

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



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE FUSES –

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

FOREWORD

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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

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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).~~

2.2.101.3

sub-array or array or array field fuse-link

fuse-link for the short-circuit and cable overload protection in an sub-array or array or array field

2.2.101.4

functional earthing fuse-link

fuse-link for earthing circuit protection of the photovoltaic (or PV) arrays. Functional earthing fuse-link arrangement can be found in IEC 60364-7-712 and IEC 62548

~~2.2.102~~

~~photovoltaic cell~~

~~most elementary photovoltaic device which generate d.c. voltage by the absorption of photons~~

~~[IEC 61836, 3.1.43 a) and d) modified]~~

~~2.2.103~~

~~photovoltaic module~~

~~complete and environmentally protected assembly of interconnected PV cells~~

~~[IEC 61836, 3.1.43 f)]~~

2.2.104102

photovoltaic array, ~~array field, assembly, generator, panel,~~ string, sub-array

2.2.104102.1

photovoltaic array

assembly of mechanically integrated and electrically interconnected PV modules, PV panels or PV sub-array and its support structure

~~2.2.104.2~~

~~photovoltaic array field~~

~~aggregate of all PV arrays within a given PV system focusing on the mechanical arrangement of the PV technology~~

~~2.2.104.3~~

~~photovoltaic assembly~~

~~PV components that are installed outdoors and remote from its loads, including modules, support structure, foundation, wiring, tracking apparatus, and thermal control (were specified), and including junction boxes, charge controllers and inverters depending on the assembly's installed configuration~~

~~2.2.104.4~~

~~photovoltaic generator~~

~~generator that uses the photovoltaic effect to convert sunlight into electricity~~

~~2.2.104.5~~

~~photovoltaic panel~~

~~PV modules mechanically integrated, pre-assembled and electrically interconnected~~

2.2.104.6102.2

photovoltaic string

circuit of series-connected PV modules

2.2.104.7102.3

photovoltaic sub-array

portion of a PV array that can be considered as a unit

[IEC 61836, 3.3.56 a), b), c), d), e), f) and g)]

2.2.105**inverter**

~~electric energy converter that changes direct electric current to single phase or polyphase alternating currents~~

~~[IEC 61836, 3.3.15] and [IEV 151-13-46]~~

2.2.106**junction box**

~~closed or protected enclosure in which circuits are electrically connected~~

2.2.106.1**array junction box**

~~junction box where PV strings are connected~~

2.2.106.2**generator junction box**

~~junction box where PV arrays are connected~~

~~[IEC 61836, 3.2.16]~~

2.2.107102.4**standard operating conditions****SOC**

operating value of in-plane irradiance ($1\,000\text{ Wm}^{-2}$), PV device junction temperature equals the nominal operating PV cell junction temperature (NOCT), and air mass ($AM=1,5$)

[IEC 61836, 3.4.16 d)]

2.2.108102.5**standard test conditions****STC**

reference values of in-plane irradiance ($G_{I,ref} = 1\,000\text{ Wm}^{-2}$), PV cell junction temperature (25 °C), and air mass ($AM=1,5$) to be used during the testing of any PV device

[IEC 61836, 3.4.16 e)]

2.2.109103**photovoltaic currents****2.2.109.1****load current**

~~(symbol I_L) (unit: A)~~

~~electric current supplied to a load by a PV system~~

~~[IEC 61836, 3.4.39 a)]~~

2.2.109.2**maximum power current**

~~(symbol I_{PMax}) (unit: A)~~

~~electric current at the conditions of maximum power~~

~~[IEC 61836, 3.4.42 a)]~~

2.2.109.3**rated current**

~~(symbol I_R) (unit: A)~~

~~electric current produced by a PV device at a rated voltage under specified operating conditions~~

~~[IEC 61836, 3.4.69 c)]~~

2.2.109.4

short-circuit current

(symbol I_{SC}) (unit: A)

electric current at the output terminals of a PV device at a particular temperature and irradiance when the device output voltage is equal to or close to zero

[IEC 61836, 3.4.80]

2.2.103.1

short circuit current

(symbol I_{SC}), (unit: A)

electric current at the output terminals of a PV device at a particular temperature and irradiance, when the device output voltage is equal or close to zero

2.2.103.2

maximum overcurrent rating

$I_{MOD_MAX_OCPR}$

PV module maximum overcurrent protection rating determined by IEC 61730-2

2.2.103.3

short circuit current of a PV module

$I_{SC\ MOD}$

short circuit current of a PV module or PV string at standard test conditions (STC), as specified by the manufacturer

2.2.103.4

short circuit current of an array

$I_{SC\ ARRAY}$

short-circuit current of the PV array at standard test conditions (STC), which is equal to

$I_{SC\ ARRAY} = I_{SC\ MOD} \times N_S$ where N_S is the total number of parallel-connected PV strings in the PV array

NOTE 1 A PV string is a number of PV modules connected in series. The short circuit current of a string is equal to $I_{SC,MOD}$.

2.2.103.5

short circuit current of an sub-array

$I_{SC\ S-ARRAY}$

short circuit current of a PV sub-array at standard test conditions (STC), which is equal to

$I_{SC\ S-ARRAY} = I_{SC\ MOD} \times N_{SA}$ where N_{SA} is the number of parallel-connected PV strings in the PV sub-array

2.2.103.6

maximum reverse current of an array

(symbol I_{RM}) (unit: A)

maximum reverse current accepted by the module or the panel

2.2.110.104

photovoltaic PV voltages

2.2.110.1

load voltage

(symbol V_L) (unit: V)

voltage supplied across the terminals of a load by a PV system

[IEC 61836, 3.4.39 c)]

2.2.110.2

maximum power voltage

(symbol V_{PMax}) (unit: V)

voltage at the conditions of maximum power

~~[IEC 61836, 3.4.42 h)]~~

~~2.2.110.3~~

~~maximum power voltage under standard operating conditions~~

~~(unit: V)~~

~~voltage at the maximum power point of a PV device under standard operating conditions, SOG~~

~~[IEC 61836, 3.4.42 i)]~~

~~2.2.110.4~~

~~maximum power voltage under standard test conditions~~

~~(unit: V)~~

~~voltage at the maximum power point of a PV device under standard test conditions, STC~~

~~[IEC 61836, 3.4.42 j)]~~

~~2.2.110.5~~104.1

open-circuit voltage of PV devices

(symbol V_{OC}) (unit: V)

voltage at the output terminals of a PV device at a particular temperature and irradiance when the ~~output electric~~ load current of the PV device is zero

~~2.2.110.6~~104.2

open-circuit voltage under standard test conditions

(symbol $V_{OC\ STC}$)

open-circuit voltage as measured under standard test conditions, STC

[IEC 61836, 3.4.56 a)]

~~2.2.110.7~~

~~rated voltage~~

~~(symbol V_R) (unit: V)~~

~~voltage at which a generator is designed to generate maximum electricity under specified operating conditions~~

~~[IEC 61836, 3.4.69 k)]~~

3 Conditions for operation in service

IEC 60269-1 applies with the following supplementary requirements.

3.4 Voltage

3.4.1 Rated voltage

The rated d.c. voltage of a fuse-link shall exceed the maximum value of the open circuit voltage (V_{OC}) of the PV string. See Annex BB.2.1

3.5 Current

3.5.1 Rated Current

The rated current of a fuse-link shall exceed the maximum value of the current produced by the module. See Annex BB.3.1

3.6 Frequency, power factor and time constant

3.6.1 Frequency

Not applicable

3.6.2 Power factor

Not applicable

3.6.3 Time constant

The time constants expected in practice are considered to correspond to those in Table 104.

3.10 Temperature inside an enclosure

Since the rated values of the fuse-links are based on specified conditions that do not always correspond to those prevailing at the point of installation, including the local air conditions, the user may have to consult the manufacturer concerning the possible need for re-rating.

4 Classification

IEC 60269-1 applies.

5 Characteristics of fuses

IEC 60269-1 applies with the following supplementary requirements.

5.1 Summary of characteristics

5.1.2 Fuse-links

- a) Rated voltage (see 5.2)
- b) Rated current (see 5.3 of IEC 60269-1)
- c) Rated power dissipation (see 5.5)
- d) Time-current characteristics (see 5.6)
- e) Breaking range (see 5.7.1)
- f) Rated breaking capacity (see 5.7.2)
- g) Dimensions or size (if applicable)
- h) Utilization category (see 5.7.1)

5.2 Rated voltage

For voltages up to 750 V, IEC 60269-1 applies; for higher voltages, the values should be selected from R5 series or, where not possible, from the R10 series of ISO 3.

5.5 Rated power dissipation of the fuse-link

In addition to the requirements of IEC 60269-1, the manufacturer shall indicate the power dissipation as a function of current for the range contained between 70 % to 100 % of the rated current.

5.6 Limits of time-current characteristics

5.6.1 Time-current characteristics, time-current zones

5.6.1.1 General requirements

The time-current characteristics depend on the design of the fuse-link, and, for a given fuse-link, on the ambient air temperature and the cooling conditions.

The manufacturer shall provide mean time-current characteristics in accordance with the conditions specified in 8.3.1.

5.6.2 Conventional times and currents

5.6.2.2 Conventional times and currents for "gPV"- fuse-links

The conventional times and currents are given in Table 101.

Table 101 – Conventional times and currents for "gPV" fuse-links

Rated current	Conventional time h	Conventional current	
		Type “gPV”	
		<i>I_{nt}</i>	<i>I_t</i>
$I_n \leq 63$	1	$1,13 \cdot I_n$	$1,45 \cdot I_n$
$63 < I_n \leq 160$	2		
$160 < I_n \leq 400$	3		
$I_n > 400$	4		

Rated current <i>A</i>	Conventional time <i>h</i>	Conventional current		Fuse type
		Type "gPV"		
		<i>I</i> _{nf}	<i>I</i> _f	
<i>I</i> _n ≤ 63	1	1,05	-	String fuse-link
	2	-	1,35 ¹⁾	
63 < <i>I</i> _n ≤ 160	2	1,13*	1,45*	Subarray or Array fuse-link
160 < <i>I</i> _n ≤ 400	3			
400 < <i>I</i> _n	4			

NOTE 1) For *I*_f = 1,35 *I*_n the operating time is 2 h (The thermal withstand capability of a PV module under reverse current is qualified during a 2 h test specified in module safety test from IEC 61730 and is specified on the module as the "maximum overcurrent protection" value).

* The use of these values for conventional currents is not permitted in North America. String fuse-link conventional current values are permitted for sub-array and array fuse-links

5.6.3 Gates

Not applicable.

5.7 Breaking range and breaking capacity

IEC60269-1 applies with the following supplementary requirement.

5.7.1 Breaking range and utilization category

The first letter indicates the breaking range:

- "g" fuse-links (full-range breaking capacity fuse-link).

The following letters indicate the utilization category:

- "gPV" indicates fuse-links with a full-range d.c. breaking capacity for photovoltaic energy systems.

5.7.2 Rated breaking capacity

The rated breaking capacity is based on type tests performed in a circuit containing linear components with mean value of applied voltage. The minimum value of the rated breaking capacity is 10 kA d.c.

6 Markings

IEC 60269-1 applies with the following supplementary requirements.

6.2 Markings on fuse-links

Subclause 6.2 of IEC 60269-1 applies with the following addition:

- utilization category "gPV".

7 Standard conditions for construction

IEC 60269-1 applies with the following supplementary requirement.

7.5 Breaking capacity

A fuse-link shall be capable of breaking, at rated d.c. voltage, any circuit having a prospective current between the conventional fusing current and the rated breaking capacity with time constant not greater than the values specified in Table 104.

8 Tests

IEC 60269-1 applies with the following supplementary requirements.

8.1 General

8.1.4 Arrangement of the fuse and dimensions

The fuse-link shall be mounted open in surroundings free from draughts and, unless otherwise specified, in a vertical position (see 8.3.1).

8.1.5 Testing of fuse-links

The following Tables 102 and 103 replaces Tables 11, 12 and 13 of IEC 60269-1.

8.1.5.1 Complete tests

Before the tests are commenced, the internal resistance R of all samples shall be measured at an ambient-air temperature of $(20 \pm 5)^\circ\text{C}$ with a measuring current of not more than $0,1 I_n$. The value R shall be recorded in the test report.

A survey of the complete tests is given in Table 102.

8.1.5.2 Type test exemptions for fuse-links of a homogeneous series

Fuse-links having intermediate values of rated current of a homogeneous series are exempted from type tests if the fuse-link of the largest rated current has been tested to the requirements of 8.1.5.1 and if the fuse-link of the smallest rated current has been submitted to the tests indicated in Table 103.

Table 102 – Survey of complete tests on fuse-links and number of fuse-links to be tested

Test according to subclause		Number of samples								
		1	3	1	1	3	3	1	1	1
8.1.4	Dimensions	X		X					X	X
8.1.5.1	Resistance	X	X	X	X	X	X	X	X	X
8.3	Temperature rise and power dissipation	X								
8.4.3.2	Verification of rated current		X							
8.11.2.4	Verification of freedom from unacceptable levels of thermally induced drift After 50 temperature cycles, but tested at ambient temperature			X	X	X	X	X		
8.4.3.1	Conventional non-fusing current (I_{nt})			X						
	Conventional fusing current (I_f)				X					
8.5	No.1 Breaking capacity and operating characteristics (Table 104)					X				
	No.2 Breaking capacity and operating characteristics (Table 104)						X			
	No.5 Breaking capacity and operating characteristics (Table 104)							X		
8.11.2.5	Verification of functionality at temperature extreme (50 °C)								X	X
a	Verification of ability to carry rated current at temperature extreme								X	
b	Conventional fusing current (I_f) at temperature extreme									X

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

Test according to subclause		Number of samples				
		1	1	3	1	1
8.1.4	Dimensions	X			X	
8.1.5.1	Resistance	X	X	X	X	X
8.11.2.4	Verification of freedom from unacceptable levels of thermally induced drift and of functionality at temperature extremes After 50 temperature cycles, but tested at ambient temperature	X	X	X		
8.4.3.1	Conventional non-fusing current (I_{nf})	X				
	Conventional fusing current (I_f)		X			
8.5	No. 1 Breaking capacity and operating characteristics (Table 104)			X		
8.11.2.5	Verification of functionality at temperature extreme (50 °C)				X	X
a	Verification of ability to carry rated current at temperature extreme				X	
b	Conventional fusing current (I_f) at temperature extreme					X

8.3 Verification of temperature rise limits and power dissipation

8.3.1 Arrangement of the fuse-link

The fuse-link shall be mounted vertically in the conventional test arrangement.

For special fuse-links that cannot be accommodated in the conventional test arrangement, or for which this test arrangement is not applicable, special tests shall be performed according to the manufacturer's instructions and all pertinent data shall be recorded in the test report.

8.3.3 Measurement of power dissipation of the fuse-link

In addition to 8.3.3 of IEC 60269-1 the following applies.

The power dissipation test shall be made successively at least at 70 % and at 100 % of rated current. This test may be performed with either alternating or direct current.

8.3.5 Acceptability of test results

The temperature rise of the fuse-link shall not exceed the values specified in Table 5 of IEC 60269-1

The power dissipation of the fuse-link shall not exceed the values specified by the manufacturer.

8.4 Verification of operation

8.4.1 Arrangement of fuse-link

The arrangement of the fuse-link for the verification of operation shall be as described in 8.1.4 and 8.3.1.

8.4.3 Test method and acceptability of test results

8.4.3.1 Verification of conventional non-fusing and fusing current

It is permissible to make the following tests at a reduced voltage and either alternating or direct current:

- a) the fuse-link is subjected to its conventional non-fusing current (I_{nf}) for a time equal to the conventional time specified in Table 101. It shall not operate during this time;
- b) The fuse-link, ~~after having cooled down to ambient temperature,~~ is subjected to the conventional fusing current (I_f). It shall operate within the conventional time (Table 101). For string fuse-links it is also acceptable when $I_f = 1,35 I_n$ when the fuse link operates within $t_c = 2$ hours as specified in Table 101, Note 2. The fuse-link shall operate without external effects or damage.

NOTE ~~The tests in IEC 60269-6 are deemed to give satisfactory results for operation at $1,35 I_n$ within two hours in typical applications.~~ If this test arrangement is not applicable, special tests shall be performed according to the manufacturer's instructions and all pertinent data shall be recorded in the test report.

8.4.3.2 Verification of rated current

The test requested in 8.4.3.2 of IEC 60269-1:2006 is replaced by the following. The requirements for safe operation apply from IEC 60 269-1, 8.5.8:2006.

The tests may be performed with either alternating or direct current at reduced voltage.

- a) String fuse-links:

Rated current ≤ 63 A: Three samples are to undergo 3 000 repetitions of current cycling where one cycle is represented in Figure 101. None of the samples shall exhibit cracking ~~or crazing~~ of the fuse body. This test maybe performed with either alternating or direct current.

After this test, the resistance of the fuse-link at room temperature shall not have changed by more than 10 %, and then tests presented in 8.11.2.4 and Tables 102 and 103 shall be made.

- b) Sub array and Array fuse-links, rated current > 63 A (these fuse-links protect cables):

The test required in 8.4.3.2 of IEC 60269-1:2006 is applicable with the following modifications:

One fuse-link is submitted to a pulse test for 100 h, in which the fuse-link will be cyclically loaded. Each cycle with an on-period of the conventional time and an off-period of 0,1 of the conventional time, the test current being equal to 0,85 of the rated current of the fuse-link.

After the test the fuse-link shall not have changed its characteristics. Verification shall be carried out by the test as described in item a) of 8.4.3.1.

This test may be performed with either alternating or direct current.

8.4.3.5 Conventional cable overload protection test

Not applicable.

8.4.3.6 Operation of indicating devices and strikers, if any

The correct operation of indicating devices is verified in combination with the verification of breaking capacity (see 8.5.5).

For verifying the operation of strikers, if any, an additional test sample shall be tested:

- at a current of I_5 (see Table 104);
- at a recovery voltage of 50 V.

The value of the recovery voltage may be exceeded by 10 %.

The striker shall operate during all tests.

8.5 Verification of the breaking capacity

8.5.1 Arrangement of the fuse

In addition to the conditions of 8.1.4 and 8.3.1, the following requirement applies.

For breaking-capacity tests, the fuse-link shall be mounted and connected the same way as it would be in service.

8.5.5 Test method

8.5.5.1 In order to verify that the fuse-link satisfies the conditions of 7.5, tests number – 1, 2 and 5 – shall be made. The number of fuse-links requested in Table 102 shall be tested with the values stated in Table 104.

Test nos. 1 and 2 : If, during test no. 1, the requirements of test no. 2 are met, then this test need not be repeated as test no. 2.

Test nos. 5 – The value of test current is specified in Table 104.

8.5.5.2 For the tests the recovery voltage shall be maintained at a value of 100^{+5}_0 % of the rated voltage for at least:

- 30 s after operation of fuse-links not containing organic materials in their body or filler;
- 5 min after operation of the fuse-links in all other cases, switching over to another source of supply being permitted after 15 s if the switching time (interval without voltage) does not exceed 0,1 s.

In a lapse of time of at least 6 min and maximum 10 min after the operation, the resistance between the contacts of the fuse-link shall be measured (see 8.5.8 of IEC 60269-1) and noted. With the manufacturer's consent, shorter times are possible if the fuse-link does not contain organic materials in its body or filler.

8.5.8 Acceptability of test results

Fuse-links shall be deemed not to comply with this standard if, during the tests, one or more of the following failures occur:

- ignition of the fuse-link, excluding any paper labels or the like used as indicating devices;
- mechanical damage to the test arrangement;
- mechanical damage to the fuse-link;

NOTE Thermal cracking which leaves the fuse-link in one piece is accepted.

- burning or melting of end caps;
- significant movement of end caps.

Table 104 – Values for breaking-capacity tests on “gPV” fuse-links

	Tests according to 8.5.5.1		
	No. 1	No. 2	No. 5
Mean value of recovery voltage ^a	100 ⁺⁵ ₀ % of the rated voltage ^b		
Prospective test current	<i>I</i> ₁	<i>I</i> ₂	<i>I</i> ₅ = 2 <i>I</i> _n
Tolerance on current	⁺¹⁰ ₀ %	Not applicable	⁺²⁰ ₀ %
Time constant ^c	1 ms to 3 ms		Inductance ≥ 100-micro Henry ≤ 1 ms
<i>I</i> ₁ current which is used in the designation of the rated breaking capacity (see 5.7).			
<i>I</i> ₂ current which shall be chosen in such a manner that the test is made under conditions which approximate those giving maximum arc energy.			
NOTE This condition may be deemed to be satisfied if the current, at the beginning of arcing, has reached a value between 0,5 and 0,8 times the prospective current.			
<i>I</i> ₅ test current deemed to verify that the fuse is able to operate satisfactorily in the range of small over-currents.			
^a This tolerance includes ripple.			
^b The upper limit may be exceeded with the manufacturer's consent.			
^c In some practical applications, time-constant values may be found which are shorter than those indicated in the tests and which may result in a more favourable fuse performance.			

8.11 Mechanical and miscellaneous tests

8.11.2.4 Verification of freedom from unacceptable levels of thermally induced drift

Nine samples of each fuse-link having the largest rated current and five samples of each fuse-link having the smallest rated current are each to be subjected to temperature cycling consisting of 50 cycles of heating and cooling. Each cycle consisting of 15 min with the fuse-link body maintained at -40 ± 5 °C followed by 15 min with the fuse-link body maintained at 90 ± 5 °C (any convenient ramp rate). At the conclusion of the 50 cycles, the samples shall be returned to room temperature (25 ± 5 °C) for a minimum of 3 h.

At the conclusion of the temperature cycling, the samples of the fuse-link having the largest rated current are to be subjected to the tests described as follows:

- 8.4.3.1 Conventional non-fusing current (I_{nf})
Conventional fusing current (I_f)
- 8.5 No.1 Breaking capacity and operating characteristics (Table 104)
No.2 Breaking capacity and operating characteristics (Table 104)
No.5 Breaking capacity and operating characteristics (Table 104)

At the conclusion of the temperature cycling, the samples of the fuse-link having the smallest rated current are to be subjected to the tests described as follow:

- 8.4.3.1 Conventional non-fusing current (I_{nf})
Conventional fusing current (I_f)
- 8.5 No. 1 Breaking capacity and operating characteristics (Table 104)

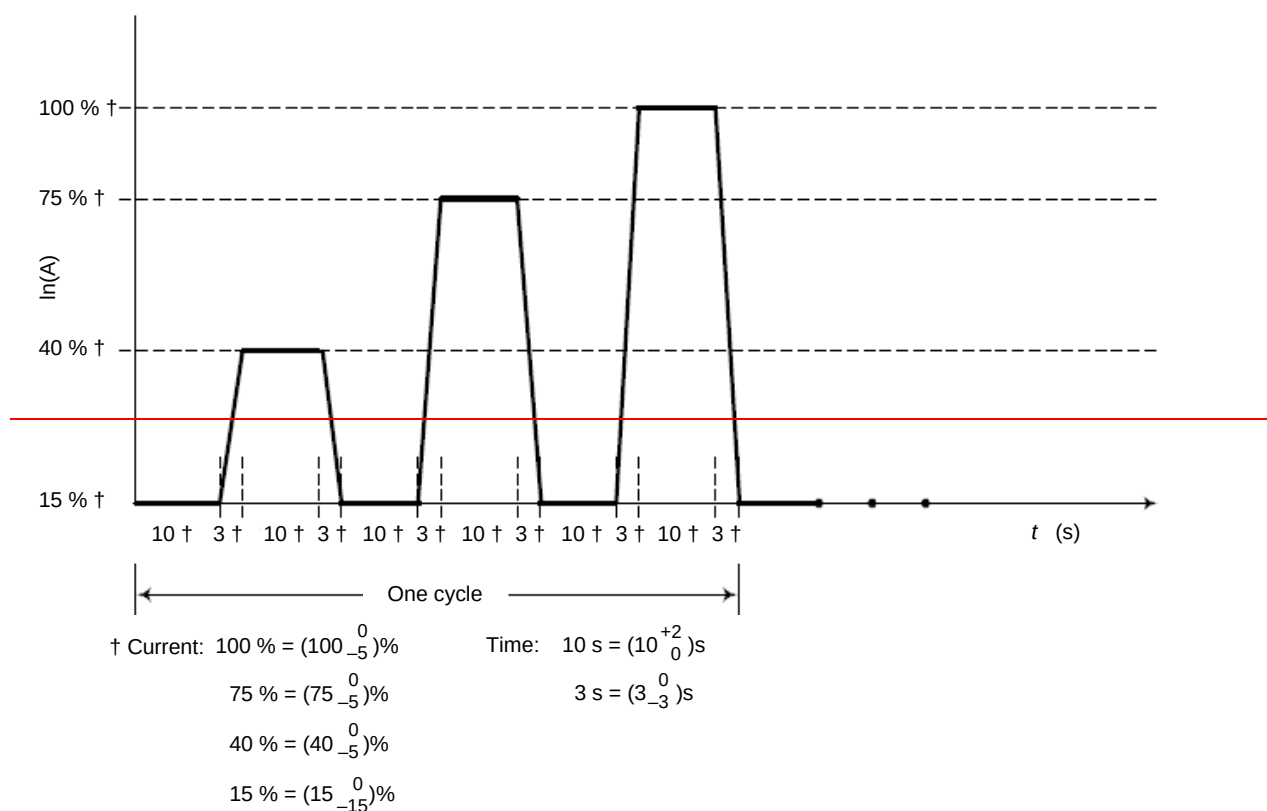
See tables 102 and 103.

8.11.2.5 Verification of functionality at temperature extremes

a) One sample of each fuse-link having the largest rated current and one sample of each fuse-link having the smallest rated current shall be subjected to a temperature of 50 ± 5 °C for a period of 3 h or until temperatures stabilize. Each fuse-link shall be subjected to its rated current (I_n) for a time equal to the conventional time specified in Table 101. It shall not operate during this time.

b) One sample of each fuse-link having the largest rated current and one sample of each fuse-link having the smallest rated current shall be subjected to a temperature of 50 ± 5 °C for a period of 3 h or until temperatures stabilize. Each fuse-link shall be subjected to its conventional fusing current (I_f). It shall operate within the conventional time as specified in Table 101. The fuse link shall operate without external effects or damage.

See Tables 102 and 103.



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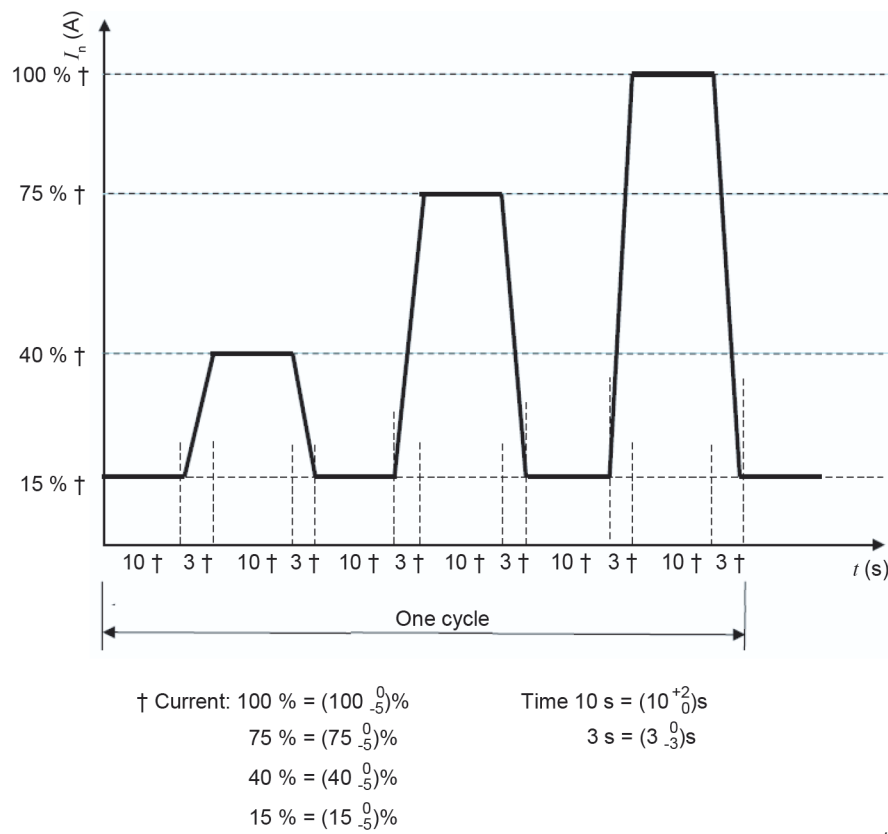


Figure 101 – Current of test cycling

Annex AA (normative)

Examples of standardized fuse-links for the protection of solar photovoltaic energy systems

AA.1 General

This annex is divided into four specific examples of standardised dimensions:

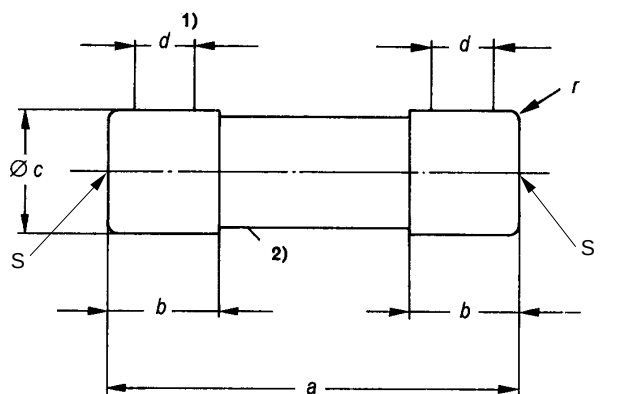
- system of fuse-links with cylindrical contact caps, type A – ~~French~~ (Figure AA.1 and Figure AA.2)
- system of cylindrical fuse-links with blade contacts, type B – ~~North American~~ (Figure AA.3)
- system of fuse-links with blade contacts, type C – ~~DIN~~ (Figure AA.4)
- ~~– system of cylindrical fuse-links with long blade contacts, type D – DIN (Figure AA.5)~~
- system of long fuse-links with blade contacts, type D (Figure AA.5)
- replacement handle for fuse links type D – Figure AA.6
- examples of fuse bases to AA.5 (long fuse links with blade contacts) – Figure AA.7
- system of long fuse links with bolted contacts – Figure AA.7

Fuse-links for the PV protection may also have the same dimensions as fuse-links according to IEC 60269-2: systems of fuses A, F and H.

In addition to ~~meeting the~~ making these requirements of this standard, the power dissipation of the fuse-link shall not exceed the acceptable power ~~dissipation~~ acceptance of the associated fuse-bases or fuse-holders.

Where the power dissipation of the fuse link exceeds the acceptable power ~~dissipation~~ acceptance of the standardised fuse-base or fuse-holder, de-rating values shall be given by the manufacturer.

AA.2 Fuse-links with cylindrical contact caps, type A



IEC 2161/10

Measuring points S for power dissipation tests.

Key

Dimensions in millimeters

Size	a	b max.	c	d min.	r
10 × 38	38 ± 0,6	10,5	10,3 ± 0,1	6	1,5 ± 0,5
14 × 51	51 ^{+0,6} ₋₁ ²⁾	13,8	14,3 ± 0,1	7,5	2 ± 1
10 × 85	85 ± 1,2	10,5	10,3 ± 0,1	6	1,5 ± 0,5
20 × 127	127 ± 2 ³⁾	16,2	20,6 ± 0,2	10,8	2 ± 1
22 × 127	127 ± 2 ³⁾	16,2	22,2 ± 0,1	11	2 ± 1
27 × 140	140 ± 2	16,2	27 ± 0,2	15,9	2 ± 1

Size	a	b _{max}	c	d _{min}	r
10 × 38	38+0,9/-0,6	10,5	10,3+/-0,1	6	1,5+/-0,5
14 × 51	51+0,6/-1 ³⁾	13,8	14,3+/-0,1	7,5	2+/-1
10 × 85	85+/-1,2	10,5	10,3+/-0,1	6	1,5+/-0,5
20 × 127	127+/-2 ³⁾	16,2	20,6+/-0,2	10,8	2+/-1
22 × 127	127+/-2 ³⁾	16,2	22,2+/-0,2	11	2+/-1
27 × 140	140+/-2	16,2	27,0+/-0,2	15,9	2+/-1

1) Cylindrical part within which the specified tolerances shall not be exceeded.

2) The diameter of the cartridge between the end caps shall not exceed diameter c.

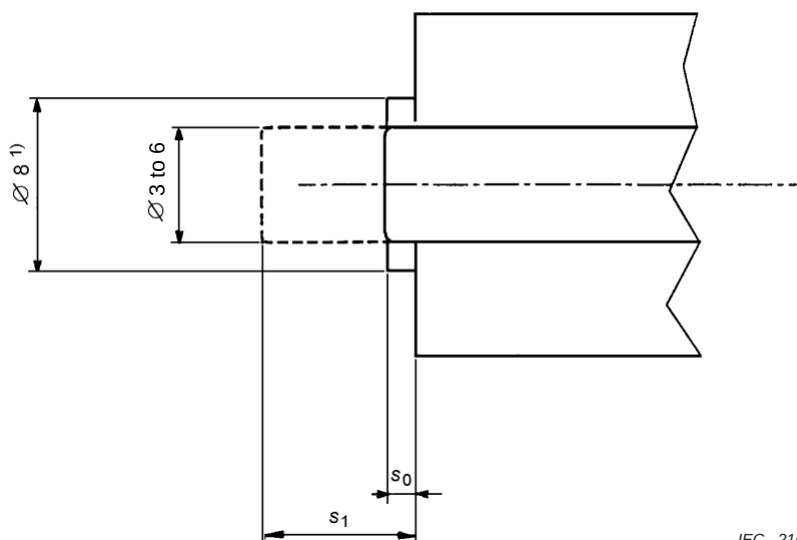
3) For striker version the tolerances are ±1.

The drawings are not intended to govern the design of fuse-links except as regards the notes and dimensions shown.

Figure AA.1 – Fuse-links with cylindrical contact caps, type A



Dimensions in millimeters



IEC 2162/10

Key

S_o 1 mm maximum

S_1 8,5 +/- 1,5 mm

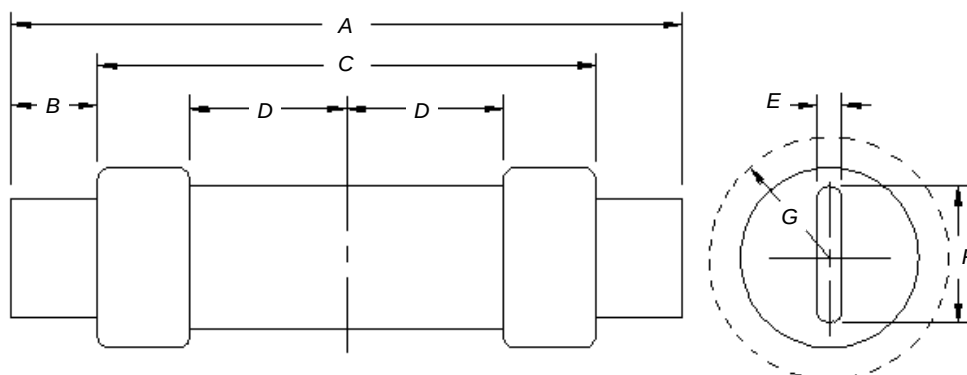
1) Diameter of cylinder in which the striker shall stay

The drawings are not intended to govern the design of fuse-links except as regards the notes and dimensions shown.

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

AA.3 **North-American** Cylindrical fuse-links with blade contacts, type B (specific for PV application)

Dimensions in millimeters



IEC 2163/10

Key

Current rating (A)	Overall fuse length (mm)	Minimum length of blade (mm)	Minimum length of body (mm)	Minimum distance from midpoint to live part (mm)	Blade thickness (mm)	Width of blade (mm)	Maximum dimension of cap (mm)
I_n	A ^a	B ^b	C ^c	D ^d	E ^e	F ^f	G
61-100	200,0	25,4	136,5	44,4	3,18	19,1	22,2
101-100	244,5	34,9	155,5	57,2	4,76	28,6	28,6
201-400	295,3	47,6	181,0	63,5	6,35	41,3	38,1
401-600	339,7	57,2	208,0	68,3	6,35	50,8	44,5

^a Tolerances: 61-100A, +/- 1,6 mm; 201-600A, +/-2,4 mm.

^b One blade shall not be more than 1,6 mm longer than the other blade. The effective length of the blade is measured from the blade end to the fuse body or other interference means in the blade, such as pins through the blade contacts, a collar or the like.

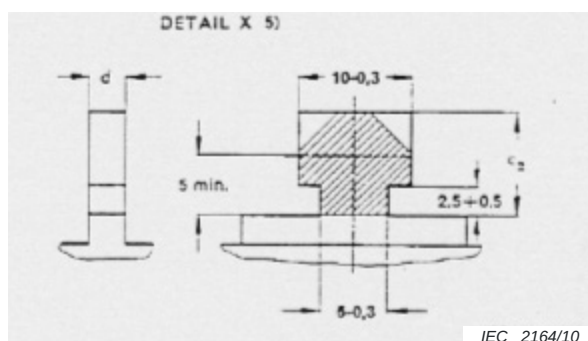
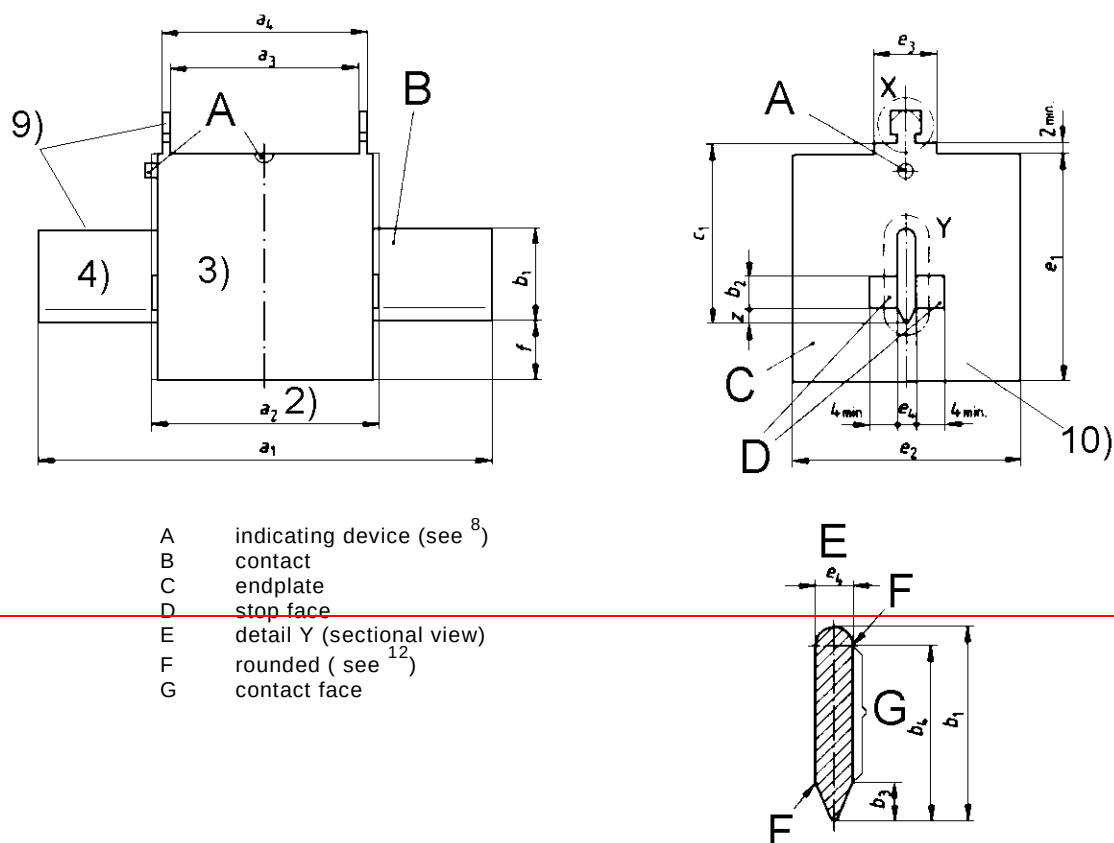
^c The length of the cylindrical body may be less than the indicated value if other acceptable interference means such as pins through the blade contacts or collars are provided to prevent mounting the fuse in a fuse holder that will accommodate a fuse rated in the next lower bracket of current ratings.

^d The minimum distance from the midpoint of the fuse to the nearest live part may be reduced to 12,7 mm minimum if the fuse is constructed so that spacing's in end use equipment are maintained.

^{e, f} Tolerances: +/- 0,1 mm.

Figure AA.3 – **North-American Cylindrical fuse-links with blade contacts
– Sizes 61-600 A**

AA.4 Fuse-links with blade contacts, type C, C referring IEC 60269-2 “Fuse system A (NH fuse system)”

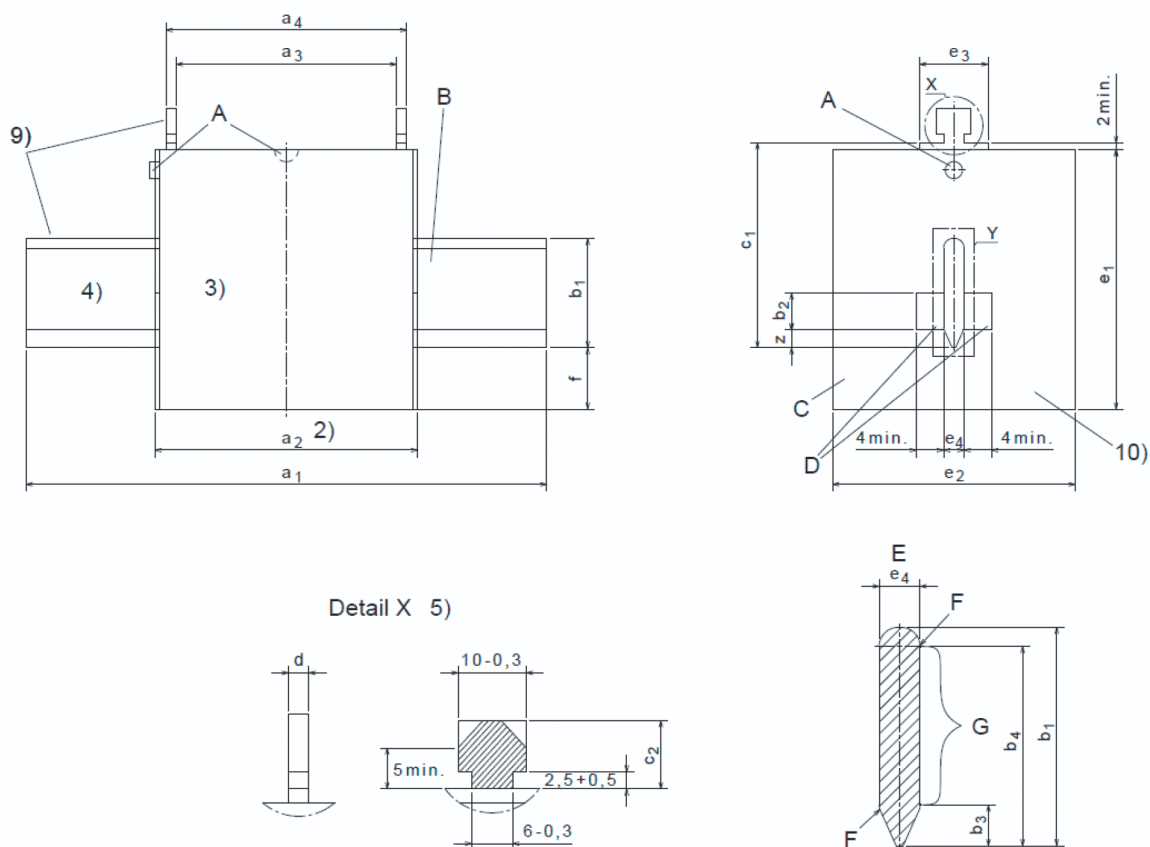


Dimensions in millimeters

Size	a_1 1)	a_2 2)	a_3 1)	a_4 1)	b_1 min. 11)	b_2 min. 11)	b_3 max. 11)	b_4 min. 11)	e_1 $\pm 0,8$	e_2	d 5)	e_1 max. 6)	e_2 max. 6)	e_3	e_4 $\pm 0,2$	f max.	z max.
1	135 $\pm 2,5$	75 -10	62 $\pm 2,5$	68 $\pm 2,5$	20	5	6	17	40	11 -2	2,5 $\frac{+1,5}{-0,5}$	53	52	20	6	15	5
2	150 $\pm 2,5$	75 -10	62 $\pm 2,5$	68 $\pm 2,5$	25	8	6	22	48	11 -2	2,5 $\frac{+1,5}{-0,5}$	61	60	20	6	15	5
3	150 $\pm 2,5$	75 -10	62 $\pm 2,5$	68 $\pm 2,5$	32	11	6	29	60	11 -2	2,5 $\frac{+1,5}{-0,5}$	76	75	20	6	18	5

Dimensions in millimeters

- 1) The centres of the dimensions a_1 , a_3 and a_4 shall not deviate from the centre of a_2 by more than 1,5 mm.
- 2) The dimension a_2 shall be observed within the total area of the stop faces ($b_2 \times 4$ min.) on both sides of the blades. Outside of these areas the maximum dimension a_2 applies.
- 3) Insulating material.
- 4) The blade contacts shall be axially aligned and contact surfaces shall be plane.
- 5) Attachment for replacement handle (detail X).
- 6) Maximum dimensions of the enclosure of the fuse-link. Within these limits, the fuse-links may be of any form, for example, square, rectangular, circular, oval, polygonal, etc.
- 8) Indicating device. Position of the indicating device as chosen by the manufacturer.
- 9) Live parts, gripping-lugs can be insulated.
- 10) With the exception of the attachment for the replacement handle (detail X), the endplates are not permitted to protrude radially from the insulation body.
- 11) As far as overlapping of rated currents exists within the sizes 1, 2 and 3 the dimension of the smaller size is permitted.
- 12) All corners shall be rounded to prevent damage to the contact surface of the base contacts.



IEC

Key

- A indicating device (see ⁸⁾)
- B contact
- C endplate
- D stop face
- E detail Y (sectional view)
- F rounded (see ¹²⁾)
- G contact face

Size	a_1 1)	a_2 2)	a_3 1)	a_4 1)	b_1 min. 11)	b_2 min. 11)	b_3 max. 11)	b_4 min. 11)	c_1 $\pm 0,8$	c_2	d 5)	e_1 max. 6)	e_2 max. 6)	e_3	e_4 $\pm 0,2$	f max.	z max.
1	135 $\pm 2,5$	75 -10	62 $\pm 2,5$	68 $\pm 2,5$	20	5	6	17	40	11	2,5 $+1,5$ $-0,5$	53	52	20	6	15	5
2	150 $\pm 2,5$	75 -10	62 $\pm 2,5$	68 $\pm 2,5$	25	8	6	22	48	11	2,5 $+1,5$ $-0,5$	61	60	20	6	15	5
3	150 $\pm 2,5$	75 -10	62 $\pm 2,5$	68 $\pm 2,5$	32	11	6	29	60	11	2,5 $+1,5$ $-0,5$	76	75	20	6	18	5

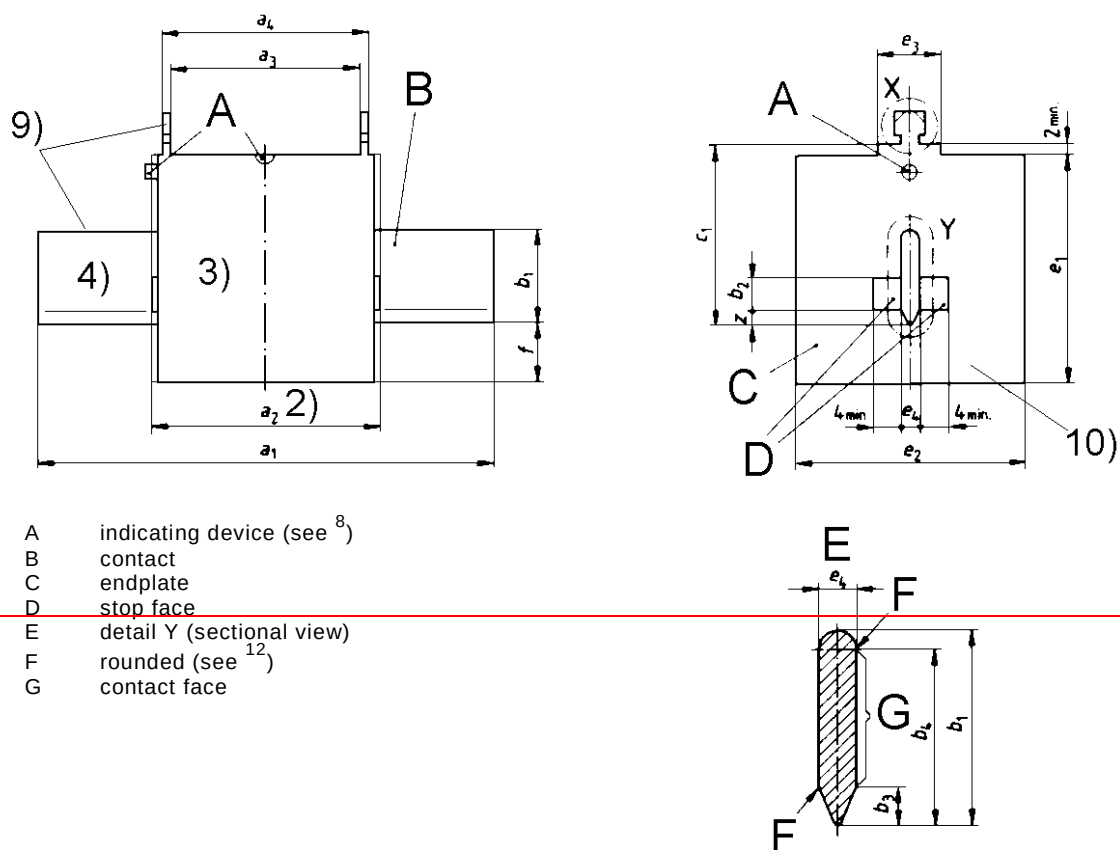
Dimensions in millimeters

- 1) The centres of the dimensions a_1 , a_3 and a_4 shall not deviate from the centre of a_2 by more than 1,5 mm.
- 2) The dimension a_2 shall be observed within the total area of the stop faces ($b_2 \times 4$ min.) on both sides of the blades. Outside of these areas the maximum dimension a_2 applies.
- 3) Insulating material.
- 4) The blade contacts shall be axially aligned and contact surfaces shall be plane.
- 5) Attachment for replacement handle (detail X).

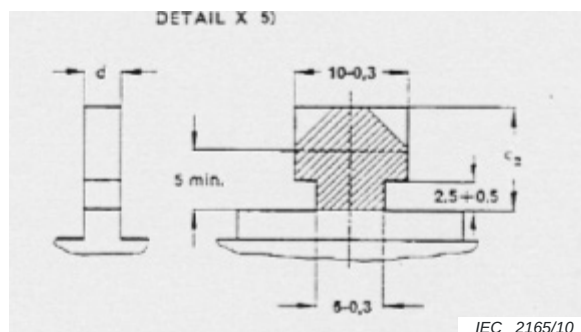
- 6) Maximum dimensions of the enclosure of the fuse-link. Within these limits, the fuse-links may be of any form, for example, square, rectangular, circular, oval, polygonal, etc.
- 8) Indicating device. Position of the indicating device as chosen by the manufacturer.
- 9) Live parts, gripping-lugs can be insulated.
- 10) With the exception of the attachment for the replacement handle (detail X), the endplates are not permitted to protrude radially from the insulation body.
- 11) As far as overlapping of rated currents exists within the sizes 1, 2 and 3 the dimension of the smaller size is permitted.
- 12) All corners shall be rounded to prevent damage to the contact surface of the base contacts.

Figure AA.4 – Fuse-links with blade contacts, type C, C referring IEC 60269-2 “Fuse system A (NH fuse system)”

AA.5 Fuse-links with long blade contacts, type D (specific for PV application)



- A indicating device (see ⁸⁾)
- B contact
- C endplate
- D stop face
- E detail Y (sectional view)
- F rounded (see ¹²⁾)
- G contact face



Dimensions in millimeters

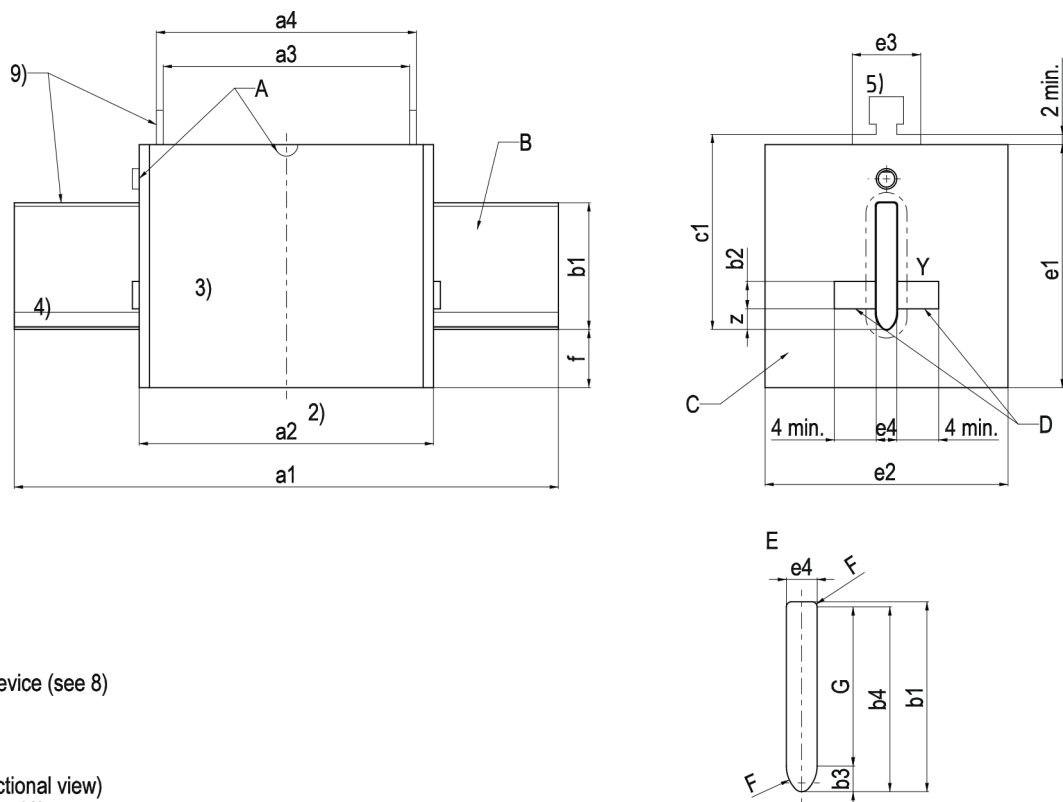
Dimensions in millimeters

Key

Size	a ₁ 1)	a ₂ 2)	a ₃ 1)	a ₄ 1)	b ₁ min. 11)	b ₂ min. 11)	b ₃ max. 11)	b ₄ min. 11)	e ₁ ±0,8	e ₂	d 5)	e ₁ max. 6)	e ₂ max. 6)	e ₃	e ₄ ±0,2	f max.	z max.
1L	170 ±3	112 -10	102 ±3	108 ±3	20	5	6	17	40	11	2,5 +1,5 -0,5	53	52	20+5 -2	6	16,5	5
1XL	189 ±5	133 -10	120 ±3	127 ±3	20	5	6	17	40	11	2,5 +1,5 -0,5	53	52	20+5 -2	6	16,5	5
2L	185 ±3	112 -10	102 ±3	108 ±3	25	8	6	22	48	11	2,5 +1,5 -0,5	61	60	20+5 -2	6	16,5	5
2XL	205 ±3	130 -10	117 ±3	123 ±3	25	8	6	22	48	11	2,5 +1,5 -0,5	61	60	20+5 -2	6	16,5	5
3L	205 ±3	130 -10	117 ±3	123 ±3	32	11	6	29	60	11	2,5 +1,5 -0,5	76	75	20+5 -2	6	18	5

- 1) — The centres of the dimensions a₁, a₃ and a₄ shall not deviate from the centre of a₂ by more than 1,5 mm.
- 2) — The dimension a₂ shall be observed within the total area of the stop faces (b₂ × 4 min.) on both sides of the blades. Outside of these areas the maximum dimension a₂ applies.
- 3) — Insulating material.
- 4) — The blade contacts shall be axially aligned and contact surfaces shall be plane.
- 5) — Attachment for replacement handle (detail X).
- 6) — Maximum dimensions of the enclosure of the fuse-link. Within these limits, the fuse-links may be of any form, for example, square, rectangular, circular, oval, polygonal, etc.
- 8) — Indicating device. Position of the indicating device as chosen by the manufacturer.
- 9) — Live parts, gripping lugs can be insulated.
- 10) — With the exception of the attachment for the replacement handle (detail X), the end plates are not permitted to protrude radially from the insulation body.
- 11) — As far as overlapping of rated currents exists within the sizes 1L, 1XL, 2L, 2XL, and 3L the dimension of the smaller size is permitted.
- 12) — All corners shall be rounded to prevent damage to the contact surface of the base contacts.

Figure AA.5 — Fuse-links with long blade contacts, type D



- A indicating device (see 8)
B contact
C endplate
D stop face
E detail Y (sectional view)
F rounded (see 12)
G contact face

IEC

Key

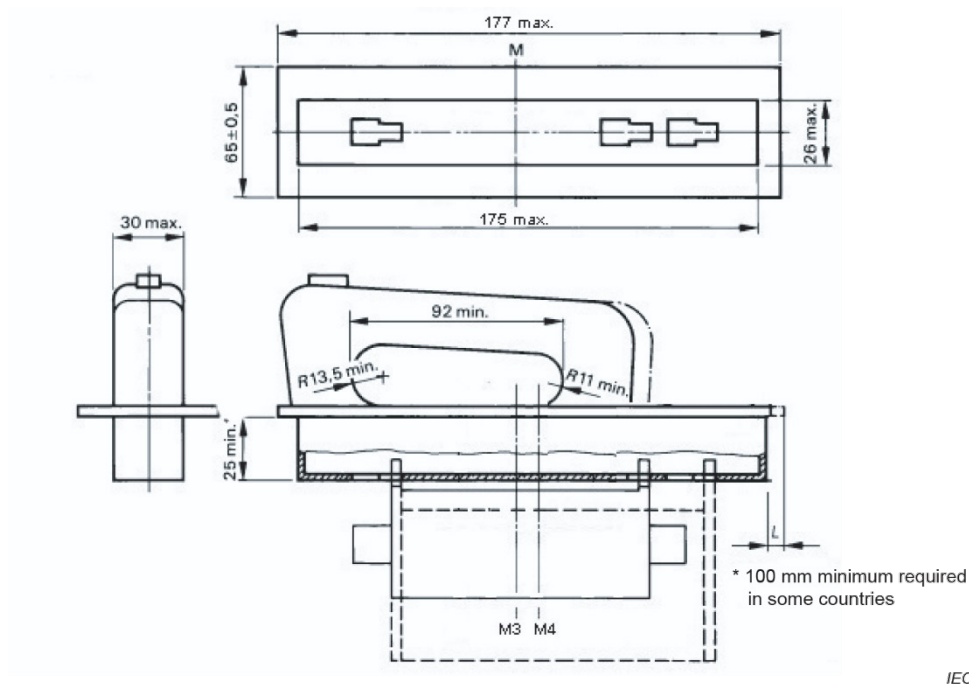
Size	a_1 1)	a_2 2)	a_3 1)	a_4 1)	b_1 min. 11)	b_2 min. 11)	b_3 max. 11)	b_4 min. 11)	c_1 $\pm 0,8$	c_2	d 5)	e_1 max. 6)	e_2 max. 6)	e_3	e_4 $\pm 0,2$	f max.	z max.
1L	170 ± 3	112 -10	102 ± 3	108 ± 3	20	5	6	17	40	11 -2	2,5 $+1,5$ $-0,5$	53	52	20 +5 -2	6	16.5	5
1XL	189 ± 5	133 -10	120 ± 3	127 ± 3	20	5	6	17	40	11 -2	2,5 $+1,5$ $-0,5$	53	52	20 +5 -2	6	16.5	5
2L	185 ± 3	112 -10	102 ± 3	108 ± 3	25	8	6	22	48	11 -2	2,5 $+1,5$ $-0,5$	61	60	20 +5 -2	6	16.5	5
2XL	205 ± 3	130 -10	117 ± 3	123 ± 3	25	8	6	22	48	11 -2	2,5 $+1,5$ $-0,5$	61	60	20 +5 -2	6	16.5	5
3L	205 ± 3	130 -10	117 ± 3	123 ± 3	32	11	6	29	60	11 -2	2,5 $+1,5$ $-0,5$	76	75	20 +5 -2	6	18	5

1) The centres of the dimensions a_1 , a_3 and a_4 shall not deviate from the centre of a_2 by more than 1,5 mm.

2) The dimension a_2 shall be observed within the total area of the stop faces ($b_2 \times 4 \text{ min.}$) on both sides of the blades. Outside of these areas the maximum dimension a_2 applies.

- 3) Insulating material.
- 4) The blade contacts shall be axially aligned and contact surfaces shall be plane.
- 5) Attachment for replacement handle (detail X).
- 6) Maximum dimensions of the enclosure of the fuse-link. Within these limits, the fuse-links may be of any form, for example, square, rectangular, circular, oval, polygonal, etc.
- 8) Indicating device. Position of the indicating device as chosen by the manufacturer.
- 9) Live parts, gripping-lugs can be insulated.
- 10) With the exception of the attachment for the replacement handle (detail X), the end plates are not permitted to protrude radially from the insulation body.
- 11) As far as overlapping of rated currents exists within the sizes 1L, 1XL, 2L, 2XL, and 3L the dimension of the smaller size is permitted.
- 12) All corners shall be rounded to prevent damage to the contact surface of the base contacts.

**Figure AA.5 – Long fuse-links with blade contacts,
type D (specific for PV application)**



IEC

Size	Distance		
	L	M-M3	M-M4
1 L/2 L	16	0 ± 6	–
1 XL/2 XL/3L	16	–	9,5 ± 6

Centre of the set-in and blocked-up fuse-link:

M3 For the sizes 1 L/2 L

M4 For the sizes 1 XL/2 XL/3 L

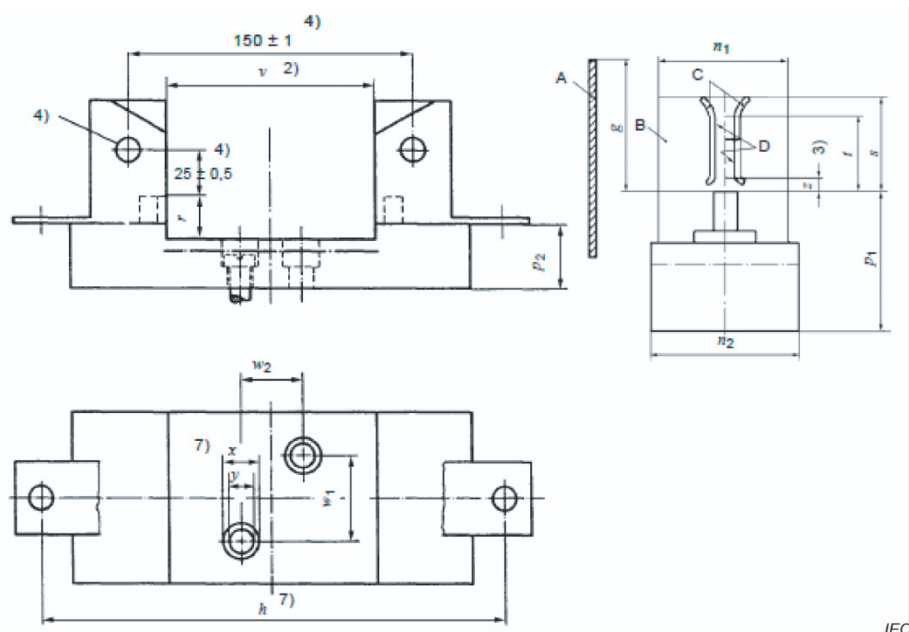
M Centre of coupling

L Permitted lift for setting in and taking out the fuse-link

NOTE The basic position of the fuse-link for measurements of the handle is defined by the manufacturer. Exclusive handles for sizes 1L, 2L and / or for sizes 1XL, 2XL, 3L can be defined here.

Figure AA.6 – Replacement handle for long fuse-links with blade contacts

AA.6 Fuse-links with bolted contacts, type E (specific for PV application)



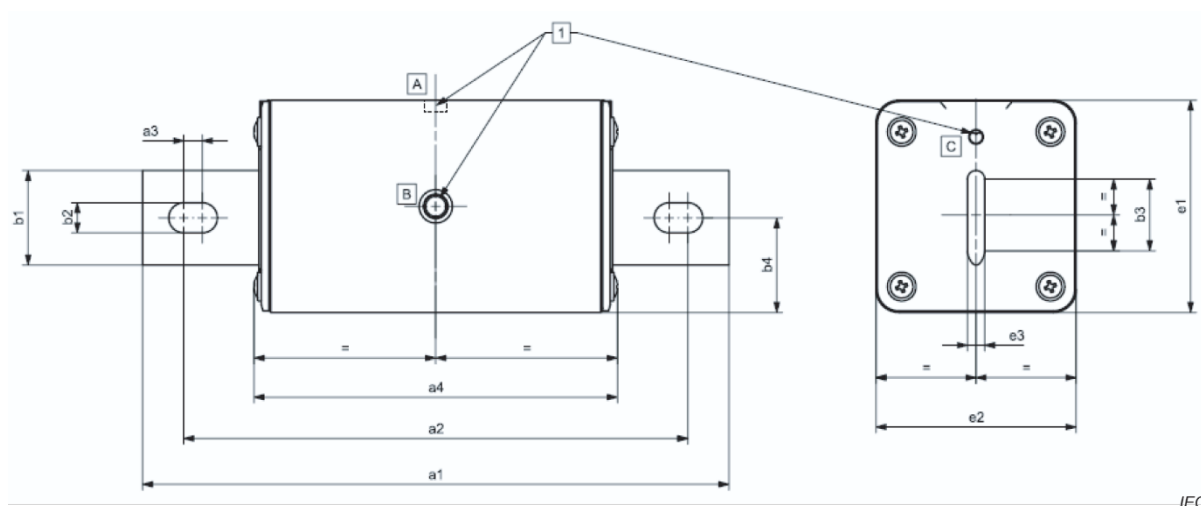
Key

- A Partition wall
- B See note 1)
- C Contacts
- D Contact surface, see note 5)

Size	g ±1 8)	h ±5 7)	n ₁ max.	n ₂ max.	P ₁ max.	P ₂ ±1,5	r min.	s max.	t min.	v	w ₁ 7)	w ₂ 7)	x min. 7)	y 7)	s max.
1 L	53	215	52	60	55	35	17	38	21	117±3	30±0,7	25±0,7	20	+1 10,5 –0,5	38
1 XL	53	233	52	60	55	35	17	38	21	135±5	30±0,7	25±0,7	20	+1 10,5 –0,5	38
2 L	61	240	60	68	60	35	17	46	27	117±3	30±0,7	25±0,7	20	+1 10,5 –0,5	38
2 XL	61	258	60	68	60	35	17	46	27	135±5	30±0,7	25±0,7	20	+1 10,5 –0,5	38
3 L	73	268	75	83	68	35	20	58	33	135±5	30±0,7	25±0,7	20	+1 10,5 –0,5	38

- 1) This area is considered to be live.
- 2) The maximum value of dimension v is intended to define a point of contact. It shall at least be observed at one point of contact within the two areas $b_2 \times 4$ min. of the fuse-link. Dimension v may also be met by means of insulating contact covers.
- 3) Height of contact surface. It shall also be possible to insert fuse-links with blade contacts according to Figure 101, even if the contact surface is not smooth but grooved or divided.
- 4) Dimensions for size 4. Fixing bolts are mandatory for size 4; M12 when threaded.
- 5) Resilient contact surface, except for size 4. Contact force by auxiliary means.
- 6) Only to be used with swivel unit having an interlocking device.
- 7) These values are only mandatory if interchangeability of fuse-bases is required.
- 8) When constructing multiple or assemblies of single-pole fuse-bases, it is necessary, for reasons of safety, to fit insulating barriers (for example, partition walls with recommended dimension "g") compatible with the maximum dimension prescribed for n_1 .

Figure AA.7 – Fuse-bases for long fuse-links with blade contacts



Size	a1	a2 +0/-10	b1 min	e +/-4	e1 max	e2 max	e3 +5/-2 (1)	e4 +/- 0.2	g1 min	g2 min
1B	135 +/-2.5	75	20	106	53	53	20	6	8.5	13
1LB	170 +/-3	112	20	146	53	53	20	6	8.5	13
1XLB	189 +/-5	133	20	163	53	53	20	6	8.5	13
2B	150 +/-2.5	75	25	110	61	61	20	6	10.5	15
2LB	185 +/-2.5	112	25	146	61	61	20	6	10.5	15
2XLB	205 +/-3	130	25	163	61	61	20	6	10.5	15
3B	150 +/-2.5	75	32	114	76	76	20	6	1.05	15
3LB	205 +/-3	130	32	170	76	76	20	6	10.5	15

Note (1) optional feature, if required

1. The blade contacts shall be axially aligned and contact surfaces shall be plane.
2. Attachment for replacement handle (detail X), if fitted.
3. Maximum dimensions of the enclosure of the fuse-link. Within these limits, the fuse-links may be of any form, for example, square, rectangular, circular, oval, polygonal, etc.
4. Indicating device. Position of the indicating device as chosen by the manufacturer (A, B or C).
5. Within the exception of the attachment for the replacement handle (detail X), the end plates are not permitted to protrude radially from the insulation body.
6. As far as overlapping of rated currents exists within the sizes 1B, 1LB, 1XLB, 2B, 2LB, 2XLB, 3B and 3LB the dimensions e1 and e2 of the smaller size are permitted

Notes:

- a) Blade contacts shall be axially aligned and contact surfaces shall be plane.
- b) Attachment for the replacement handle (detail X) , if fitted.
- c) Maximum dimensions of the enclosure of the fuse-link . Within these limits, the fus-links may be of any form, e.g. square, rectangular, circular, oval, polygonal, etc.
- d) Indicating device. Position of the indicating device as chosen by the manufacturer(A, B or C).
- e) With the exception of the attachment for the replacement handle (detail X) , the end plates are not permitted to protrude radially from the insulation body.
- f) As far as overlapping of rated currents existen within the sizes 1B, 1LB, 1XLB, 2B, 2LB, 2XLB,3B and 3LB dimensions e1 and e2 of the smaller size are permitted.

Figure AA.8 – Fuse-links with bolted blade contacts, type E (specific for PV application)

Annex BB (informative)

Guidance for the protection of photovoltaic strings and arrays with fuse-links designed for PV applications

BB.1 General

This annex is limited to the use of PV Fuse-links in circuits having the characteristics generally found in the d.c. side of photovoltaic installation.

It is the object of this annex to explain the performance from the fuse-links in term of their ratings and in term of the characteristics of the circuits of which they form a part, in such a manner that this may form the basis for the selection of the fuse-links.

BB.2 Voltage characteristics

BB.2.1 Rated voltage

The rated voltage of the fuse-link selected shall take into account V_{OC} of the string at the lowest application temperature.

For example: at -25 °C the open circuit voltage rise to 1,2 times $V_{OC\text{ STC}}$. Consequently the fuse -link rated shall be $\geq 1,2 \times V_{OC\text{ STC}}$.

BB.3 Current carrying capability

BB.3.1 Rated current

The rated current of the fuse-link selected shall take into account I_{sc} at the ambient temperature, and the cycling load, see IEC 60269-5.

For example: at 45 °C and a peak of radiation of $1\,200\text{ Wm}^{-2}$, the fuse-link rated current shall be $\geq 1,4 \times I_{sc}$.

Contact fuse manufacturer for additional de-ratings caused by higher ambient temperature or by multiple fuses arranged in an enclosure.

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