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Interested committees:

Title: Draft BS EN 60269-1/A3 Amendment 3 - Low-voltage fuses. Part 1: General requirements.

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Introduction

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

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

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Template for comments and secretariat observations

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



32B/702/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:
IEC 60269-1/AMD3 ED4

DATE OF CIRCULATION:
2021-05-14

CLOSING DATE FOR COMMENTS:
2021-07-09

SUPERSEDES DOCUMENTS:
32B/693/RR

IEC SC 32B : LOW-VOLTAGE FUSES

SECRETARIAT:
Germany

SECRETARY:
Mr Michael Altenhuber

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:



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

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

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TITLE:

Amendment 3 - Low-voltage fuses - Part 1: General requirements

NOTE FROM TC/SC OFFICERS:

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

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All changes to the present edition are marked in red for easier reading

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE FUSES –

Part 1: General requirements

FOREWORD

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This Consolidated version of IEC 60269-1 bears the edition number 4.2. It consists of the fourth edition (2006-11) [documents 32B/483/FDIS and 32B/490/RVD], its amendment 1 (2009-04) [documents 32B/534/FDIS and 32B/540/RVD] and its amendment 2 (2014-06) [documents 32B/626/FDIS and 32B/628/RVD]. The technical content is identical to the base edition and its amendments.

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

This publication has been prepared for user convenience.

252 International Standard IEC 60269-1 has been prepared by subcommittee 32B: Low-voltage
253 fuses, of IEC technical committee 32: Fuses.

254 IEC 60269 consists of the following parts, under the general title *Low-voltage fuses*:

255 Part 1: General requirements

256 Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for
257 industrial application) – Examples of standardized systems of fuses A to I

258 Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for
259 household or similar application) – Examples of standardized systems of fuses A to F

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

261 Part 5: Guidance for the application of low-voltage fuses

262 Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic
263 energy systems

264 **Part 7: Battery Fuses**

265 For reasons of convenience, when a part of this publication has come from other publications,
266 a remark to this effect has been inserted in the text.

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

- 271 • reconfirmed,
- 272 • withdrawn,
- 273 • replaced by a revised edition, or
- 274 • amended.

275

276

INTRODUCTION

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

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

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

285

286

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 **As far as not stated in subsequent parts** 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 60695-2-12:2000, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-2-13:2000, *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

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.]

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 fulfills 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~~

2.2.11 Fuses for use by authorized and unskilled persons

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).

Generally, fuses systems are divided in systems for use by authorized persons and for use by unskilled persons.

For safe operation of fuses systems used by authorized persons special skills are necessary. Authorized person is understood to have the meaning defined for categories BA 4 "instructed" and BA 5 "skilled" in IEC 60364-3.

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

Skilled persons have got technical knowledge or sufficient experience to enable them to avoid dangers which electricity may create (engineers and technicians). For e. g. dangers for persons may come from touching live parts during operation and from replacing fuse-links under load.

Unskilled persons don't have technical knowledge or sufficient experience. To avoid dangers, which electricity may create, the relevant part of the fuse standard shall provide requirements for maximum safety in service. IEC 60269-3 provides four systems for use by unskilled persons.

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]

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]

2.4 List of abbreviations and symbols used

Under consideration

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~~ preferred values of rated voltages are given in Table 1.

~~Table 1 — Standard Preferred 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
1 000*	347

Table 1 – AC systems having a nominal voltage between 100 V and 1 000 V inclusive and related equipment

Three-phase four-wire or three-wire systems		Single-phase three-wire systems
Nominal voltage V		Nominal voltage V
50 Hz	60 Hz	60 Hz
–	120/208	120/240 ^d
230 ^c	240 ^c	–
230/400 ^a	230/400 ^a	–
–	277/480	–
–	480	–
–	347/600	–
–	600	–
400/690 ^b	–	–
1 000	–	–
^a The value of 230/400 V is the result of the evolution of 220/380 V and 240/415 V systems which has been completed in Europe and many other countries. However, 220/380 V and 240/415 V systems still exist. ^b The value of 400/690 V is the result of the evolution of 380/660 V systems which has been completed in Europe and many other countries. However, 380/660 V systems still exist. ^c The value of 200 V or 220 V is also used in some countries. ^d The values of 100/200 V are also used in some countries on 50 Hz or 60 Hz systems.		

For d.c., the preferred values for rated voltages are given in Table 22.

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).

Table 22 – Preferred values of d.c. rated voltages for fuses

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

Table 22 – DC and a.c. traction systems ^a

	Voltage			Nominal frequency of a.c. systems Hz
	Lowest V	Nominal V	Highest V	
DC systems	(400)	(600)	(720)	

	500 1 000 2 000	750 1 500 3 000	900 1 800 3 600 ^b	
AC single-phase systems	(4 750) 12 000 19 000	(6 250) 15 000 25 000	(6 900) 17 250 27 500	50 or 60 16 ² / ₃ 50 or 60
a The values indicated in parentheses should be considered as non-preferred values. It is recommended that these values should not be used for new systems to be constructed in future. In particular for a.c. single-phase systems, the nominal voltage 6 250 V should be used only when local conditions make it impossible to adopt the nominal voltage 25 000 V. The values indicated in the table above are the values agreed by the international mixed committee on electric traction equipment (C.M.T.) and by IEC technical committee 9, Electrical equipment and systems for railways. b In certain European countries, this voltage may reach 4 000 V. The electrical equipment of vehicles operating international services in these countries shall be capable of withstanding this absolute maximal voltage for brief periods of up to 5 min.				

Note: This table is the same as Table 2 of IEC 60038, Ed. 7.0

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 – **13** – 16 – 20 – 25 – 32 – 35 – 40 – 50 – 63 – 80 – 100 – 125 – 160 – 200 – **224** – 250 – 315 – **355** – 400 – **425** – 500 – 630 – 800 – 1 000 – 1 250 – **1600**

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 R20 or R40 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.

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

- 833 – the pre-arcing and operating time-current characteristics;
- 834 or
- 835 – the time-current zone.

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

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

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

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

846 2 cm, 4 cm, 8 cm, 16 cm, and 2,8 cm, 5,6 cm, 11,2 cm.

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

849 **5.6.2 Conventional times and currents**

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

851

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

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		
^a Values for fuse-links with rated current less than 16 A are given in subsequent parts. <i>(to be added from subsequent parts)</i>			
^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 "gG", "gK" and "gM" fuse-links ^a

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
35	83	175	225	445
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
224	680	1 450	2 240	3 980
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.				
^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 $k_2 = 6,3$.