

Low-voltage fuses —

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

The European Standard EN 60269-4:2007 has the status of a
British Standard

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National foreword

This British Standard was published by BSI. It is the UK implementation of EN 60269-4:2007. It is identical with IEC 60269-4:2006. It supersedes BS EN 60269-4:1996 and BS EN 60269-4-1:2002, which will be withdrawn on 1 March 2010.

The UK participation in its preparation was entrusted to Technical Committee PEL/32, Fuses.

A list of organizations represented on this committee can be obtained on request to its secretary.

This standard is part of a restructured series of British Standards for Low Voltage Fuses. These cover the related parts and examples of systems of fuses given in the associated IEC 60269:2006 series of standards.

These British Standards together with their IEC counterparts are:

- BS 88-1:2007 — General requirements (IEC 60269-1)
- BS 88-2:2007 — Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) (IEC 60269-2, Fuse systems E, G and I)
- BS 88-3:2007 — Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) (IEC 60269-3, Fuse system C)
- BS 88-4:2007 — Supplementary requirements for fuse-links for the protection of semiconductor devices (IEC 60269-4)

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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**Low-voltage fuses -
Part 4: Supplementary requirements for fuse-links
for the protection of semiconductor devices
(IEC 60269-4:2006)**

Fusibles basse tension -
Partie 4: Exigences supplémentaires
concernant les éléments
de remplacement utilisés
pour la protection des dispositifs
à semiconducteurs
(CEI 60269-4:2006)

Niederspannungssicherungen -
Teil 4: Zusätzliche Anforderungen
an Sicherungseinsätze zum Schutz
von Halbleiter-Bauelementen
(IEC 60269-4:2006)

This European Standard was approved by CENELEC on 2007-03-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The text of document 32B/485/FDIS, future edition 4 of IEC 60269-4, prepared by SC 32B, Low-voltage fuses, of IEC TC 32, Fuses, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60269-4 on 2007-03-01.

This European Standard supersedes EN 60269-4:1996 + A1:1997 + A2:2003 and EN 60269-4-1:2002.

This part is to be used in conjunction with EN 60269-1:2007, Part 1:General requirements.

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

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

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented
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Tables and figures which are additional to those in Part 1 are numbered starting from 101.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60269-4:2006 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

A reorganization of the different parts of the IEC 60269 series has been carried out, in order to simplify its use, especially by the laboratories which test the fuses.

IEC 60269-1, IEC 60269-2, IEC 60269-3 and IEC 60269-3-1 have been integrated into either the new part 1 or the new parts 2 or 3, according to the subjects considered, so that the clauses which deal exclusively with “fuses for authorized persons” are separated from the clauses dealing with “fuses for unauthorized persons”.

As far as IEC 60269-4 and IEC 60269-4-1 are concerned, they have been integrated into the new part 4 which deals with the fuse-links used for semiconductor protection.

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.

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 limits.

b) Type tests for verification of the characteristics of fuses.

c) The markings on fuses.

d) Availability and presentation of technical data (see Annex B).

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 – General requirements*

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

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

IEC 60417, *Graphical symbols for use on equipment*

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

2 Terms and definitions

IEC 60269-1 applies with the following supplementary requirements.

2.2 General terms

2.2.101

semiconductor device

Remark: previously 2.1.14 in IEC 60269-4, Amendment 2

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

Remark: previously 2.1.15 in IEC 60269-4, Edition 3

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

Remark: previously 2.1.16 in IEC 60269-4, Amendment 2

device forming part of the fuse and signalling the fuse operation to a remote place. A signalling device consists of a striker and an auxiliary switch. Electronic devices may also be used

3 Conditions for operation in service

IEC 60269-1 applies with the following supplementary requirements.

3.4 Voltage

3.4.1 Rated voltage

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

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

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

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

3.4.2 Applied voltage in service

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

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

For d.c., the value of the applied voltage is usually approximately the same as the mean recovery voltage.

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 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.

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).
- k) Dimensions or size (if applicable).
- l) Arc voltage limits (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 R5 series or, where not possible, from the R10 series of ISO 3.

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

The time-current characteristics of a fuse-link vary according to its design and also, for a given fuse-link, depend on the ambient 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 having voltage as a parameter. The time-current characteristics are stated for rated frequency.

For d.c. they are stated for time constants according to Table 105.

For some applications, and in particular for the higher values of prospective current (shorter times), the same information may be presented in the form of I^2t characteristics. It is recommended that in this region, I^2t characteristics shall be given as an alternative or in addition.

5.6.1.1 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).

NOTE This is of particular importance for the range of time between about ten cycles of rated frequency and a time so short that the heating is truly adiabatic.

For d.c., the pre-arcing time-current characteristic is of particular significance for times exceeding 15 τ 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 15 τ is conveniently expressed as a pre-arcing I^2t characteristic.

NOTE 2 The value of 15 τ 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.

5.6.1.2 Operating time-current characteristics

The operating time-current 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 %, 50 % and 25 % of the rated voltage.

For d.c., the operating time-current characteristics are not applicable because they are not significant for times in excess of 15 τ (see 5.6.1.1).

5.6.2 Conventional times and currents

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

Not applicable.

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

*Remark: this table refers to Table 2 in IEC 60269-1
and was previously Table II in IEC 60269-4, Amendment 2*

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

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 0,01s 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.

5.7.1 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 faster acting than type “S” and gives lower I^2t values.

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

5.7.2 Rated breaking capacity

A breaking capacity of at least 50 kA for a.c. and 8 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.

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 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 are verified 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 the Table 105. These values will be exceeded in circuits of smaller time constants. 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., 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., the pre-arcing I^2t characteristic shall be based on r.m.s. d.c. current at a time constant specified in Table 105.

NOTE For certain fuses, 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.

5.8.2.2 Operating I^2t characteristics

For a.c., 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 %, 50 % and 25 % of rated voltage.

For d.c., 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. 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.

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 106 and, in the case of d.c. at time constants specified in Table 105.

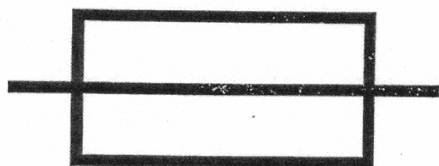
6 Markings

IEC 60269-1 applies with the following supplementary requirements.

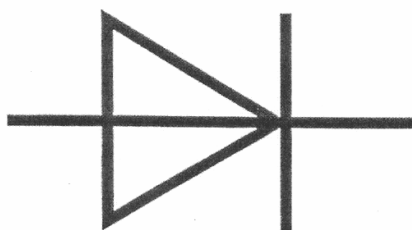
6.2 Markings on fuse-links

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

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



Symbol IEC 60417-5016



Symbol IEC 60417-5186

7 Standard conditions for construction

IEC 60269-1 applies with the following supplementary requirements.

7.3 Temperature rise and power dissipation of the fuse-link

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

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

7.4 Operation

The fuse-link shall be so designed and proportioned as to carry continuously any value of current up to its rated current (see 8.4.3.4).

“aR” fuse-links shall operate and break the circuit for any current value not exceeding the rated breaking capacity and not less than a current sufficient to melt the fuse element(s) in a time not exceeding 30 s.

NOTE By agreement between manufacturer and user, shorter times may be chosen for special applications.

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

- its fuse-element does not melt, when it carries any current not exceeding the conventional non-fusing current (I_{nf});
- it operates when it carries any current equal to, or exceeding, the conventional fusing current (I_f).

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 the current which causes melting of the fuse-element(s) in a time corresponding 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 appropriate to the value of the prospective current.

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).

7.14 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).

7.15 Special operating conditions

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