

Low-voltage fuses —

Part 1: General requirements

ICS 29.120.50

National foreword

This British Standard is the UK implementation of EN 60269-1:2007+A2:2014. It is identical to IEC 60269-1:2006, incorporating amendments 1:2009 and 2:2014. It supersedes BS EN 60269-1:2007+A1:2009, which will be withdrawn on 4 August 2017.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

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 series of standards.

These British Standards together with their IEC counterparts are:

BS 88-1 — General requirements (IEC 60269-1)

BS 88-2 — 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 — 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 — Supplementary requirements for fuse-links for the protection of semiconductor devices (IEC 60269-4)

PD 88-5 — Guidance for the application of low-voltage fuses (IEC/TR 60269-5)

The 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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English version

**Low-voltage fuses -
Part 1: General requirements
(IEC 60269-1:2006)**

Fusibles basse tension -
Partie 1: Exigences générales
(CEI 60269-1:2006)

Niederspannungssicherungen -
Teil 1: Allgemeine Anforderungen
(IEC 60269-1:2006)

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The text of document 32B/483/FDIS, future edition 4 of IEC 60269-1, 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 60269-1 on 2007-03-01.

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The following dates were fixed:

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Annex ZA has been added by CENELEC.

Endorsement notice

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Foreword to amendment A2

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

Endorsement notice

The text of the International Standard IEC 60269-1:2006/A2:2014 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 1: General requirements

1 General

1.1 Scope and object

This part of IEC 60269 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:
 - their rated values;
 - their insulation;
 - their temperature rise in normal service;
 - their power dissipation and acceptable power dissipation;
 - their time/current characteristics;
 - their breaking capacity;
 - 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 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 60038:1983, *IEC standard voltages*

IEC 60050(441):1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*
Amendment 1 (2000)

Ⓐ IEC 60228:2004, *Conductors of insulated cables* Ⓐ

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 I)*

IEC 60269-3, *Low-voltage fuses – Part 3: 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 60269-4, *Low-voltage fuses – Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices*

IEC 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 60364-3:1993, *Electrical installations of buildings – Part 3: Assessment of general characteristics*

IEC 60364-5-52:2001, *Electrical installations of buildings – Part 5-52: Selection and erection of electrical equipment – Wiring system*

IEC 60529:1989, *Degrees of protection provided by enclosures (Code IP)*

IEC 60584-1:1995, *Thermocouples – Part 1: Reference tables*

IEC 60617, *Graphical symbols for diagrams*

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

Ⓐ IEC 60695-2-10, *Fire Hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*

IEC 60695-2-11:2000, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60695-2-12:2010, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-2-13:2010, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials* Ⓐ

ISO 3:1973, *Preferred numbers – Series of preferred numbers*

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 4046:1978, *Paper, board, pulp and related terms – Vocabulary – Bilingual edition*

2 Terms and definitions

NOTE For general definitions concerning fuses, see also IEC 60050-441.

For the purposes of this document, the following terms and definitions apply.

2.1 Fuses and their component parts

2.1.1

fuse

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]

2.1.2

fuse-holder

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)

fixed part of a fuse provided with contacts and terminals

[IEV 441-18-02]

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

2.1.2.2

fuse-carrier

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

[IEV 441-18-13]

2.1.3

fuse-link

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

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

[IEV 441-18-08]

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

2.1.6

indicating device (indicator)

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

[IEV 441-18-17]

2.1.7

striker

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

[IEV 441-18-18]

2.1.8

terminal

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 (for example, main terminal, earth terminal, etc.) and also according to their design (for example, screw terminal, plug terminal, etc.).

2.1.9

dummy fuse-link

test fuse-link with defined power dissipation and dimensions

2.1.10

test rig

defined test fuse-base

2.1.11

gauge-piece

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

A1 2.1.12

linked fuse-carrier

a fuse-carrier which is mechanically linked to the fuse-base and gives a defined insertion and withdrawal movement to the fuse-link

[This definition was definition 2.1.12 in IEC 60269-2-1, Section I, which has been withdrawn.] **A1**

2.2 General terms

2.2.1

enclosed fuse-link

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, for example, 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)
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)
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

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

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

2.2.6

overcurrent discrimination

coordination 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

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

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

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 fuse-links 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 12 and 13).

[IEV 441-18-34, modified]

2.2.10

utilization category (of a fuse-link)

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"¹ and BA 5 "skilled"² 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 non-interchangeability may be required, if necessary

2.2.13

non-interchangeability

limitations on shape and/or 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]

¹ Instructed: Persons adequately advised or supervised by skilled persons to enable them to avoid dangers which electricity may create (operating and maintenance staff).

² 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

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

[IEV 441-18-36]

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)

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

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

2.3.4

breaking capacity of a fuse

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 modified]

2.3.5

breaking range

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

2.3.6

cut-off current

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

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)

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

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

interval of time between the instant of the initiation of the arc in a fuse and the instant of final arc extinction in that fuse

[IEV 441-17-37 modified]

2.3.11

operating time; total clearing time

sum of the pre-arcing time and the arcing time

[IEV 441-18-22]

2.3.12

I^2t ; Joule integral

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 1Ω 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

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

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

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

2.3.16

time-current characteristic

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

[IEV 441-17-13]

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

2.3.17

time-current zone

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}

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

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

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

2.3.21

power dissipation (in a fuse-link)

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

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 abbreviation TRV

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

NOTE 1 The transient recovery voltage may be oscillatory or non-oscillatory or a combination of these, 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

recovery voltage after the transient voltage phenomena have subsided

[IEV 441-17-27 modified]

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

2.3.24

arc voltage of a fuse

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)

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 humidity is permitted at lower temperatures, for example, 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 20, appropriate to the value of prospective current.

3.6.3 Time constant

For d.c. the time constant corresponds to that shown in Table 21.

Some service duties may be found which exceed the limits shown in the Table 21 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 (for example, "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 7 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 ^{A2} Text deleted ^{A2}
500	480*
690*	600
^{A2} 1000 ^{A2}	^{A2} 347 ^{A2}

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.

^{A2} For d.c. the preferred values for rated voltages are given in Table 22. ^{A2}

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).

^{A2} Table 22 – Preferred values of d.c. rated voltages for fuses

Series I V	Series II V
	110*
220*	
	250
400	
440*	460
500	
	600*
750*	
1 000	
	1 200
1 500*	

^{A2}

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 – ^{A2}35 – ^{A2}40 – 50 – 63 – 80 – 100 – 125 – 160 – 200 – 250 – 315 – 400 – 500 – 630 – 800 – 1 000 – 1 250

^{A2} If it is necessary to choose lower values or intermediate values or higher values, these values should be selected from the series R10 of ISO 3, and in exceptional cases from ^{A2} of ISO 3. ^{A2}

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 coordinate 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) be used.

5.6.2 Conventional times and currents

A2 The conventional times and currents for "gG" and "gM" fuse-links are given in Table 2. **A2**

Table 2 – Conventional time and current for **A2 "gG", "gK" and "gM" fuse-links **A2****

Rated current I_n for «gG» Characteristic current I_{ch} for «gM» ^b A	Conventional time h	Conventional current	
		I_{nf}	I_f
$I_n < 16$	1	a	a
$16 \leq I_n \leq 63$	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		
A1 ^a Values for fuse-links with rated current less than 16 A are given in subsequent parts. A1			
^b 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 **A2 "gG", "gK" and "gM" fuse-links **A2****

1	2	3	4	5
I_n for "gG" I_{ch} for "gM" ^b A	I_{min} (10 s) ^c A	I_{max} (5 s) A	I_{min} (0,1 s) A	I_{max} (0,1 s) A
16	33	65	85	150
20	42	85	110	200
25	52	110	150	260
32	75	150	200	350
A2 35	83	175	225	445 A2
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

^a Values for fuses with rated current less than 16 A are given in subsequent parts **A1** text deleted **A1**.

^b For "gM" fuse-links, see 5.7.1.

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



For "aM" fuses the standard gates for time- current characteristics based on reference ambient air temperature of 20 °C are given in Table 4 and Figure 3. The standardized k-factors are $k_0 = 1,5$; $k_1 = 4$ and $k_2 = 6,3$.

Table 4 – Gates for "aM" fuse-links (all rated currents)

Remark: this table was previously Table A in IEC 60269-2, Edition 2

	$4 I_n$	$6,3 I_n$	$8 I_n$	$10 I_n$	$12,5 I_n$	$19 I_n$
$t_{\text{operating}}$	-	60 s	-	-	0,5 s	0,10 s
$t_{\text{pre-arcing}}$	60 s	-	0,5 s	0,2 s	-	-

For "gD" and "gN" fuse-links, gates are given in IEC 60269-2, fuse system H.

 For "gK" fuse-links, gates are given in IEC 60269-2, fuse system K. 

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.

 – "gK" indicates fuse-link with a full-range breaking capacity for general application. 

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 7.

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, for example, 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 4, 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 coordinate axes. (For the use of 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.

- A1** 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 aliphatic solvent hexane.

NOTE It is recommended to use aliphatic 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. **A1**

6.1 Markings of fuse-holders

The following information shall be marked on all fuse-holders:

- name of the manufacturer or a trade mark by which he may be readily identified;
- manufacturer's identification reference enabling all the characteristics listed in 5.1.1 to be found;
- rated voltage;

- rated current;
- kind of current and rated frequency, when applicable.

NOTE A fuse-holder marked with a.c. ratings may also be used for d.c. If a fuse-holder contains a removable fuse-base and a removable fuse-carrier, both should be separately marked for the purpose of identification.

6.2 Markings of fuse-links

The following information shall be marked on all fuse-links except small fuse-links where this is impracticable:

- name of the manufacturer or a trade mark by which he may be readily identified;
- manufacturer's identification reference, enabling all the characteristics listed in 5.1.2 to be found;
- rated voltage;
- rated current (for "gM" type see 5.7.1);
- breaking range and utilization category (letter code), where applicable (see 5.7.1);
- kind of current and, if applicable, rated frequency (see 5.4).

NOTE Fuse-links should be marked separately for a.c. and d.c. if the fuse-link is provided for a.c. and d.c.

For small fuse-links, where it is impracticable to include all the specified information on the fuse-link, the trade mark, list reference of the manufacturer, rated voltage and the rated current shall be marked.

6.3 Marking symbols

For the kind of current and frequency, use symbols in accordance with IEC 60417.

NOTE The marking for rated current and rated voltage may, for instance, be as follows:

$$10 \text{ A} \quad 500 \text{ V} \quad \text{or } 10/500 \quad \text{or } \frac{10}{500}$$

7 Standard conditions for construction

7.1 Mechanical design

7.1.1 Replacement of fuse-links

A fuse-link shall have adequate mechanical strength and its contacts shall be securely fixed. It shall be possible to replace the fuse-links easily and safely.

7.1.2 Connections, including terminals

The fixed connections shall be such that the necessary contact force is maintained under the conditions of service and operation.

No contact force on connections shall be transmitted through insulating material other than ceramic or other material with characteristics not less suitable, unless there is sufficient resilience in the metallic parts to compensate for any possible shrinkage or other deformation of the insulating material. Tests are specified in subsequent parts, where necessary.

Terminals shall be such that they cannot turn or be displaced when the connecting screws are tightened, and such that the conductors cannot be displaced. The parts gripping the conductors shall be of metal and shall have such a shape that they cannot unduly damage conductors.

Terminals shall be so arranged that they are readily accessible (after removal of covers, if any) under the intended conditions of installation.

[A1] NOTE Requirements of screwless-type terminals are given in Annex E. **[A1]**

7.1.3 Fuse-contacts

Fuse-contacts shall be such that the necessary contact force is maintained under the conditions of service and operation, in particular under the conditions corresponding to 7.5.

Contact shall be such that the electromagnetic forces occurring during operation under conditions in accordance with 7.5 shall not impair the electrical connections between

- a) the fuse-base and the fuse-carrier;
- b) the fuse-carrier and the fuse-link;
- c) the fuse-link and the fuse-base, or, if applicable, any other support.

In addition, fuse contacts shall be so constructed and of such material that, when the fuse is properly installed and service conditions are normal, adequate contact is maintained

- a) after repeated engagement and disengagement;
- b) after being left undisturbed in service for a long period (see 8.10).

Fuse-contacts of copper alloy shall be free from season cracking.

These requirements are verified by the tests according to 8.10, 8.11.2.1 and in Clause 8 of subsequent parts.

7.1.4 Construction of a gauge-piece

A gauge-piece, if any, shall be so designed that it withstands normal stresses occurring during use.

7.1.5 Mechanical strength of the fuse-link

A fuse-link shall have adequate mechanical strength and its contacts shall be securely fixed.

7.2 Insulating properties and suitability for isolation

The fuses shall be such that they do not lose their insulating properties at the voltages to which they are subjected in normal service. **[A1]** The fuse shall be suitable for isolation when it is in its normal open position, the fuse-link remaining inside the fuse-carrier, or when the fuse-link, and, when applicable, the fuse-carrier is removed. **[A1]** The applicable overvoltage category is specified in subsequent parts.

The fuse shall be deemed to satisfy these conditions if it passes the tests for verification of insulating properties and suitability for isolation in accordance with 8.2.