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Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



32B/710/CD

COMMITTEE DRAFT (CD)

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32B/691/RR

IEC SC 32B : LOW-VOLTAGE FUSES

SECRETARIAT:

Germany

SECRETARY:

Mr Michael Altenhuber

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 22

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

Amendment 3 - Low-voltage fuses - Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices

NOTE FROM TC/SC OFFICERS:

All requested changes to the present Ed 4.2. are marked in **red** (like in RLV).

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE FUSES –

**Part 4: Supplementary requirements for fuse-links
for the protection of semiconductor devices**

FOREWORD

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This Consolidated version of IEC 60269-4 bears the edition number 5.2. It consists of the fifth edition (2009-05) [documents 32B/535/FDIS and 32B/541/RVD], its amendment 1 (2012-05) [documents 32B/579/CDV and 32B/586A/RVC] and its amendment 2 (2016-08) [documents 32B/651/FDIS and 32B/663/RVD]. The technical content is identical to the base edition and its amendments.

This Final version does not show where the technical content is modified by amendments 1 and 2. A separate Redline version with all changes highlighted is available in this publication.

109 International Standard IEC 60269-4 has been prepared by subcommittee 32B: Low-voltage
110 fuses, of IEC technical committee 32: Fuses.

111 This fifth edition constitutes a technical revision. The significant technical changes to the
112 fourth edition are:

- 113 • the introduction of voltage source inverter fuse-links, including test requirements;
- 114 • coverage of the tests on operating characteristics for a.c. by the breaking capacity tests;
- 115 • the updating of examples of standardised fuse-links for the protection of semiconductor
116 devices.

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

119 This Part 4 supplements or modifies the corresponding clauses or subclauses of Part 1.

120 Where no change is necessary, this Part 4 indicates that the relevant clause or subclause
121 applies.

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

123 Additional annexes are lettered AA, BB, etc.

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

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

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

- 131 • reconfirmed,
- 132 • withdrawn,
- 133 • replaced by a revised edition, or
- 134 • amended.

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LOW-VOLTAGE FUSES –

Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices

1 General

IEC 60269-1 applies with the following supplementary requirements.

Fuse-links for the protection of semiconductor devices 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.

1.1 Scope and object

These supplementary requirements apply to fuse-links for application in equipment containing semiconductor devices for circuits of nominal voltages up to 1 000 V a.c. or 1 500 V d.c. and also, in so far as they are applicable, for circuits of higher nominal voltages.

NOTE 1 Such fuse-links are commonly referred to as “semiconductor 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 60269-1.

NOTE 3 IEC 60269-6 (Low-voltage fuses – Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems) is dedicated to the protection of solar photovoltaic energy systems.

NOTE 4 These fuse-links are intended for use on systems employing the standardized voltages and tolerances of IEC 60038. Tests carried out on fuse-links in accordance with previous editions of this standard shall remain valid until such time as complimentary equipment has evolved to the standardized voltages and tolerances of IEC 60038.

The object of these supplementary requirements is to establish the characteristics of semiconductor 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 temperature rises in normal service;
- 3) their power dissipation;
- 4) their time-current characteristics;
- 5) their breaking capacity;
- 6) their cut-off current characteristics and their I^2t characteristics;
- 7) their arc voltage characteristics;

b) type tests for verification of the characteristics of fuses;

c) the markings on fuses;

d) availability and presentation of technical data (see Annex BB).

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, *Low-voltage fuses – Part 1: General requirements*

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 K*

IEC 60269-3, *Low-voltage fuses – Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) – Examples of standardized systems of fuses A to F*

IEC TR 60269-5, *Low-voltage fuses – Part 5: Guidance for the application of low-voltage fuses*

IEC 60269-6, *Low-voltage fuses – Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems*

IEC 60269-7, *Low-voltage fuses – Part 7: Supplementary requirements for fuse-links for the protection of battery systems*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60664-1:2000, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

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

2 Terms and definitions

IEC 60269-1 applies with the following supplementary definitions.

2.2 General terms

2.2.101

semiconductor device

device whose essential characteristics are due to the flow of charge carriers within a semiconductor

[IEV 521-04-01]

2.2.102

semiconductor fuse-link

current-limiting fuse-link capable of breaking, under specific conditions, any current value within the breaking range (see 7.4)

2.2.103

signalling device

device forming part of the fuse and signalling the fuse operation to a remote place

NOTE A signalling device consists of a striker and an auxiliary switch. Electronic devices may also be used.

219 **2.2.104**
220 **voltage source inverter**
221 **VSI**
222 a voltage stiff inverter

223 [IEV 551-12-11]

224 NOTE Also referred to as a voltage stiff inverter i.e. an inverter that supplies current without any practical change
225 in its output voltage.

226 **2.2.105**
227 **voltage source inverter fuse-link**
228 **VSI fuse-link**
229 current-limiting fuse-link capable of breaking, under specified conditions, the short circuit
230 current supplied by the discharge of a d.c.-link capacitor in a voltage source inverter

231 NOTE 1 The abbreviation "VSI fuse-link" is used in this document.

232 NOTE 2 A VSI fuse-link usually operates under a short circuit current supplied by the discharge of a d.c.-link
233 capacitor through a very low inductance, in order to allow high frequency in normal operation. This short circuit
234 condition leads to a very high rate of rise of current equivalent to a very low value of time constant, typically 3 ms
235 or less. The supply voltage is d.c., even though the applied voltage decreases as the current increases during the
236 short circuit.

237 NOTE 3 In some multiple a.c. drive applications, individual output inverters may be remote from the main input
238 rectifier. In these cases, the associated fault circuit impedances may influence the operation of the fuse-links - the
239 associated time constant and the size of the capacitors need to be considered when choosing the appropriate short
240 circuit protection.

241 **3 Conditions for operation in service**

242 IEC 60269-1 applies with the following supplementary requirements.

243 **3.4 Voltage**

244 **3.4.1 Rated voltage**

245 For a.c., the rated voltage of a fuse-link is related to the applied voltage; it is based on the
246 r.m.s. value of a sinusoidal a.c. voltage. It is further assumed that the applied voltage retains
247 the same value throughout the operation of the fuse-link. All tests to verify the ratings are
248 based on this assumption.

249 NOTE In many applications, the applied voltage will be sufficiently close to the sinusoidal form for the significant
250 part of the operating time, but there are many cases where this condition is not satisfied.

251 The performance of a fuse-link subjected to a non-sinusoidal applied voltage can be
252 evaluated by comparing, for the first approximation, the arithmetic mean values of the non-
253 sinusoidal and sinusoidal applied voltages.

254 For d.c. and VSI fuse-links, the rated voltage of a fuse-link is related to the applied voltage. It
255 is based on the mean value. When d.c. is obtained by rectifying a.c., the ripple is assumed
256 not to cause a variation of more than 5 % above or 9 % below the mean value.

257 **3.4.2 Applied voltage in service**

258 Under service conditions, the applied voltage is that voltage which, in the fault circuit, causes
259 the current to increase to such proportions that the fuse-link will operate.

260 For a.c., consequently, the value of the applied voltage in a single-phase a.c. circuit is usually
261 identical to the power-frequency recovery voltage. For all cases other than the sinusoidal a.c.
262 voltage, it is necessary to know the applied voltage as a function of time.

For a unidirectional voltage and for VSI fuse-links, the important values are:

- the average value over the entire period of the operation of the fuse-link;
- the instantaneous value near the end of the arcing period.

3.5 Current

The rated current of a semiconductor fuse-link is based on the r.m.s. value of a sinusoidal a.c. current at rated frequency.

For d.c., the r.m.s. value of current is assumed not to exceed the r.m.s. value based on a sinusoidal a.c. current at rated frequency.

NOTE The thermal response time of the fuse-element may be so short that it cannot be assumed that operation under conditions which deviate much from sinusoidal current can be estimated on the basis of the r.m.s. current alone. This is so, in particular at lower frequency values and when the current presents salient peaks separated by appreciable intervals of insignificant current; for example, in the case of frequency converters and traction applications.

3.6 Frequency, power factor and time constant

3.6.1 Frequency

The rated frequency refers to the frequency of the sinusoidal current and voltage that form the basis of the type tests.

NOTE In particular, where service frequency deviates significantly from rated frequency the manufacturer should be consulted.

3.6.3 Time constant (τ)

For d.c., the time constants expected in practice are considered to correspond to those in Table 105.

NOTE 1 Some service conditions may be found which exceed the specified performance shown in the table as regards time constant. In such a case, a design of fuse-link which has been tested and marked accordingly should be used or the suitability of such a fuse-link be subject to agreement between manufacturer and user. In some service conditions, the time constant is significantly lower than the values stated in the table. In such a case, the applied voltage can be higher than the rated voltage defined according to Table 105.

For VSI fuse-links, equivalent time constants expected in practice are considered to correspond to those in Table 106.

NOTE 2 The high rate of rise of short circuit current is due to the low inductance, which is considered to be equivalent to a low time constant.

NOTE 3 Instead of time constant di/dt can be used in case of short circuit condition

$di/dt = E/L$.

E = voltage value of the DC power source,

L = total inductance of the capacitor discharge circuit.

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) Kind of current and frequency (see 5.4 of IEC 60269-1)
- d) Rated power dissipation (see 5.5 of IEC 60269-1)
- e) Time-current characteristics (see 5.6)
- f) Breaking range (see 5.7.1 of IEC 60269-1)
- g) Rated breaking capacity (see 5.7.2 of IEC 60269-1)
- h) Cut-off current characteristics (see 5.8.1)
- i) I^2t characteristics (see 5.8.2)
- j) Dimensions or size (if applicable)
- k) Arc voltage characteristics (see 5.9)

5.2 Rated voltage

For rated a.c. voltages up to 690 V and d.c. voltages up to 750 V, IEC 60269-1 applies; for higher voltages, the values shall be selected from the R 5 series or, where not possible, from the R 10 series of ISO 3.

A fuse-link shall have an a.c. voltage rating or a d.c. voltage rating or a VSI voltage rating. It may have one or more of these voltage ratings.

5.4 Rated frequency

The rated frequency is that frequency to which the performance data are related.

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 50 % to 100 % of the rated current or for 50 %, 63 %, 80 % and 100 % of the rated current.

NOTE In cases where the resistance of the fuse-link is of interest, this resistance should be determined from the functional relation between the power dissipation and the associated value of 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 time-current characteristics based on an ambient temperature of 20 °C to 25 °C in accordance with the conditions specified in 8.3. The time-current characteristics of interest are the pre-arcing characteristic and operating characteristics.

For a.c., the time-current characteristics are stated at rated frequency and for pre-arcing or operating times longer than 0,1 s.

For d.c., they are stated for time constants according to Table 105 and for pre-arcing or operating times longer than 15τ .

For the higher values of prospective current (shorter times), the same information shall be presented in the form of I^2t characteristics (see 5.8.2).

5.6.1.2 Pre-arcing time-current characteristics

For a.c., the pre-arcing time-current characteristic shall be based on a symmetrical a.c. current of a stated value of frequency (rated frequency).

For d.c., the pre-arcing time-current characteristic is of particular significance for times exceeding 15τ for the relevant circuit, and is identical to the a.c. pre-arcing time-current characteristic in this zone.

NOTE 1 Because of the wide range of circuit time constants likely to be experienced in service, the information for times shorter than 15τ is conveniently expressed as a pre-arcing I^2t characteristic.

NOTE 2 The value of 15τ has been chosen to avoid the effects which different rates of rise of current have on the pre-arcing time-current characteristic at shorter times.

5.6.1.3 Operating time-current characteristics

For a.c. with times longer than 0,1 s and for d.c. with times longer than 15τ , the arcing period is negligible compared to the pre-arcing time. The operating time is then equivalent to the pre-arcing time.

5.6.2 Conventional times and currents

5.6.2.1 Conventional times and currents for “aR” fuse-links

See 7.4.

5.6.2.2 Conventional times and currents for “gR” and “gS” fuse-links

The conventional times and currents are given in Table 101.

Table 101 — Conventional times and currents for “gR” and “gS” fuse-links

Rated current A	Conventional time h	Conventional current			
		Type “gR”		Type “gS”	
		I_{nf}	I_f	I_{nf}	I_f
$I_n \leq 63^a$	1				
$63 < I_n \leq 160$	2				
$160 < I_n \leq 400$	3	$1,1 I_n$	$1,6 I_n$	$1,25 I_n$	$1,6 I_n$
$400 < I_n$	4				
^a In Annex CC, some examples specify the requirements for $I_n \leq 16$.					
NOTE For explanation of gR and gS see 5.7.1.					

Table 101 – Conventional time and current for "gR" and "gS" fuse-links

Rated current A	Conventional time h	Conventional current			
		Type “gR”		Type “gS”	
		I_{nf}	I_t	I_{nf}	I_t
$I_n \leq 4$	1	1,1 I_n	2,1 I_n	1,5 I_n	2,1 I_n
$4 < I_n < 16$	1	1,1 I_n	1,9 I_n	1,5 I_n	1,9 I_n
$16 \leq I_n \leq 63$	1	1,1 I_n	1,6 I_n	1,25 I_n	1,6 I_n
$63 < I_n \leq 160$	2				
$160 < I_n \leq 400$	3				
$400 < I_n$	4				

Note: The conventional times also apply for “aR” - fuses

5.6.3 Gates

Not applicable.

5.6.4 Overload curves**5.6.4.1 Verified overload capability**

The manufacturer shall indicate sets of coordinate points along the time-current characteristics (see 5.6.1) for which the overload capability has been verified in accordance with the procedure indicated in 8.4.3.4.

The number and the location of the sets of coordinate points for which the overload capability shall be verified shall be selected at the discretion of the manufacturer. The time coordinates for the verification of the overload capability shall be selected within the range of 0,01 s to 60 s. Further sets of the coordinate points may be added according to agreement between manufacturer and user.

5.6.4.2 Conventional overload curve

The conventional overload curve is formed of straight-line sections emanating from the coordinate points of verified overload capability. From each set of coordinate points, two lines are drawn:

- one from the verified point and following points of constant values of current towards shorter times;
- the other from the verified point and following points of constant values of I^2t towards longer times.

These line sections, ending at the line representing rated current, form the conventional overload curve (see Figure 101).

NOTE For practical applications, a few points of verified overload capability are sufficient. As the number of points of verified overload capability increases, the conventional overload curve becomes more precise.

5.7 Breaking range and breaking capacity

5.7.1 Breaking range and utilization category

The first letter shall indicate the breaking range:

- “a” fuse-links (partial-range breaking capacity, see 7.4);
- “g” fuse-links (full-range breaking capacity).

The second letter “R” and “S” shall indicate the utilization category for fuse-links complying with this standard for the protection of semiconductor devices.

The type “R” is typically faster acting than type “S” and gives lower I^2t values.

The type “S” generally has lower power dissipation and gives enhanced utilization of cables compared to type “R”.

For example:

- aR indicates fuse-links with partial range breaking capacity for the protection of semiconductor devices;
- gR indicates fuse-links with full-range breaking capacity for general application and semiconductor protection, optimised to low I^2t values;
- gS indicates fuse-links with full range breaking capacity for general application and semiconductor protection, optimised to low power dissipation.

Some aR fuse-links are used to protect voltage source inverters. Even though they are common aR fuses on a.c., they must be tested differently under VSI d.c. short-circuit conditions. For these reasons, their designation is still “aR” but their d.c. characteristics must be clearly stated “for VSI protection” in the manufacturer’s data sheets.

5.7.2 Rated breaking capacity

A breaking capacity of at least 50 kA for a.c. and 8 30 kA for d.c. is recommended.

For a.c., the rated breaking capacity is based on type tests performed in a circuit containing only linear impedance and with a constant sinusoidal applied voltage of rated frequency.

For d.c., the rated breaking capacity is based on type tests performed in a circuit containing only linear inductance and resistance with mean applied voltage.

For VSI the rated breaking capacity is based on type tests performed in a circuit containing very low inductance and resistance with d.c. or capacitor discharged applied voltage.

NOTE The addition in practical applications of non-linear impedances and unidirectional voltage components may significantly influence the breaking severity either in a favourable or unfavourable direction.

5.8 Cut-off current and I^2t characteristics

5.8.1 Cut-off current characteristics

~~The manufacturer shall provide~~ Consult the manufacturer for the cut-off current characteristics which shall be given, according to the example shown in Figure 4 of IEC 60269-1, in a double logarithmic presentation with the prospective current as abscissa and, if necessary, with applied voltage and/or frequency as a parameter.

For a.c., the cut-off current characteristics shall represent the highest values of current likely to be experienced in service. They shall refer to the conditions corresponding to the test conditions of this standard, for example, given voltage, frequency and power-factor values. The cut-off current characteristics may be defined by the tests specified in 8.6.

For d.c., the cut-off current characteristics shall represent the highest values of current likely to be experienced in service in circuits having a time constant specified in Table 105 for aR, gS and gR fuse-links, or in Table 106 for aR fuse-links in VSI applications. For aR, gS and gR fuse-links, these values will be exceeded in circuits of smaller time constants than those of Table 105. The manufacturer shall provide the relevant information to enable the determination of these higher cut-off current characteristics.

NOTE The cut-off current characteristic varies with the circuit time constant. The manufacturer should provide the relevant information to enable these variations to be determined at least for time constants of 5 ms and 10 ms.

5.8.2 I^2t characteristics

5.8.2.1 Pre-arcing I^2t characteristic

For ~~a.c.~~ AC, the pre-arcing I^2t characteristic shall be based on a symmetrical a.c. current at a stated frequency value (rated frequency).

For ~~d.c.~~ DC, the pre-arcing I^2t characteristic shall be based on r.m.s. d.c. current at a time constant specified in the Table 105 for aR, gS and gR fuse-links or in Table 106 for aR fuse-links in VSI applications.

NOTE ~~For aR and gR and gS fuse-links, the pre-arcing I^2t characteristic varies with the circuit time constant. The manufacturer should provide the relevant information to enable these variations to be determined at least for time constants of 5 ms and 10 ms.~~ For DC the pre-arcing I^2t value represents the lowest value likely to be experienced in service. It shall be based on r.m.s DC current as defined in the test requirements of test No.1 of the breaking capacity.

5.8.2.2 Operating I^2t characteristics

For ~~a.c.,~~ AC, the operating I^2t characteristics shall be given with applied voltage as a parameter and for a stated power-factor value. In principle, they shall be based on the moment of current initiation that leads to the highest operating I^2t value (see 8.7). The voltage parameters shall include at least 100 %, ~~and~~ 50 % ~~and 25 %~~ of rated voltage.

For ~~d.c.~~ DC, the operating I^2t characteristics shall be given with the applied voltage as a parameter and for a time constant specified in the Table 105 for aR, gS and gR fuse-links, or Table 106 for aR fuse-links in VSI applications. The voltage parameters shall include at least 100 % and 50 % of rated voltage. It is permitted to determine the operating I^2t characteristics at lower voltages from tests in accordance with Table 105 or Table 106 according to their d.c. application or VSI application.

The I^2t at reduced voltages may be calculated using the method described in Part 1, Annex B3.

5.9 Arc voltage characteristics

Arc voltage characteristics provided by the manufacturer shall give the highest (peak) value of arc voltage as a function of the applied voltage of the circuit in which the fuse-link is inserted and, in the case of a.c., for power factors as stated in Table 104 and, in the case of d.c. at time constants specified in Table 105 or in Table 106 according to their d.c. application or VSI application.

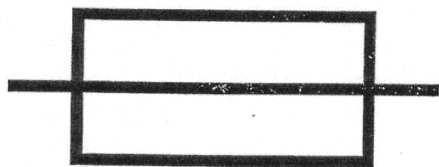
6 Markings

IEC 60269-1 applies with the following supplementary requirements.

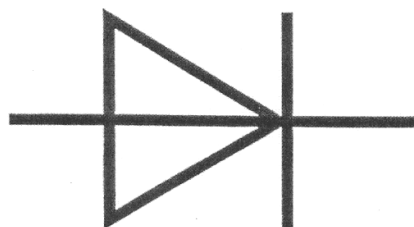
6.2 Markings on fuse-links

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

- 477 – manufacturer's identification reference and/or symbols enabling all the characteristics
- 478 listed in 5.1.2 of IEC 60269-1 to be found;
- 479 – utilization category, “aR” or “gR” or “gS”;
- 480 – a combination of symbols of IEC 60417 of a fuse (5016) and a rectifier (5186) as shown
- 481 below:



Symbol IEC 60417-5016 (2002-10)



Symbol IEC 60417-5186 (2002-10)

482

483 For VSI rated fuse-links an additional mark e.g. “1200V d.c. VSI” with the voltage rating value
484 must be stated on the product.

485 7 Standard conditions for construction

486 IEC 60269-1 applies with the following supplementary requirements.

487 7.3 Temperature rise and power dissipation of the fuse-link

488 Fuse-links shall be so designed and proportioned as to carry, when tested in accordance with
489 8.3, the rated current without exceeding

- 490 – the temperature rise limit of the hottest upper metal part of the fuse-link indicated by the
- 491 manufacturer (see Figures 102 and 103);
- 492 – the power dissipation at the rated current indicated by the manufacturer.

493 7.4 Operation

494 The fuse-link shall be so designed and proportioned as to carry continuously any value of
495 current up to its rated current.

496 “aR” fuse-links shall operate and break the circuit for any current value not exceeding the
497 rated breaking capacity and not less than a current sufficient to interrupt the fuse-link
498 specified by the manufacturer.

499 For “gR” and “gS” fuse-links within the conventional time:

- 500 – it ~~does~~ shall not operate, when it carries any current not exceeding the conventional non-
- 501 fusing current (I_{nf});
- 502 – it shall operate when it carries any current equal to, or exceeding, the conventional
- 503 fusing current (I_f) and equal to or lower than the rated breaking capacity.

7.5 Breaking capacity

A fuse-link shall be capable of breaking, at a voltage not exceeding the voltage specified in 8.5, any circuit having a prospective current between a current according to 7.4 and the rated breaking capacity:

- for a.c. at power factors not lower than those in Table 104 appropriate to the value of the prospective current;
- for d.c., at time constants not greater than the values specified in Table 105;
- for VSI applications, the fuse-link shall be capable of breaking a current specified in 8.5 at time constants not greater than the value specified in Table 106.

7.7 I^2t characteristics

The values of operating I^2t determined as described in 8.7 shall not exceed those stated by the manufacturer. The values of pre-arcing I^2t determined as described in 8.7 shall be not less than the values stated (see 5.8.2.1 and 5.8.2.2).

7.15 Arc voltage characteristics

The arc voltage values measured as described in 8.7.5 shall not exceed those stated by the manufacturer (see 5.9).

7.16 Special operating conditions

Special operating conditions, such as high value of acceleration, shall be subject to agreement between manufacturer and user.

8 Tests

IEC 60269-1 applies with the following supplementary requirements.

8.1 General

8.1.4 Arrangement of the fuse-link

The fuse-link shall be mounted open in surroundings free from draughts and, unless otherwise specified, in a vertical position (see 8.3.1). Examples of test arrangements are given in Figures 102 and 103. Test arrangements for other kinds of fuse-links are given in IEC 60269-2 and IEC 60269-3.

8.1.5 Testing of fuse-links

8.1.5.1 Complete tests

The complete tests on fuse-links are listed in Table 102. The internal resistance of all fuse-links shall be determined and recorded in the test report(s).

A fuse-link shall have an a.c. breaking capacity or a d.c. breaking capacity or a VSI breaking capacity. It may have one or more of these breaking capacities.