

Australian Standard™

Low-voltage fuses

Part 4.0: Supplementary requirements for fuse-links for the protection of semiconductor devices



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Part 4.0: Supplementary requirements for fuse-links for the protection of semiconductor devices

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PREFACE

This Standard was prepared by the Standards Australia Committee EL-007, Power Switchgear to supersede AS/NZS 60269.4.0:2000.

The objective of this Standard is to provide supplementary requirements for those stated in AS 60269.1 for fuse-links for application in equipment containing semi-conductor devices for circuits of rated voltages up to 1000 V a.c. or circuits of nominal voltages up to 1500 V d.c. and also, in so far as they are applicable, for circuits of higher voltages and so establish the characteristics of semi-conductor 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.

This Standard is Part 4.0 of a series which, when complete, will consist of the following:

AS

60269	Low-voltage fuses
60269.1	Part 1: General requirements
60269.2.0	Part 2.0: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)
60269.2.1	Part 2.1: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)—Sections I to VI: Examples of types of standardized fuses
60269.3.0	Part 3.0: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)
60269.3.1	Part 3.1: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)—Sections I to IV: Examples of types of standardized fuses
60269.4.0	Part 4.0: Supplementary requirements for fuse-links for the protection of semiconductor devices (this Standard)
60269.4.1	Part 4.1: Supplementary requirements for fuse-links for the protection of semiconductor devices—Sections I to III: Examples of types of standardized fuse-links

This Standard is identical with, and has been reproduced from, IEC 60269-4, Ed.3.0(1986), *Low-voltage fuses, Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices* incorporating its Amendment 1:1995, Amendment 2:2002 and Corrigendum 2003.

This Standard differs from the Standard it supersedes in the following major areas:

- Standard is now Australian only to reflect the withdrawal of New Zealand participation in Committee EL-007.
- Definition 'Semiconductor device' (Subclause 2.2.14) has been replaced.
- A new definition 'Signalling device' (Subclause 2.2.16) has been added.
- Characteristics of fuses 'Rated Voltage' (Clause 5.2) has been replaced.
- Characteristics of fuses 'Conventional times and currents' (Subclause 5.6.2) has been replaced.
- Table 2 – Conventional times and currents for 'gR' and 'gS' fuse-links has been added.
- Characteristics of fuses 'Breaking range and utilization category' (Subclause 5.7.1) has been replaced.
- Markings on fuse-links (Clause 6.2) has been replaced.
- The standard conditions for construction (Clause 7.4) 'Operation' has been replaced.

- (j) The test 'Arrangement of the fuse-links' (Subclause 8.1.4) has been replaced.
- (k) Table 7A 'List of complete tests' has been replaced.
- (l) The test 'Verification of conventional non-fusing and fusing current' (Subclause 8.4.3.1) has been added.
- (m) 'Test method' (Subclauses 8.5.5.1 and 8.5.5.2) have been replaced.
- (n) Table 12A 'Values for breaking-capacity tests on a.c fuses' has been replaced.
- (o) Table 12B 'Values for breaking-capacity tests on d.c fuses' has been replaced.
- (p) Appendix A and Appendix B have been renamed Annex A and Annex B respectively to reflect recent style changes.

In view of the fact that this Standard should be read together with AS 60269.1 the numbering of its clauses and sub-clauses is made to correspond to the latter. Regarding the tables, their numbering also corresponds to that of AS 60269.1, however, when additional tables appear, they are referred to by capital letters, for example, Table A, Table B, etc.

As this Standard is reproduced from an International Standard, the following applies:

- (i) Its number does not appear on each page of text and its identity is shown only on the cover and title page.
- (ii) In the source text 'this international standard' should read 'this Australian Standard'.
- (iii) A full point should be substituted for a comma when referring to a decimal marker.
- (iv) Any French text on figures should be ignored.

The terms 'normative' and 'informative' are used to define the application of the annex to which they apply. A normative annex is an integral part of a standard, whereas an informative annex is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard**Low-voltage fuses****Part 4.0: Supplementary requirements for fuse-links for the protection of semiconductor devices**

1 General

Fuse-links for the protection of semiconductor devices shall comply with all requirements of IEC Publication 60269-1, if not otherwise indicated hereinafter, and shall also comply with the supplementary requirements laid down below.

1.1 Scope

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

Notes

1. - Such fuse-links are commonly referred to as 'semiconductor fuse-links'.
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 Publication 60269-1.

1.2 Object

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:

1.2.1 The following characteristics of fuses:

- a) their rated values;
- c) their temperature rises in normal service;
- d) their power dissipation;
- e) their time-current characteristics;
- f) their breaking capacity;
- g) their cut-off current characteristics and their I^2t characteristics;
- h) their arc voltage limits.

1.2.2 Type tests for verification of the characteristics of fuses.**1.2.3 The markings on fuses.****1.2.4 Availability and presentation of technical data (see Annex B).**

1.3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60269. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60269 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below:

References to International Standards that are struck through in this Clause are replaced by references to equivalent Australian Standards that are listed immediately thereafter and identified by shading. Any Australian Standard that is identical to the International Standard it replaces is appropriately identified.

~~IEC 60050(521), International Electrotechnical Vocabulary. Chapter 521: Semi-conductor devices and integrated circuits~~

AS 1852.521—1988, *International Electrotechnical Vocabulary. Chapter 521: Semi-conductor devices and integrated circuits* (identical to IEC 60050(521):1984)

~~IEC 60269-1, Low-voltage fuses — Part 1: General requirements~~

AS 60269.1, *Low-voltage fuses, Part 1: General requirements* (identical to IEC 60269-1)

~~IEC 60269-2-1, Low-voltage fuses — Part 2-1: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) — Sections I to V: Examples of types of standardized fuses~~

AS 60269.2.1, *Low-voltage fuses, Part 2.1: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) — Sections I to VI: Examples of types of standardized fuses* (identical to IEC 60269-2-1)

~~IEC 60269-3-1, Low-voltage fuses — Part 3-1: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) — Sections I to IV~~

AS 60269.3.1, *Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications) — Sections I to IV: Examples of types of standardized fuses* (identical to IEC 60269-3-1)

IEC 60747, Semiconductor devices—Discrete devices

~~ISO 3, Preferred numbers—Series of preferred numbers~~

AS 2752, Preferred numbers and their use

2 Definitions

2.2 General terms

2.2.14 Semiconductor device (according to IEC 60050(521))

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

2.2.15 Semiconductor fuse-link

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

2.2.16 Signalling device

A 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

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 nonsinusoidal 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 12B.

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.

5 Characteristics of fuses

5.1 Summary of characteristics

5.1.2 Fuse-links

- a) Rated voltage (see Sub-clause 5.2).
- b) Rated current (see Sub-clause 5.3 of IEC Publication 60269-1).
- c) Kind of current and frequency (see Sub-clause 5.4 of IEC Publication 60269-1).
- d) Rated power dissipation (see Sub-clause 5.5 of IEC Publication 60269-1).
- e) Time-current characteristics (see Sub-clause 5.6).
- f) Breaking range (see Sub-clause 5.7.1 of IEC Publication 60269-1).
- g) Rated breaking capacity (see Sub-clause 5.7.2 of IEC Publication 60269-1).
- h) Cut-off current characteristics (see Sub-clause 5.8. 1).
- j) I^2t characteristics (see Sub-clause 5.8.2).
- k) Dimensions or size (if applicable).
- l) Arc voltage limits (see Sub-clause 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 Publication 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 Sub-clause 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 12 B.

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 15τ for the relevant circuit, and is identical to the a.c. pre-arcing time-current characteristic in this zone.

Notes

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.
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.

5.6.1.2 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 Sub-clause 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 15τ (see Sub-clause 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 2.

Table 2 – 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
$I_n \leq 63$	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				

5.6.3 Gates

Not applicable.

5.6.4 Overload curves

5.6.4.1 Verified overload capability

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

The number and the location of the sets of co-ordinate points for which the overload capability shall be verified are to 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 1).

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.