

FOREWORD

This amendment has been prepared by subcommittee 32B: Low-voltage fuses, of IEC technical committee 32: Fuses.

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

FDIS	Report on voting
32B/698/FDIS	32B/699/RVD

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

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

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- withdrawn,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

The contents of the corrigendum of November 2021 have been included in this copy.

1.1 Scope and object

Replace the first two sentences of the Scope with the following new text:

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 DC, and also, in so far as they are applicable, for circuits of higher nominal voltages.

1.2 Normative references

Delete the date and the footnote after the following reference:

IEC 60269-1

Add the following new references:

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*

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

2 Terms and definitions

2.2 General terms

Add, after the title of 2.2, the following new note:

NOTE Photovoltaic = PV.

2.2.101

Replace the existing title and text of 2.2.101 with the following new title and text:

2.2.101

PV fuse-link

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

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

Delete existing Subclause 2.2.102.

2.2.103

Delete existing Subclause 2.2.103.

2.2.104

Delete the words “array field, assembly, generator, panel” from the text of Subclause 2.2.104 and renumber 2.2.104 to 2.2.102 and 2.104.1 to 2.2.102.1

Delete Subclauses 2.2.104.2, 2.2.104.3, 2.2.104.4 and 2.2.104.5.

Renumber 2.2.104.6 as 2.2.102.2 and 2.2.104.7 as 2.2.102.3.

2.2.105

Delete Subclause 2.2.105.

2.2.106

Delete Subclause 2.2.106.

2.2.107

Renumber 2.2.107 as 2.2.102.4.

2.2.108

Renumber 2.2.108 as 2.2.102.5.

2.2.109

Renumber 2.2.109 as 2.2.103 and replace the existing text with the following new text:

2.2.103**currents****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

Renumber 2.2.110 as 2.2.104.

Replace, in the title of 2.2.110, "photovoltaic" by "PV".

Delete Subclauses 2.2.110.1, 2.2.110.2, 2.2.110.3 and 2.2.110.4.

Renumber 2.2.110.5 as 2.2.104.1 and replace "output electrical current" by "load current".

Renumber 2.2.110.6 as 2.2.104.2.

Delete Subclause 2.2.110.7.

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

Replace existing Table 101 with the following new table:

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

Rated current <i>A</i>	Conventional time <i>h</i>	Conventional current		Fuse type
		Type "gPV"		
		<i>I_{nf}</i>	<i>I_f</i>	
$I_n \leq 63$	1	1,05	-	String fuse-link
	2	-	1,35 ¹⁾	
$63 < I_n \leq 160$	2	1,13 [*]	1,45 [*]	Subarray or Array fuse-link
$160 < I_n \leq 400$	3			
$400 < I_n$	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

8.3.3 Measurement of power dissipation of the fuse-link

Add the following new sentence at the end of the second paragraph of 8.3.3:

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

8.4.3.1 Verification of conventional non-fusing and fusing current

Replace the existing first sentence of 8.4.3.1 with the following new sentence:

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

Replace existing bullet point b) with the following new text:

- b) The fuse-link is subjected to the conventional fusing current. 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 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

Replace the existing text of 8.4.3.2 with the following new text:

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 of the fuse body. This test may be 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.

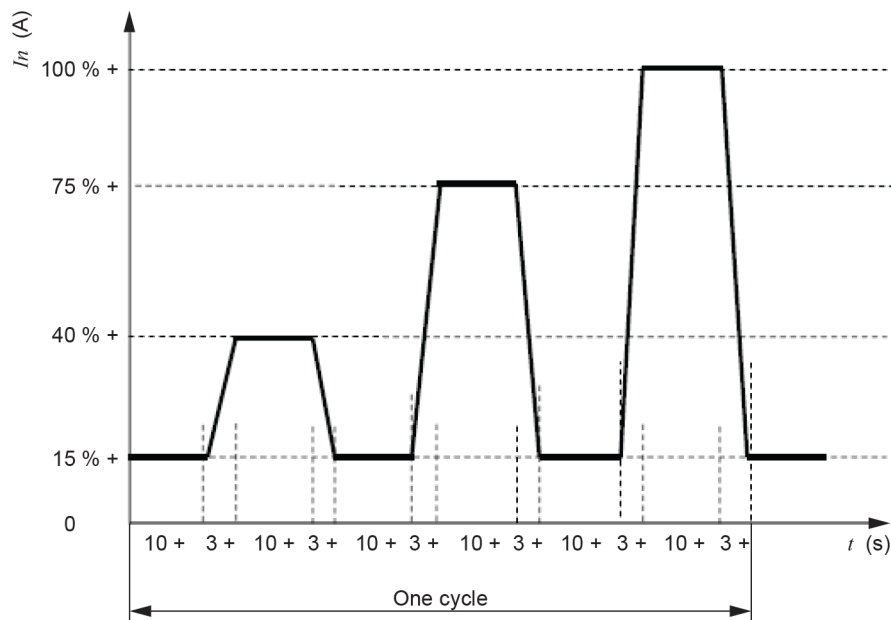
Table 104 – Values for breaking capacity tests on “gPV” fuse-links

Replace the existing text of the cell concerning time constant for test No.5 with the following new text:

≤ 1 ms

Figure 101 – Current of test cycling

Replace existing Figure 101 with the following new Figure 101:



+ Current: 100 % = $(100 \begin{smallmatrix} 0 \\ -5 \end{smallmatrix})$	Time: 10 s = $(10 \begin{smallmatrix} +2 \\ 0 \end{smallmatrix})$ s
% 75 % = $(75 \begin{smallmatrix} 0 \\ -5 \end{smallmatrix})$ %	3 s = $(3 \begin{smallmatrix} 0 \\ -3 \end{smallmatrix})$ s
40 % = $(40 \begin{smallmatrix} 0 \\ -5 \end{smallmatrix})$ %	
15 % = $(15 \begin{smallmatrix} 0 \\ -5 \end{smallmatrix})$ %	

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

AA.1 General

Delete the words “French”, “North American” and “DIN” after the bullet points for systems type A, type B and type C.

Replace the existing fourth bullet point with the following new text:

- system of long fuse-links with blade contacts, type D (Figure AA.5)

Add, after the fourth bullet point, the following new text:

- 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

Replace the last two paragraphs of Clause AA.1 with the following new text:

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

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

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

Replace the existing table in the key to Figure AA.1 with the following new table:

Size	<i>a</i>	<i>b</i> _{max}	<i>c</i>	<i>d</i> _{min}	<i>r</i>
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

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

Replace the existing title of Clause AA.3 with the following new title:

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

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

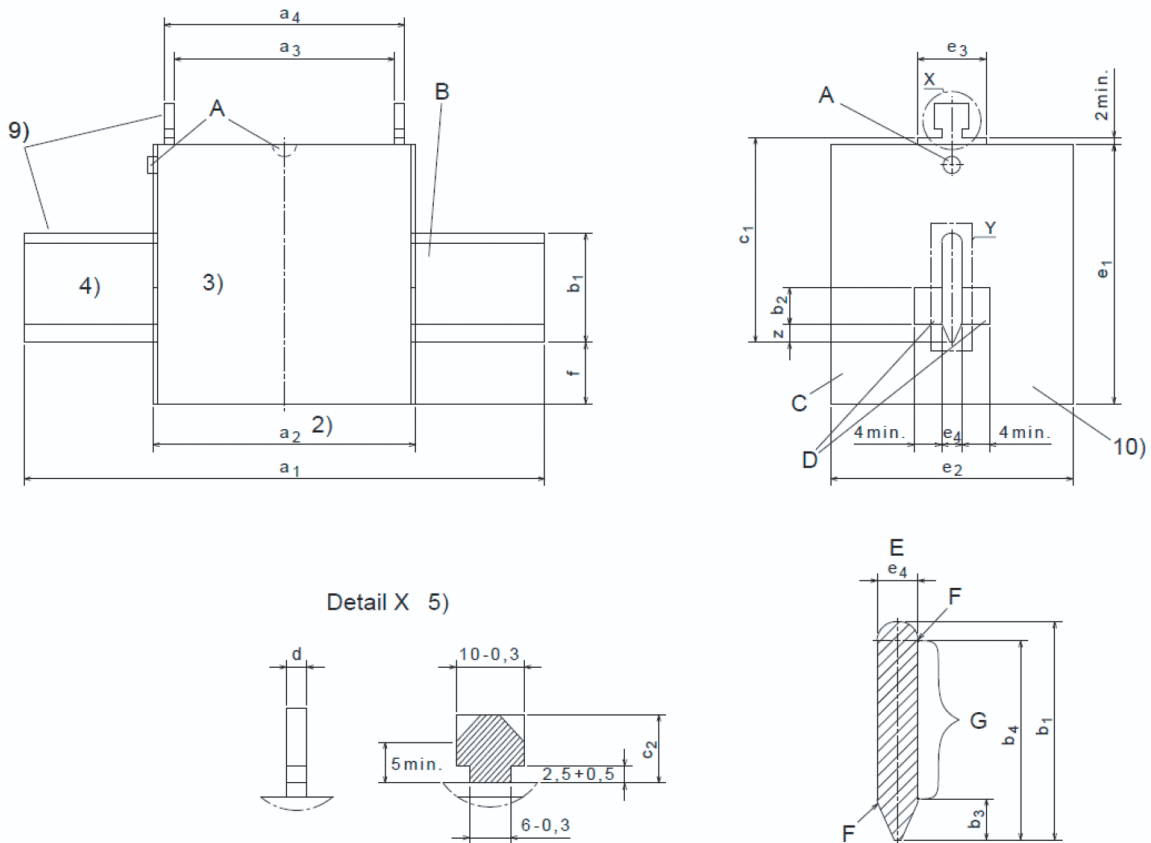
Replace the existing title of Figure AA.3 with the following new title:

Figure AA.3 – 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)"

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

Replace existing Figure AA.4 with the following new Figure AA.4:



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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	a_2	a_3	a_4	b_1 min.	b_2 min.	b_3 max.	b_4 min.	c_1 $\pm 0,8$	c_2	d	e_1 max.	e_2 max.	e_3	e_4 $\pm 0,2$	f max.	z max.
	1)	2)	1)	1)	11)	11)	11)	11)			5)	6)	6)				
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	76	75	20	6	18	5

												+1,5							
												-0,5							

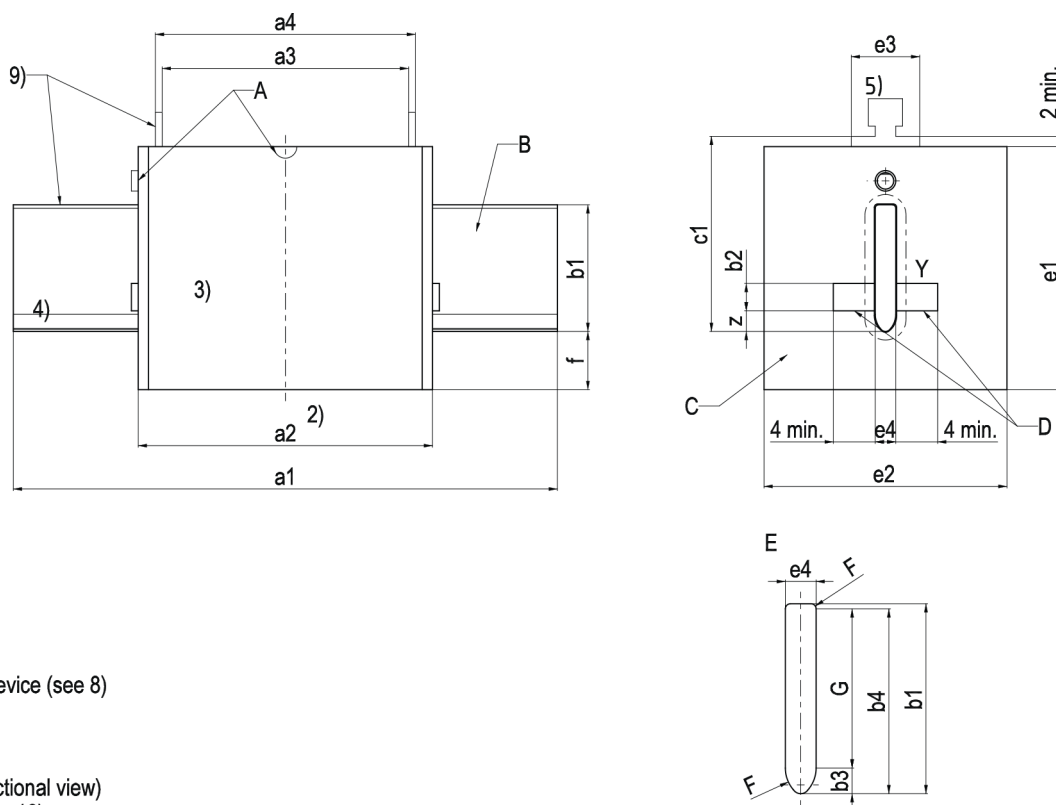
Dimensions in millimeters

- 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.

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

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

Replace existing Figure AA.5 and its title with the following new Figure AA.5 and title:



- 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 ±0,8	c 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

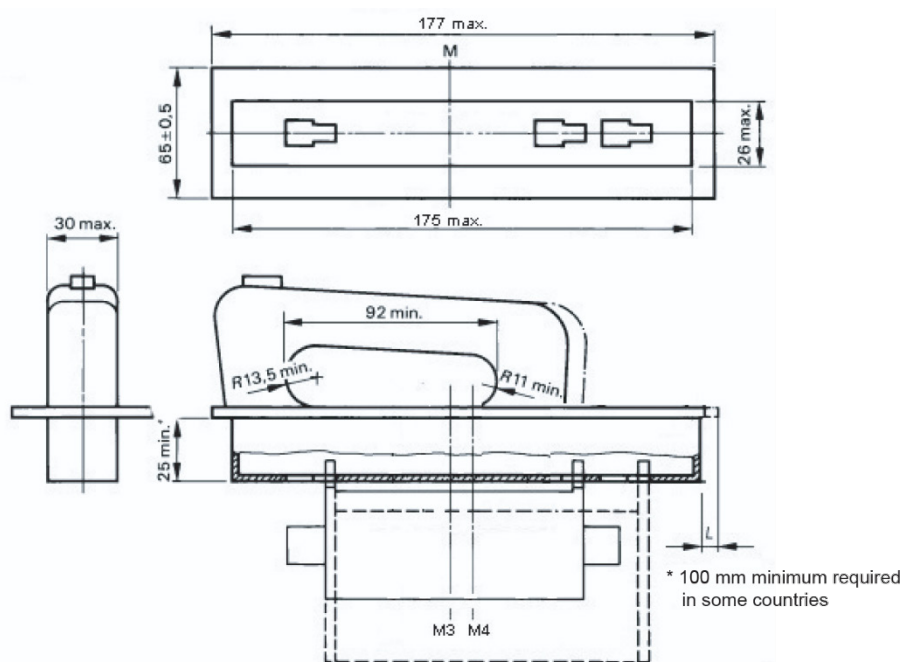
3L	205 ±3	130 -10	117 ±3	123 ±3	32	11	6	29	60	11 -2	2,5 +1,5 -0,5	76	75	20 +5 -2	6	18	5
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- 1) The centres of the dimensions a_1 , a_3 and a_4 shall not deviate from the centre of a_2 by more than 1,5 mm.
- 2) The dimension a_2 shall be observed within 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 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)**

Add, at the end of Clause AA.5, the following new figure:

Dimensions in millimetres



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Size	L	Distance	
		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

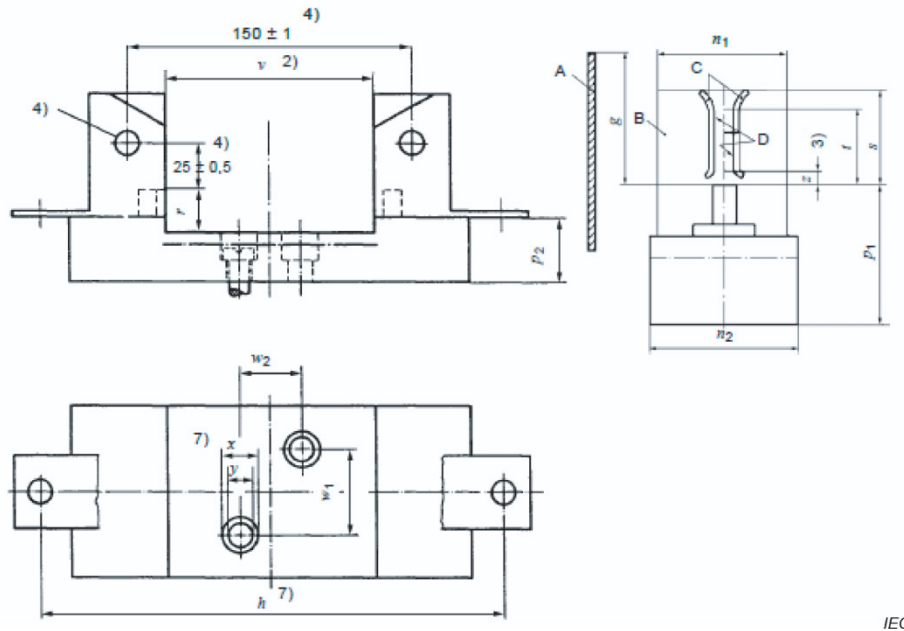
L Permitted lift for setting in and taking out the fuse-link

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

Add the following new subclauses at the end of Annex AA:

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



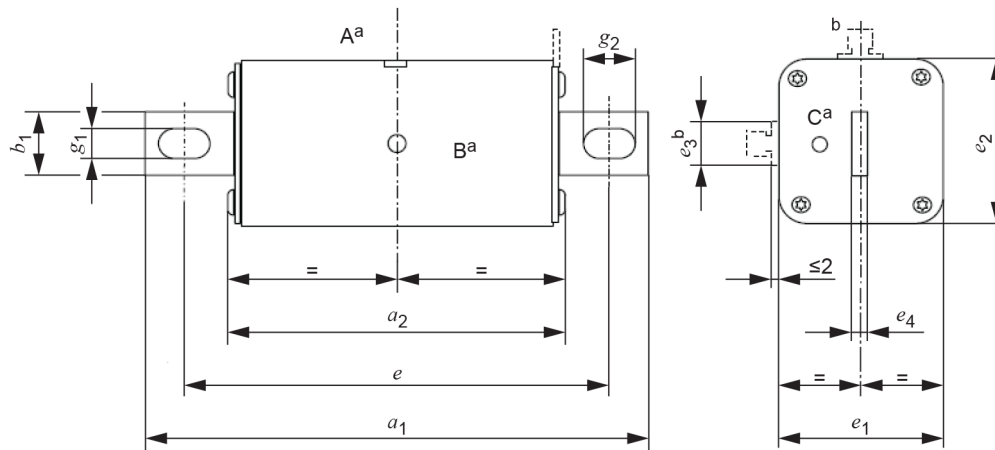
Key

- 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 b₂ × 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 n₁.

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



^a Indicator position at A, B, C if required

^b Lifting lug, optional, with or without indication option C, See Detail X in AA.5

Note 1) it is possible that the centre line of the two slots may be offset from "e" when g_2 exceeds the minimum value

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

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

BB.3.1 Rated current

Replace the existing text of BB.3.1 with the following new text:

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 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.

Bibliography

Add the following new references to the Bibliography:

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 62548:2016, *Photovoltaic (PV) arrays – Design requirements*

IEC TS 62738:2018, *Ground-mounted photovoltaic power plants – Design guidelines and recommendations*
