

Australian Standard™

Low-voltage fuses

Part 1: General requirements



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Australian Standard™

Low-voltage fuses

Part 1: General requirements

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PREFACE

This Standard was prepared by the Standards Australia Committee EL-007, Power Switchgear to supersede AS/NZS 60269.1:2000.

The objective of this Standard is to provide requirements to establish the characteristics of low-voltage fuses, or parts of low-voltage fuses, in such a way that they are interchangeable as far as their dimensions are concerned.

This Standard is Part 1 of a series which, when complete, will consist of the following:

AS

60269	Low-voltage fuses
60269.1	Part 1: General requirements (this Standard)
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
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 60269-1, Ed.3.0 (1998), *Low-voltage fuses*—Part 1: *General requirements* incorporating its Corrigendum 1:2000 and Amendment 1:2005. The amendment 1 is added in anticipation of its publication in 2005.

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

- (a) Standard is now Australian only to reflect the withdrawal of New Zealand participation in Committee EL-007.
- (b) Normative references IEC 60291 and IEC 60291A have been deleted and IEC 60664-1 has been added.
- (c) Definitions (Clause 2 and its subclauses) have been updated.
- (d) Discrimination of fuse-links (Subclause 3.9) the second paragraph of the subclause has been replaced.
- (e) The term ‘rated acceptance’ has been replaced by ‘rated acceptable power dissipation’ throughout the standard.
- (f) Markings (Clause 6) has been replaced.
- (g) The requirements for the suitability for isolation (Subclause 7.2) have been added.
- (h) Table 13 ‘Rated impulse withstand voltage’ has been added.
- (i) New subclauses ‘Clearances and creepage distances’ (Subclause 7.9.1), ‘Leakage currents of equipment for isolation’ (Subclause 7.9.2) and ‘Additional constructional requirements for fuses with non-separable fuse-carriers, suitable for isolation’ (Subclause 7.9.3) are added.

- (j) The requirements for the suitability for isolation (Subclause 8.2 and Subclause 8.2.1) have been added.
- (k) The Subclauses 8.2.2 to 8.2.5.2 have been replaced.
- (l) In Table 12A the first line 'power-frequency recovery voltage' has been replaced.
- (m) A new Clause B.3 'Calculation of operating I^2t at reduced voltage' has been added.

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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NOTES

STANDARDS AUSTRALIA

Australian Standard**Low-voltage fuses**
Part 1: General requirements

1 General**1.1 Scope and object**

This standard is applicable to fuses incorporating enclosed current-limiting fuse-links with rated breaking capacities of not less than 6 kA, intended for protecting power-frequency a.c. circuits of nominal voltages not exceeding 1 000 V or d.c. circuits of nominal voltages not exceeding 1 500 V.

Subsequent parts of this standard, referred to herein, cover supplementary requirements for such fuses intended for specific conditions of use or applications.

Fuse-links intended to be included in fuse-switch combinations according to IEC 60947-3 should also comply with the following requirements.

NOTE 1 – For "a" fuse-links, details of performance (see 2.2.4) on d.c. circuits should be subject to agreement between user and manufacturer.

NOTE 2 – Modifications of, and supplements to, this standard required for certain types of fuses for particular applications – for example certain fuses for rolling stock, or fuses for high-frequency circuits – will be covered, if necessary, by separate standards.

NOTE 3 – This standard does not apply to miniature fuses, these being covered by IEC 60127.

The object of this standard is to establish the characteristics of fuses or parts of fuses (fuse-base, fuse-carrier, fuse-link) in such a way that they can be replaced by other fuses or parts of fuses having the same characteristics provided that they are interchangeable as far as their dimensions are concerned. For this purpose, this standard refers in particular to:

- the following characteristics of fuses:
 - a) their rated values;
 - b) their insulation;
 - c) their temperature rise in normal service;
 - d) their power dissipation and acceptance;
 - e) their time/current characteristics;
 - f) their breaking capacity;
 - g) their cut-off current characteristics and their I^2t characteristics.
- type test for verification of the characteristics of fuses;
- the marking of fuses.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60269. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, 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. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

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

~~IEC 60038:1983, IEC standard voltages~~

AS 60038, *Standard voltages*

~~IEC 60050(441):1984, International Electrotechnical Vocabulary (IEV) — Chapter 441: Switchgear, controlgear, fuses~~

AS 1852.441, *International Electrotechnical Vocabulary, Part 441: Switchgear, controlgear and fuses* (identical to IEC 60050(441):1984)

IEC 60127, *Cartridge fuse-links for miniature fuses*

~~IEC 60269-2: 1986 Low voltage fuses — Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial applications)~~

AS 60269.2.0, *Low-voltage fuses, Part 2.0: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial applications)* (identical to IEC 60269-2:1986)

~~IEC 60364-3:1993, Electrical installations of buildings — Part 3: Assessment of general characteristics~~

AS/NZS 3000, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

~~IEC 60364-5-52:2001, Electrical installations of buildings — Part 5-52: Selection and erection of electrical equipment — Wiring systems~~

AS/NZS 3000, *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

IEC 60417:1973, *Graphical symbols for use on equipment — Index, survey and compilation of the single sheets*

~~IEC 60529 Ed.2.1:2001, Degrees of protection provided by enclosures (Code IP)~~

AS 60529, *Degrees of protection provided by enclosures (IP Code)* (identical to IEC 60529:2001)

IEC 60584-1:1995, *Thermocouples — Part 1: Reference Tables*

IEC 60617 (all parts) ([DB]¹, Graphical symbols for diagrams

IEC 60664-1:2002, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and test*

~~IEC 60695-2-10 Ed.1.0:2000, Fire hazard testing — Part 2-10: Glow-wire apparatus and common test procedure~~

AS/NZS 60695.2.10, *Fire hazard testing, Part 2.10: Glow/hot wire based test methods—Glow-wire apparatus and common test procedure* (identical to IEC 60695-2-10:2000)

¹"DB" refers to the IEC on-line database.

~~IEC 60695-2-11 Ed.1.0:2000, Fire hazard testing — Part 2-11: Glowing/hot wire based test methods—Glow-wire flammability test method for end-products~~

AS/NZS 60695.2.11, Fire hazard testing, Part 2.11: Glowing/hot wire based test methods—Glow-wire flammability test method for end-products

~~IEC 60695-2-12 Ed.1.0:2000, Fire hazard testing — Part 2-12: Glowing/hot wire based test methods—Glow-wire flammability test method for materials~~

AS/NZS 60695.2.12, Fire hazard testing, Part 2.12: Glowing/hot wire based test methods—Glow-wire flammability test method for materials

~~IEC 60692-2-13 Ed.1.0:2000, Fire hazard testing — Part 2-13: Glowing/hot wire based test methods—Glow-wire ignitability test method for materials~~

AS/NZS 60695.2.13:2001, Fire hazard testing, Part 2.13: Glowing/hot wire based test methods—Glow-wire ignitability test method for materials

~~IEC 60947-3:1998, Low-voltage switchgear and controlgear — Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units~~

AS 3947.3, Low-voltage switchgear and controlgear, Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units

ISO 3:973, Preferred numbers — Series of preferred numbers

AS 2752, Preferred numbers and their use

ISO 478:1974, Paper — Untrimmed stock sizes for the ISO-A series — ISO primary range

ISO 593:1974, Paper — Untrimmed stock size for the ISO-A series — ISO supplementary range

ISO 4046:2002, Paper, board, pulp and related terms — Vocabulary — Bilingual edition

2 Terms and definitions

NOTE — For general definitions concerning fuses, see also IEC 60050-441².

For the purpose of this standard, the following definitions shall apply.

2.1 Fuses and their component parts

2.1.1 fuse

a device that by the fusing of one or more of its specially designed and proportioned components opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device

[IEV 441-18-01]

² IEC 60050-441:1984, International Electrotechnical Vocabulary — Chapter 441: Switchgear, controlgear and fuses Amendment 1(2000)

2.1.2**fuse-holder**

the combination of the fuse-base with its fuse-carrier

NOTE – Where in this standard the term "fuse-holder" is used, it covers fuse-bases and/or fuse-carriers, if no clearer distinction is necessary.

[IEV 441-18-14]

2.1.2.1**fuse-base (fuse-mount)**

the fixed part of a fuse provided with contacts and terminals

NOTE – Where applicable, covers are considered as part of the fuse-base.

[IEV441-18-02]

2.1.2.2**fuse-carrier**

the movable part of a fuse designed to carry a fuse-link

[IEV 441-18-13]

2.1.3**fuse-link**

the part of a fuse including the fuse-element(s), intended to be replaced after the fuse has operated

[IEV 441-18-09]

2.1.4**fuse-contact**

two or more conductive parts designed to ensure circuit continuity between a fuse-link and the corresponding fuse-holder

2.1.5**fuse-element**

a part of a fuse-link designed to melt under the action of current exceeding some definite values for a definite period of time

NOTE – The fuse-link may comprise several fuse-elements in parallel.

[IEV 441-18-08]

2.1.6**indicating device (indicator)**

a part of a fuse provided to indicate whether the fuse has operated

[IEV 441-18-17]

2.1.7**striker [IEV 441-18-18]**

a mechanical device forming part of a fuse-link which, when the fuse operates, releases the energy required to cause operation of other apparatus or indicators or to provide interlocking

2.1.8**terminal**

a conductive part of a fuse provided for electric connection to external circuits

NOTE – Terminals may be distinguished according to the kind of circuits for which they are intended (e.g. main terminal, earth terminal, etc.) and also according to their design (e.g. screw terminal, plug terminal, etc.).

2.1.9**dummy fuse-link**

a test fuse-link with defined power dissipation and dimensions

2.1.10**test rig**

a defined test fuse-base

2.1.11**gauge-piece**

an additional part of a fuse-base intended to achieve a degree of non-interchangeability

2.2 General terms**2.2.1****enclosed fuse-link**

a fuse-link in which the fuse-element(s) is (are) totally enclosed, so that during operation within its rating it cannot produce any harmful external effects, e.g. due to development of an arc, the release of gas or the ejection of flame or metallic particles
[IEV 441-18-12]

2.2.2**current-limiting fuse-link**

fuse-link that during and by its operation in a specified current range, limits the current to a substantially lower value than the peak value of the prospective current
[IEV 441-18-10]

2.2.3

"g" fuse-link (full-range breaking-capacity fuse-link, formerly general purpose fuse-link)

a current-limiting fuse-link capable of breaking under specified conditions all currents, which cause melting of the fuse-element up to its rated breaking capacity

2.2.4

"a" fuse-link (partial-range breaking-capacity fuse-link, formerly back-up fuse-link)

a current-limiting fuse-link capable of breaking under specified conditions all currents between the lowest current indicated on its operating time-current characteristic ($k_2 I_n$ in Figure 2) and its rated breaking capacity

NOTE – "a" fuse-links are generally used to provide short-circuit protection. Where protection is required against over-currents less than $k_2 I_n$ in Figure 2, they are used in conjunction with another suitable switching device designed to interrupt such small overcurrents.

2.2.5**temperatures****2.2.5.1****ambient air temperature**

(T_a)

the temperature of the air surrounding the fuse (at a distance of about 1 m from the fuse or its enclosure, if any)

2.2.5.2**fluid environment temperature**

(T_e)

the temperature of the fluid cooling the fuse-components [contact, terminal, etc.]. It is the sum of the ambient air temperature T_a and the temperature rise ΔT_e with respect to the ambient temperature of the internal fluid in contact with the fuse-components [contact, terminal, etc.] if the latter is in an enclosure. If it is not in an enclosure, it is assumed that T_e is equal to T_a

2.2.5.3**fuse-component temperature**

(T)

the fuse-component [contact, terminal, etc.] temperature T is that of the relevant part

2.2.6**overcurrent discrimination**

the co-ordination of the relevant characteristics of two or more overcurrent protective devices such that, on the occurrence of overcurrents within stated limits, the device intended to operate within these limits does so, while the other(s) do(es) not

2.2.7**fuse-system**

a family of fuses following the same physical design principles with respect to the shape of the fuse-links, type of contact, etc.

2.2.8**size**

a specified set of dimensions of fuses within a fuse-system. Each individual size covers a given range of rated currents for which the specified dimensions of the fuses remain unchanged

2.2.9**homogeneous series of fuse-links**

a series of fuse-links, within a given size, deviating from each other only in such characteristics that for a given test, the testing of one or a reduced number of particular fuselinks of that series may be taken as representative for all the fuse-links of the homogeneous series

NOTE – The characteristics by which the fuse-links of a homogeneous series may deviate and details on which of the fuse-links shall be tested are specified in association with the tests concerned (see Tables 7B and 7C).

[IEV 441-18-34, modified]

2.2.10**utilization category** (of a fuse link)

a combination of specified requirements related to the conditions in which the fuse-link fulfils its purpose, selected to represent a characteristic group of practical applications [see 5.7.1]

2.2.11**fuses for use by authorized persons** [formerly called fuses for industrial application]

fuses intended to be used in installations where the fuse-links are accessible to and intended to be replaced by authorized persons only

NOTE 1 – Non-interchangeability and protection against accidental contact with live parts need not necessarily be ensured by constructional means.

NOTE 2 – Authorized person is understood to have the meaning defined for categories BA 4 "Instructed"³ and BA 5 "Skilled"⁴ in IEC 60364-3.

2.2.12**fuses for use by unskilled persons** (formerly called fuses for domestic and similar applications)

fuses intended to be used in installations where the fuse-links are accessible to and can be replaced by unskilled persons

NOTE – For these fuses protection against direct contact with live parts is recommended and noninterchangeability may be required, if necessary

2.2.13**non-interchangeability**

limitations on shape and/on dimensions with the object of avoiding in a specific fuse-base the inadvertent use of fuse-links having electrical properties other than those ensuring the desired degree of protection

[IEV 441-18-33]

³ Instructed: Persons adequately advised or supervised by skilled persons to enable them to avoid dangers which electricity may create (operating and maintenance staff).

⁴ Skilled: Persons with technical knowledge or sufficient experience to enable them to avoid dangers which electricity may create (engineers and technicians).

2.3 Characteristic quantities

2.3.1

rating

a general term employed to designate the characteristic values that together define the working conditions upon which the tests are based and for which the equipment is designed

NOTE – Rated values usually stated for low-voltage fuses are: voltage, current, breaking capacity, power dissipation and acceptable power dissipation and frequency, where applicable. In the case of a.c., rated voltage and rated current are stated as r.m.s. symmetrical values; in the case of d.c., when ripple is present, the rated voltage is stated as a mean value, the rated current as an r.m.s. value. The above applies to any value of voltage and current, if not indicated otherwise.

2.3.2

prospective current [of a circuit and with respect to a fuse]

the current that would flow in the circuit if each pole of the fuse were replaced by a conductor of negligible impedance.

For a.c., the prospective current is expressed by the r.m.s. value of the a.c. component.

NOTE - The prospective current is the quantity to which the breaking capacity and characteristics of the fuse are normally referred, e.g. I^2t and cut-off current characteristics (see 8.5.7)

[IEV 441-17-01, modified]

2.3.3

gates

the limiting values within which the characteristics, for example time-current characteristics, shall be obtained

2.3.4

breaking capacity of a fuse

a value of prospective current that a fuse is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

[IEV 441-17-08]

2.3.5

breaking range

range of prospective currents within which the breaking capacity of a fuse-link is assured

2.3.6

cut-off current

the maximum instantaneous value reached by the current during the breaking operation of a fuse-link when it operates in such a manner as to prevent the current from reaching the otherwise attainable maximum

2.3.7

cut-off current characteristic; let-through current characteristic

a curve giving the cut-off current as a function of the prospective current under stated conditions of operation

NOTE – In the case of a.c., the values of the cut-off currents are the maximum values which can be reached whatever the degree of asymmetry. In the case of d.c., the values of the cut-off currents are the maximum values reached related to the time constants as specified.

[IEV 441-17-14]

2.3.8

peak withstand current (of a fuse-holder)

the value of cut-off current that the fuse-holder can withstand

NOTE – The peak withstand current is not less than the highest cut-off current of any fuse-link with which the fuseholder is intended to be associated.

2.3.9**pre-arcing time; melting time**

the interval of time between the beginning of a current large enough to cause a break in the fuse-element[s] and the instant when an arc is initiated
[IEV 441-18-21]

2.3.10**arcing time of a fuse**

the interval of time between the instant of the initiation of the arc and the instant of final arc extinction in that fuse
[IEV 441-17-37]

2.3.11**operating time; total clearing time**

the sum of the pre-arcing time and the arcing time
[IEV 441-18-22]

2.3.12 **I^2t ; Joule integral**

the integral of the square of the current over a given time interval:

$$I^2t = \int_{t_0}^{t_1} i^2 dt$$

NOTE 1 – The pre-arcing I^2t is the I^2t integral extended over the pre-arcing time of the fuse.

NOTE 2 – The operating I^2t is the I^2t integral extended over the operating time of the fuse.

NOTE 3 – The energy in joules released in 1 & of resistance in a circuit protected by a fuse is equal to the value of the operating I^2t expressed in A^2s .

[IEV 441-18-23]

2.3.13 **I^2t characteristic**

a curve giving I^2t values [pre-arcing I^2t and/or operating I^2t] as a function of prospective current under stated conditions of operation

2.3.14 **I^2t zone**

the range contained by the minimum pre-arcing I^2t characteristic and the maximum operating I^2t characteristic, under specified conditions

2.3.15**rated current of a fuse-link****(I_n)**

the value of current that the fuse-link can carry continuously without deterioration under specified conditions

2.3.16**time-current characteristic**

a curve giving the pre-arcing time or operating time as a function of the prospective current under stated conditions of operation

NOTE – For times longer than 0,1 s, for practical purposes the difference between pre-arcing and operating time is negligible.

[IEV 441-17-13]

2.3.17**time-current zone**

the range contained by the minimum pre-arcing time-current characteristics and the maximum operating time-current characteristic, under specified conditions

2.3.18**conventional non-fusing current****(I_{nf})**

a value of current specified as that which the fuse-link is capable of carrying for a specified time (conventional time) without melting

[IEV 441-18-27]

2.3.19**conventional fusing current****(I_f)**

a value of current specified as that which causes operation of the fuse-link within a specified time (conventional time)

[IEV 441-18-28]

2.3.20**overload curve of an "a" fuse-link**

a curve showing the time for which an "a" fuse-link shall be able to carry the current without deterioration (see 8.4.3.4 and Figure 2)

2.3.21**power dissipation [in a fuse-link]**

the power released in a fuse-link carrying a stated value of electric current under prescribed conditions of use and behaviour

NOTE - The prescribed conditions of use and behaviour generally include a constant r.m.s. value of the electric current after steady-state temperature conditions are reached.

[IEV 441-18-38, modified]

2.3.22**acceptable power dissipation (of a fuse-base or a fuse-holder)**

stated value of power dissipation in a fuse-link which a fuse-base or a fuse-holder can accept under prescribed conditions of use and behaviour

[IEV 441-18-39]

2.3.23**recovery voltage**

the voltage which appears across the terminals of a pole of a fuse after the breaking of the current

NOTE – This voltage may be considered in two successive intervals of time, one during which a transient voltage exists (see 2.3.23.1) followed by a second one during which only the power frequency or d.c. recovery voltage [see 2.3.23.2] exists.

[IEV 441-17-25, modified]

2.3.23.1**transient recovery voltage**

the recovery voltage during the time in which it has a significant transient character

NOTE 1 – The transient voltage may be oscillatory or non-oscillatory or a combination of both, depending on the characteristics of the circuit and the fuse. It includes the voltage shift of the neutral of a polyphase circuit.

NOTE 2 – The transient recovery voltage in three-phase circuits is, unless otherwise stated, that which appears across the first pole to clear, because this voltage is generally higher than that which appears across each of the other two poles.

[IEV 441-17-26]

2.3.23.2**power-frequency or d.c. recovery voltage**

the recovery voltage after the transient voltage phenomena have subsided

NOTE – The power frequency or d.c. recovery voltage may be referred to as a percentage of the rated voltage.

[IEV 441-17-27, modified]

2.3.24**arc voltage of a fuse**

the instantaneous value of the voltage which appears across the terminals of a fuse during the arcing time
[IEV 441-18-30]

2.3.25**isolating distance (for a fuse)**

the shortest distance between the fuse-base contacts or any conductive parts connected thereto measured on a fuse with the fuse-link or the fuse-carrier removed
[IEV 441-18-06]

3 Conditions for operation in service

Where the following conditions apply, fuses complying with this standard are deemed capable of operating satisfactorily without further qualification. These conditions also apply for tests except those otherwise specified in Clause 8.

3.1 Ambient air temperature (T_a)

The ambient air temperature T_a (see 2.2.5.1) does not exceed 40 °C, its mean value measured over a period of 24 h does not exceed 35 °C, and its mean value measured over a period of one year is lower.

The minimum value of the ambient air temperature is –5 °C.

NOTE 1 – The time-current characteristics given are related to a reference ambient air temperature of 20 °C. These time-current characteristics also approximately apply to a temperature of 30 °C.

NOTE 2 – In cases where the temperature conditions vary significantly from these values, this should be taken into consideration from the points of view of operation, temperature rise, etc. See annex D.

3.2 Altitude

The altitude of the site of installation of the fuses does not exceed 2 000 m above sea level.

3.3 Atmospheric conditions

The air is clean and its relative humidity does not exceed 50 % at the maximum temperature of 40 °C.

Higher relative humidities are permitted at lower temperatures, e.g. 90 % at 20 °C.

Under these conditions, moderate condensation may occasionally occur due to variation in temperature.

NOTE – Where fuses are to be used under conditions different from those mentioned in 3.1, 3.2 and 3.3, in particular outdoors without protection, the manufacturer should be consulted. This applies also in cases where deposits of sea salt or abnormal deposits of industrial origin may occur.

3.4 Voltage

The system voltage has a maximum value not exceeding 110 % of the rated voltage of the fuse. For d.c. when obtained by rectifying a.c., the ripple shall not cause a variation of more than 5 % above or 9 % below the mean value of 110 % of the rated voltage.

For fuses rated 690 V the maximum system voltage shall not exceed 105 % of the rated voltage of the fuse.

NOTE – Attention is drawn to the fact that the indicating device or striker of a fuse may not operate if the fuse-link operates at a voltage which is considerably lower than its rated voltage (see 8.4.3.6).

3.5 Current

The currents to be carried and to be broken are within the range specified in 7.4 and 7.5.

3.6 Frequency, power factor and time constant

3.6.1 Frequency

For a.c. the frequency is the rated frequency of the fuse-link.

3.6.2 Power factor

For a.c. the power factor is not lower than that shown in Table 12A, appropriate to the value of prospective current.

3.6.3 Time constant

For d.c. the time constant corresponds to that shown in Table 12B.

Some service duties may be found which exceed the limits shown in the Table as regards time constant. For such an application, a fuse-link which has been tested to verify that it meets the required time constant and is marked accordingly shall be used.

3.7 Conditions of installation

The fuse is installed in accordance with the manufacturer's instructions.

If the fuse is likely to be exposed in service to abnormal vibrations or shocks, the manufacturer should be consulted.

3.8 Utilization category

Utilization categories (e.g. "gG") are specified according to 5.7.1.

3.9 Discrimination of fuse-links

Limits of discrimination for times greater than 0,1 s are given in Tables 2 and 3.

For "gG" and "gM" fuse-links pre-arcing I^2t values are given in Table 6 and operating I^2t values are given in subsequent parts. Values for other breaking ranges and utilization categories are shown in subsequent parts.

4 Classification

Fuses are classified according to Clause 5 and the subsequent parts.

5 Characteristics of fuses

5.1 Summary of characteristics

The characteristics of a fuse shall be stated in the following terms, where such terms are applicable.

5.1.1 Fuse-holders

- a) Rated voltage (see 5.2)
- b) Rated current (see 5.3.2)
- c) Kind of current and rated frequency, if applicable (see 5.4)
- d) Rated acceptable power dissipation (see 5.5)
- e) Dimensions or size
- f) Number of poles, if more than one
- g) Peak withstand current

5.1.2 Fuse-links

- a) Rated voltage (see 5.2)
- b) Rated current (see 5.3.1)
- c) Kind of current and rated frequency, if applicable (see 5.4)
- d) Rated power dissipation (see 5.5)
- e) Time-current characteristics (see 5.6)
- f) Breaking range (see 5.7.1)
- g) Rated breaking capacity (see 5.7.2)
- h) Cut-off current characteristics (see 5.8.1)
- i) I^2t characteristics (see 5.8.2)
- k) Dimensions or size

5.1.3 Complete fuses

Degree of protection according to IEC 60529.

5.2 Rated voltage

For a.c. the standard values of rated voltages are given in Table 1.

Table 1 – Standard values of a.c. rated voltages for fuses

Series I V	Series II V
	120*
	208
230*	240
	277*
400*	415
500	480*
690*	600

The values marked with an asterisk are standardized values according to IEC 60038. In the meantime, the other values of the Table will also be used.

For d.c., the preferred values for rated voltages are given as follows: 110* – 125* – 220* – 250* – 440* – 460 – 500 – 600* – 750 V.

NOTE – The rated voltage of the fuse-link may be a value other than the rated voltage of the fuse-holder in which the fuse-link is to be used. The rated voltage of the fuse is the lowest value of the rated voltages of its parts (fuse-holder, fuse-link).

5.3 Rated current

5.3.1 Rated current of the fuse-link

The rated current for the fuse-link, expressed in amperes, should be selected from the following values:

2 – 4 – 6 – 8 – 10 – 12 – 16 – 20 – 25 – 32 – 40 – 50 – 63 – 80 – 100 – 125 – 160 – 200 – 250 – 315 – 400 – 500 – 630 – 800 – 1 000 – 1 250

NOTE 1 – If higher or lower values are required, these values should be selected from the series R10 of ISO 3.

NOTE 2 – If, in exceptional cases, it is necessary to choose an intermediate value, this value should be selected from the series R20 of ISO 3.

5.3.2 Rated current of the fuse-holder

The rated current of the fuse-holder, expressed in amperes, should be selected from the series of rated currents of fuse-links if not otherwise specified in subsequent parts. For "gG" and "aM" fuses, the rated current of the fuse-holder represents the highest rated current of the fuse-link with which it is intended to be used.

5.4 Rated frequency (see 6.1 and 6.2)

The absence of any marking regarding rated frequency shall imply that the fuse meets the conditions laid down in this standard for frequencies between 45 Hz and 62 Hz only.

5.5 Rated power dissipation of a fuse-link and rated acceptable power dissipation of a fuse-holder

The rated power dissipation of a fuse-link is stated by the manufacturer if not otherwise specified in subsequent parts. That value shall not be exceeded under specified test conditions.

The rated acceptable power dissipation of a fuse-holder is stated by the manufacturer if not otherwise specified in the subsequent parts. It is intended to be the maximum power dissipation the fuse-holder can tolerate under specified test conditions without exceeding the specified temperature rise.

5.6 Limits of time-current characteristics

The limits are based on a reference ambient air temperature T_a of +20 °C.

5.6.1 Time-current characteristics, time-current zones

They depend on the design of the fuse-link, and, for a given fuse-link, on the ambient air temperature and the cooling conditions.

NOTE – For ambient air temperatures deviating from the temperature range according to 3.1, consultation with the manufacturer is necessary.

For fuse-links not complying with the standardized time-current zones as specified in the subsequent parts, the manufacturer should keep available (with their tolerances):

- the pre-arcing and operating time-current characteristics
- or
- the time-current zone.

NOTE – For pre-arcing times smaller than 0,1 s the manufacturer should keep available I^2t characteristics with their tolerances (see 5.8.2).

When the time-current characteristics are presented for pre-arcing times exceeding 0,1 s, they should be given with current as abscissa and time as ordinate. Logarithmic scales shall be used on both co-ordinate axes.

The basis of the logarithmic scales (the dimensions of one decade) shall be in the ratio 2/1 with the longer dimensions on the abscissa. However, because of long-established practice in the United States of America, a ratio of 1/1 is recognized as an alternative standard. The presentation shall be made on standardized paper A3 or A4, according to ISO 478 or ISO 593.

The dimensions of the decades shall be selected from the following series:

2 cm, 4 cm, 8 cm, 16 cm, and 2,8 cm, 5,6 cm, 11,2 cm.

NOTE – It is recommended that, whenever possible, the preferred values 2,8 cm (ordinate) and 5,6 cm (abscissa) should be used.

5.6.2 Conventional times and currents

The conventional times and currents are given in Table 2. For "gD" and "gN" fuse-links, conventional times and currents are given in IEC 60269-2-1, section V.

Table 2 – Conventional time and current for "gG" and "gM" fuse-links

Rated current I_n for «gG» Characteristic current I_{ch} for «gM»** A	Conventional time h	Conventional current	
		I_{nf}	I_f
$I_n < 16$	1	*	*
$16 \leq I_n \leq 63$	1	1,25 I_n	1,6 I_n
$63 < I_n \leq 160$	2		
$160 < I_n \leq 400$	3		
$400 < I_n$	4		
* Under consideration.			
** For "gM" fuse links, see 5.7.1.			

5.6.3 Gates

For "gG" and "gM" fuse-links, the gates given in Table 3 apply.

Table 3 – Gates for specified pre-arcing times of "gG" and "gM" fuse-links*

1	2	3	4	5
I_n for "gG" I_{ch} for "gM"***	I_{min} (10 s)***	I_{max} (5 s)	I_{min} (0,1 s)	I_{max} (0,1 s)
A	A	A	A	A
16	33	65	85	150
20	42	85	110	200
25	52	110	150	260
32	75	150	200	350
40	95	190	260	450
50	125	250	350	610
63	160	320	450	820
80	215	425	610	1 100
100	290	580	820	1 450
125	355	715	1 100	1 910
160	460	950	1 450	2 590
200	610	1 250	1 910	3 420
250	750	1 650	2 590	4 500
315	1 050	2 200	3 420	6 000
400	1 420	2 840	4 500	8 060
500	1 780	3 800	6 000	10 600
630	2 200	5 100	8 060	14 140
800	3 060	7 000	10 600	19 000
1 000	4 000	9 500	14 140	24 000
1 250	5 000	13 000	19 000	35 000

* Values for fuses with rated current less than 16 A are given in subsequent parts or are under consideration.

** For "gM" fuse-links see 5.7.1.

*** I_{min} (10 s) is the minimum value of current for which the pre-arcing time is not less than 10 s.

For "gD" and "gN" fuse-links, gates are given in IEC 60269-2-1, section V.

5.7 Breaking range and breaking capacity

5.7.1 Breaking range and utilization category

The first letter shall indicate the breaking range:

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

The second letter shall indicate the utilization category; this letter defines with accuracy the time-current characteristics, conventional times and currents, gates:

For example

- "gG" indicates fuse-links with a full-range breaking capacity for general application;
- "gM" indicates fuse-links with a full-range breaking capacity for the protection of motor circuits;
- "aM" indicates fuse-links with a partial range breaking capacity for the protection of motor circuits;
- "gD" indicates time-delay fuse-links with a full range breaking capacity;
- "gN" indicates non-time-delay fuse-links with a full range breaking capacity.

NOTE 1 – At present "gG" fuse-links are often used for the protection of motor circuits, which is possible when their characteristics are suitable to be capable of withstanding the motor starting current.

NOTE 2 – A "gM" fuse-link, which has a dual rating is characterized by two current values. The first value I_n denotes both the rated current of the fuse-link and the rated current of the fuse-holder; the second value I_{ch} denotes the time-current characteristic of the fuse-link as defined by the gates in Tables 2, 3 and 6.

These two ratings are separated by a letter which defines the applications.

For example: I_n m I_{ch} denote a fuse intended to be used for protection of motor circuits and having the characteristic G. The first value I_n corresponds to the maximum continuous current for the whole fuse and the second value I_{ch} corresponds to the G characteristic of the fuse-link.

NOTE 3 – An "aM" fuse-link is characterized by one current value I_n and time-current characteristics as defined in 8.4.3.3.1 and Figure 2.

5.7.2 Rated breaking capacity

The rated breaking capacity of a fuse-link is given by the manufacturer corresponding to the rated voltage. Values of minimum rated breaking capacity are given in subsequent parts.

5.8 Cut-off current and I^2t characteristics

The value for cut-off and I^2t characteristics shall take into account manufacturing tolerances and shall refer to the service conditions as specified in subsequent parts, e.g. the values of voltage, frequency and power factor.

5.8.1 Cut-off current characteristics

The cut-off current characteristics shall represent the maximum instantaneous values of current likely to be experienced in service. (See 8.6.1 and annex C.)

Where the cut-off current characteristics are required, and unless specified in subsequent parts, they should be given by the manufacturer according to the example shown in Figure 3, in a double logarithmic presentation with the prospective current as abscissa.

5.8.2 I^2t characteristics

The pre-arcing I^2t characteristics for pre-arcing times of less than 0,1 s down to a time corresponding to the rated breaking capacity shall be given by the manufacturer. They shall represent the lowest values likely to be experienced in service as a function of the prospective current.

The operating I^2t characteristics with specified voltages as parameters shall be given by the manufacturer for pre-arcing times less than 0,1 s. They shall represent the highest values likely to be experienced in service as a function of the prospective current.

When presented graphically, the I^2t characteristics shall be given with prospective current as abscissa and I^2t values as ordinate. Logarithmic scales shall be used on both co-ordinate axes. (For using the logarithmic scales, see 5.6.1.)

6 Markings

The marking shall be durable and easily legible. Compliance is checked by inspection and by the following test.

The marking is rubbed by hand for 5 s with a piece of cloth soaked with water and again for 5 s with a piece of cloth soaked with petroleum spirit.

NOTE - It is recommended that the petroleum spirit used consists of a solvent hexane with an aromatic content of maximum 0,1 volume percentage, a kauributanol value of approximately 29, an initial boiling point of approximately 65 °C, a dry point of approximately 69 °C and a density of approximately 0,68 g/cm³.