

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Low-voltage fuses –

Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems

Fusibles basse tension –

Partie 6: Exigences supplémentaires concernant les éléments de remplacement utilisés pour la protection des systèmes d'énergie solaire photovoltaïque



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2021 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
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

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 It also gives information on projects, replaced and withdrawn publications.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 once a month by email.

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: sales@iec.ch.

IEC online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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.

Recherche de publications IEC - webstore.iec.ch/advsearchform

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 une fois par mois par email.

Service Clients - webstore.iec.ch/csc

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

IEC online collection - oc.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Low-voltage fuses –

Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems

Fusibles basse tension –

Partie 6: Exigences supplémentaires concernant les éléments de remplacement utilisés pour la protection des systèmes d'énergie solaire photovoltaïque

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.120.50

ISBN 978-2-8322-9695-0

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.

REDLINE VERSION

VERSION REDLINE



Low-voltage fuses –

Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems

Fusibles basse tension –

Partie 6: Exigences supplémentaires concernant les éléments de remplacement utilisés pour la protection des systèmes d'énergie solaire photovoltaïque

CONTENTS

FOREWORD.....	4
1 General.....	6
1.1 Scope and object.....	6
1.2 Normative references	6
2 Terms and definitions	7
2.2 General terms	7
3 Conditions for operation in service.....	11
3.4 Voltage.....	11
3.4.1 Rated voltage	11
3.5 Current.....	11
3.5.1 Rated Current.....	11
3.6 Frequency, power factor and time constant	12
3.6.1 Frequency	12
3.6.2 Power factor	12
3.6.3 Time constant.....	12
3.10 Temperature inside an enclosure	12
4 Classification.....	12
5 Characteristics of fuses	12
5.1 Summary of characteristics	12
5.1.2 Fuse-links.....	12
5.2 Rated voltage	12
5.5 Rated power dissipation of the fuse-link	12
5.6 Limits of time-current characteristics	13
5.6.1 Time-current characteristics, time-current zones	13
5.6.2 Conventional times and currents.....	13
5.6.3 Gates	13
5.7 Breaking range and breaking capacity	13
5.7.1 Breaking range and utilization category	14
5.7.2 Rated breaking capacity	14
6 Markings	14
6.2 Markings on fuse-links.....	14
7 Standard conditions for construction.....	14
7.5 Breaking capacity	14
8 Tests	14
8.1 General.....	14
8.1.4 Arrangement of the fuse and dimensions	14
8.1.5 Testing of fuse-links	14
8.3 Verification of temperature rise limits and power dissipation.....	16
8.3.1 Arrangement of the fuse-link.....	16
8.3.3 Measurement of power dissipation of the fuse-link.....	16
8.3.5 Acceptability of test results	16
8.4 Verification of operation	16
8.4.1 Arrangement of fuse-link.....	16
8.4.3 Test method and acceptability of test results	17
8.5 Verification of the breaking capacity	18

8.5.1 Arrangement of the fuse	18
8.5.5 Test method	18
8.5.8 Acceptability of test results	18
8.11 Mechanical and miscellaneous tests	19
Annex AA (normative) Examples of standardized fuse-links for the protection of solar photovoltaic energy systems	22
Annex BB (informative) Guidance for the protection of photovoltaic strings and arrays with fuse-links designed for PV applications	37
Bibliography	38
Figure 101 – Current of test cycling	21
Figure AA.1 – Fuse-links with cylindrical contact caps, type A	23
Figure AA.2 – Fuse-links with cylindrical contact caps type A with striker – Additional dimensions for sizes 14 × 51, 20 × 127 and 22 × 127 only	24
Figure AA.3 – North American Cylindrical fuse-links with blade contacts – Sizes 61-600 A	25
Figure AA.4 – Fuse-links with blade contacts, type C, C referring IEC 60269-2 “Fuse system A (NH fuse system)”	29
Figure AA.5 – Fuse-links with long blade contacts, type D	33
Figure AA.5 – Long fuse-links with blade contacts, type D (specific for PV application)	33
Figure AA.6 – Replacement handle for long fuse-links with blade contacts	34
Figure AA.7 – Fuse-bases for long fuse-links with blade contacts	35
Figure AA.8 – Fuse-links with bolted blade contacts, type E (specific for PV application)	36
Table 101 – Conventional times and currents for “gPV” fuse-links	13
Table 102 – Survey of complete tests on fuse-links and number of fuse-links to be tested	15
Table 103 – Survey of tests on fuse-links of the smallest rated current of a homogeneous series and number of fuse-links to be tested	16
Table 104 – Values for breaking-capacity tests on “gPV” fuse-links	19

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE FUSES –

**Part 6: Supplementary requirements for fuse-links
for the protection of solar photovoltaic energy 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.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60269-6 edition 1.1 contains the first edition (2010-09) [documents 32B/561/FDIS and 32B/569/RVD] and its corrigendum (2010-12), and its amendment 1 (2021-04) [documents 32B/698/FDIS and 32B/699/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 60269-6 has been prepared by subcommittee 32B: Low-voltage fuses, of IEC technical committee 32: Fuses.

This part is to be used in conjunction with IEC 60269-1:2006, *Low-voltage fuses, Part 1: General requirements*.

This Part 6 supplements or modifies the corresponding clauses or subclauses of Part 1.

Where no change is necessary, this Part 6 indicates that the relevant clause or subclause applies.

Tables and figures which are additional to those in Part 1 are numbered starting from 101.

Additional annexes are lettered AA, BB, etc.

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

A list of all parts of the IEC 60269 series, under the general title: *Low-voltage fuses*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendment 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

- 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.

LOW-VOLTAGE FUSES –

Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems

1 General

IEC 60269-1 applies with the following supplementary requirements.

Fuse-links for the protection of solar photovoltaic (PV) energy systems shall comply with all requirements of IEC 60269-1, if not otherwise indicated hereinafter, and shall also comply with the supplementary requirements laid down below.

NOTE The abbreviation “PV” (photovoltaic) is used in this document.

1.1 Scope and object

These supplementary requirements apply to fuse-links for protecting PV strings and PV arrays in equipment for circuits of nominal voltages up to 1 500 V ~~d.c~~ DC, and also, in so far as they are applicable, for circuits of higher nominal voltages.

~~Their rated voltage may be up to 1 500 V d.c.~~

NOTE 1 Such fuse-links are commonly referred to as “PV fuse-links”.

NOTE 2 In most cases, a part of the associated equipment serves the purpose of a fuse-base. Owing to the great variety of equipment, no general rules can be given; the suitability of the associated equipment to serve as a fuse-base should be subject to agreement between the manufacturer and the user. However, if separate fuse-bases or fuse-holders are used, they should comply with the appropriate requirements of IEC 60269 series.

NOTE 3 PV fuse-links protect down stream inverter components such as capacitors or the discharge of capacitors back into the arrays or array wiring up to the rated breaking capacity.

The object of these supplementary requirements is to establish the characteristics of PV fuse-links in such a way that they can be replaced by other fuse-links having the same characteristics, provided that their dimensions are identical. For this purpose, this standard refers in particular to

- a) the following characteristics of fuses:
 - 1) their rated values;
 - 2) their utilisation category;
 - 3) their temperature rises in normal service;
 - 4) their power dissipation;
 - 4) their time-current characteristics;
 - 6) their breaking capacity;
 - 7) their dimensions or size (if applicable).
- b) type tests for verification of the characteristics of fuses;
- c) the markings on fuses.

1.2 Normative references

The following referenced documents are indispensable for the application 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 60269-1:2006, *Low-voltage fuses – Part 1: General requirements*¹
~~Amendment 1 (2009)~~

IEC 60269-2, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Examples of standardized systems of fuses A to J*

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

IEC 61386-1, *Conduit systems for cable management – Part 1: General requirements*

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

IEC 62548, *Photovoltaic (PV) arrays – Design requirements*

ISO 3, *Preferred numbers – Series of preferred numbers*

2 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60269-1 as well as the following apply.

2.2 General terms

NOTE Photovoltaic = PV.

2.2.101

~~photovoltaic~~ PV fuse-link

~~fuse-link capable of breaking, under specific conditions, any current value within the breaking range (see 7.5)~~

~~NOTE A PV fuse-link operates under two main conditions:~~

- ~~— Short-circuit in a string or in an array which leads to a very low over-current.~~
- ~~— Short-circuit current supplied by the discharge of the PV inverter through a very low inductance. This short-circuit condition leads to a very high rate of rise of current equivalent to a low value of time constant, corresponding to Table 104.~~

2.2.101.1

PV fuse-link (general)

fuse-link capable of breaking, under specified conditions, any current value within the breaking range

NOTE A PV fuse-link operates under two main conditions:

- Short-circuit in a string (see IEC 62548 and IEC 60634-7-712 or in an array or sub-array (see IEC 62548 and IEC 60634-7-712) which leads to a very low over-current.
- Short-circuit current supplied by the discharge of the PV inverter through a very low inductance. This condition leads to a very high rate of rise of current equivalent to a low value of time constant, corresponding to Table 104.

2.2.101.2

PV string fuse-link

fuse-link for the short-circuit and overload protection in a string

¹ ~~There is a consolidated edition 4.1 (2009) that includes IEC 60269-1(2006) and its amendment 1 (2009).~~