)	21
Figure 5	– Installation of SPDs on the AC side with a long distance between the origin of the installation and the PV inverter ($E \geq 10\ m$)	21
Figure 6	– Example of overvoltage protection on the DC side of a PV installation	24
Figure 7	– Example of SPD connections on the DC side of an unearthed PV source.....	25
Figure 8	– Example of SPD connection on the DC side of a reliable earthed PV source	26
Figure A.1	– Example of a structure with two external down conductors to determine the value of the discharge current for the selection of SPDs	30
Figure A.2	– Example of the structure of an extended PV installation. A PV power plant with multiple earthing and a meshed earthing system.....	33
Figure B.1	– Schematic of a PV current source	35
Figure B.2	– U/I characteristics of a non-linear PV current source.....	35
Figure C.1	– Example of SPDs installed on a PV system protected by an external LPS where the separation distance (s) is maintained – Installation includes data acquisition and control system.....	39
Figure C.2	– Example of a building with an external LPS – Dimensions of equipotential bonding conductors when the separation distance (s) is maintained, or an isolated LPS is used	40
Figure C.3	– Example of a building with an external LPS – Dimensions of equipotential bonding conductors when the separation distance (s) is not maintained.....	41
Table 1	– Selection of SPD test class and cross section of bonding conductor.....	14
Table 2	– Rated impulse voltage U_w for equipment between PV array and inverter (where no other information is available).....	23
Table A.1	– Values of I_{imp} ($I_{10/350}$) and I_n ($I_{8/20}$) for voltage-limiting SPDs on the DC side of a PV installation mounted on the roof of a building with an external LPS if the separation distance is not maintained	31
Table A.2	– Values of I_{imp} ($I_{10/350}$) for voltage-switching SPDs on the DC side of a PV installation mounted on the roof of a building with an external LPS, if the separation distance is not maintained	31
Table A.3	– Values of I_{imp} ($I_{10/350}$) and I_n ($I_{8/20}$) for SPDs used on the DC side in PV power plants with a central inverter, multiple earthing and a meshed earthing system.....	33

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SURGE PROTECTIVE DEVICES –**Part 32: Surge protective devices connected to the d.c. side of photovoltaic installations – Selection and application principles****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 61643-32 has been prepared by subcommittee 37A: Low-voltage surge protective devices, of IEC technical committee 37: Surge arresters.

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

FDIS	Report on voting
37A/302/FDIS	37A/303/RVD

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

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

The following differing practices of a less permanent nature exist in the countries indicated below.

Annex D: Class I tested SPDs are not required (United States)

A list of all parts of the IEC 61643 series can be found, under the general title *Low-voltage surge protection devices*, on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://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
- 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

This part of IEC 61643 provides useful information for the selection of SPDs connected to photovoltaic installations.

This part of IEC 61643 provides information to evaluate, with reference to the IEC 62305 series, IEC 60364 series and IEC 61643-12, the additional needs for surge protective devices (SPDs) to be installed on the DC side of a photovoltaic (PV) system, to protect against induced and direct lightning effects. It gives guidance for selection, operation and installation of SPDs, including the selection of SPD test class, surge current values and cross section of bonding conductors. Guidance for selection of SPDs connected to the AC side is also given.

The specific electrical parameters of a PV array or a PV source require specific SPDs on the DC side.

This part of IEC 61643 considers SPDs used in different locations and in different kinds of PV systems. It gives examples and provides a simplified and common approach to determine impulse discharge current values for the DC side of different PV installations.

LOW-VOLTAGE SURGE PROTECTIVE DEVICES –

Part 32: Surge protective devices connected to the DC side of photovoltaic installations – Selection and application principles

1 Scope

This part of IEC 61643 describes the principles for selection, installation and coordination of SPDs intended for use in Photovoltaic (PV) systems up to 1 500 V DC and for the AC side of the PV system rated up to 1 000 V rms 50/60 Hz.

The photovoltaic installation extends from a PV array or a set of interconnected PV-modules to include the associated cabling and protective devices and the inverter up to the connection point in the distribution board or the utility supply point.

This part of IEC 61643 considers SPDs used in different locations and in different kinds of PV systems:

- PV systems located on the top of a building.
- PV systems located on the ground like free field power plants characterized by multiple earthing and a meshed earthing system.

The term PV installation is used to refer to both kinds of PV systems. The term PV power plant is only used for extended free-field multi-earthed power systems located on the ground.

For PV installations including batteries additional requirements may be necessary.

NOTE 1 IEC 60364 series, IEC 62305 series and IEC 61643-12 also apply.

NOTE 2 This standard deals only with SPDs and not with surge protective components integrated inside equipment (e.g. inverters, (PCE) power conversion equipment).

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 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 60364-5-53:2015, *Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control*

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

IEC 60364-7-712:2017, *Low voltage electrical installations – Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61643-11:2011, *Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods*

IEC 61643-12, *Low-voltage surge protective devices – Part 12: Surge protective devices connected to low-voltage power distribution systems – Selection and application principles*

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, *Low-voltage surge protective devices – Part 31: Surge protective devices connected to the DC side of photovoltaic installations – Requirements and test methods*¹

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

IEC 62305-3:2010, *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*

ITU-T, Recommendation K.20, *Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents*

ITU-T, Recommendation K.21, *Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents*

3 Terms and definitions

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

PV array

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

Note 1 to entry: For the purposes of this document a PV array is all components up to the d.c. input terminals of the PCE or other power conversion equipment or DC loads. A PV array does not include its foundation, tracking apparatus, thermal control and other such components.

¹ Under preparation: Stage at the time of publication: IEC/FDIS 61643-31:2017.