SLOVENSKI STANDARD
oSIST prEN IEC 60282-1:2018

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Visokonapetostne varovalke - 1. del: Tokovno omejilne varovalke

High-voltage fuses - Part 1: Current-limiting fuses

Hochspannungssicherungen - Teil 1: Strombegrenzende Sicherungen

Fusibles à haute tension - Partie 1: Fusibles limiteurs de courant

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COMMITTEE DRAFT FOR VOTE (CDV)

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IEC SC 32A : HIGH-VOLTAGE FUSES

SECRETARIAT: France	SECRETARY: Mr Raphaël Buisson
OF INTEREST TO THE FOLLOWING COMMITTEES: SC 17A,SC 17C	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY

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TITLE:

High-voltage fuses - Part 1: Current-limiting fuses

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NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HIGH-VOLTAGE FUSES –

Part 1: Current-limiting fuses

FOREWORD

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International Standard IEC 60282-1 has been prepared by subcommittee 32A: High-voltage fuses, of IEC technical committee 32: Fuses.

This eighth edition cancels and replaces the seventh edition published in 2009. The content of the amendment (2013) has been considered for this revision.

The main changes introduced by this new edition are:

Additional information concerning thermally operated strikers, the division of ratings, characteristics and type tests into those applicable to all fuses and those applicable to particular fuse-link types and applications, adjustment of Series II voltages and tests to meet present North American standard system voltages and applications, clarification of requirements for fuse-links used in surrounding temperatures above 40 °C, and clarification of homogeneous requirements for fuse-links containing one element.

The text of this standard is based on the following documents:

FDIS	Report on voting
32A/XX/FDIS	32A/XX/RVD

158 Full information on the voting for the approval of this standard can be found in the report on
159 voting indicated in the above table.

160 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

161 The IEC 60282 series consists of the following parts, under the general title *High-voltage*
162 *fuses:*

163 – Part 1: Current-limiting fuses

164 – Part 2: Expulsion fuses

165 The committee has decided that the contents of this document will remain unchanged until the
166 stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to
167 the specific document. At this date, the document will be

168 • reconfirmed,

169 • withdrawn,

170 • replaced by a revised edition, or

171 • amended.

172

173

HIGH-VOLTAGE FUSES –

Part 1: Current-limiting fuses

1 General

1.1 Scope

This part of IEC 60282 applies to all types of high-voltage current-limiting fuses designed for use outdoors or indoors on alternating current systems of 50 Hz and 60 Hz and of rated voltages exceeding 1 000 V.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60050-441:1984 + AMD1:2000, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

IEC 60050-614:2016, *International Electrotechnical Vocabulary (IEV) – Chapter 614: Generation, transmission and distribution of electricity – Operation*

IEC 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60071-1:1993, *Insulation coordination – Part 1: Definitions, principles and rules*

IEC 60085:1984, *Thermal evaluation and classification of electrical insulation*

IEC 60549, *High-voltage fuses for the external protection of shunt capacitors*

IEC 60644, *Specification for high-voltage fuse-links for motor circuit applications*

IEC 62271-100:2008+AMD1:2012+AMD2:2017, *High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers*

IEC 62271-105, *High-voltage switchgear and controlgear – Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV*

IEC/TR 62655:2013, *Tutorial and application guide for high-voltage fuses*

ISO 148-2:1998, *Metallic materials – Charpy pendulum impact test – Part 2: Verification of test machines*

ISO 179 (all parts), *Plastics – Determination of Charpy impact properties*

2 Normal and special service conditions

2.1 Normal service conditions

Fuses complying with this standard are designed to be used under the following conditions.

a) The maximum ambient air temperature is 40 °C and its mean measured over a period of 24 h does not exceed 35 °C.

   The minimum ambient air temperature is –25 °C.

   NOTE 1 The time-current characteristics of fuses will be modified at the minimum and maximum temperatures.

b) The altitude does not exceed 1 000 m.

c) The ambient air is not excessively (or abnormally) polluted by dust, smoke, corrosive or flammable gases, vapour or salt.

d) For indoor installations, the conditions of humidity are under consideration but, in the meantime, the following figures can be used as a guide:

- the average value of the relative humidity, measured during a period of 24 h, does not exceed 95 %;
- the average value of the vapour pressure, for a period of 24 h, does not exceed 22 hPa;
- the average value of the relative humidity, for a period of one month, does not exceed 90 %;
- the average value of the water vapour pressure, for a period of one month, does not exceed 18 hPa.

For these conditions, condensation may occasionally occur.

NOTE 2 Condensation can be expected where sudden temperature changes occur in periods of high humidity.

NOTE 3 To withstand the effects of high humidity and occasional condensation, such as breakdown of insulation or corrosion of metallic parts, indoor fuses designed for such conditions and tested accordingly or outdoor fuses are an alternative.

NOTE 4 Condensation is prevented by special design of the building or housing, by suitable ventilation and heating of the station or by the use of dehumidifying equipment.

e) Vibrations due to causes external to fuses or earth tremors are negligible.

In addition, for outdoor installations,

f) account should be taken of the presence of condensation or rain and rapid temperature changes;

g) the wind pressure does not exceed 700 Pa (corresponding to 34 m/s wind speed);

h) the solar radiation does not exceed 1,0 kW/m^2.

Applications involving fuse-links in enclosures (fuse enclosure packages) typically satisfy the requirements of “normal service conditions” because the ambient temperature (the temperature outside the enclosure) meets the temperatures in a) of this subclause. However, in an enclosure, surrounding temperatures (see 3.3.11) above 40 °C are to be expected and additional considerations may apply regarding assigning a current carrying capability to the device (see 4.2.4, 4.2.5, 4.2.9.2 and IEC/TR 62655:2013).

For certain fuse-links and applications in enclosures additional tests may be required as covered in this standard in Annex E.

2.2 Special service conditions

2.2.1 General

By agreement between the manufacturer and the user, high-voltage fuses may be used under conditions different from the normal service conditions given in 2.1. For any special service condition, the manufacturer shall be consulted.

2.2.2 Altitude

For installations at an altitude higher than 1 000 m, the required rated insulation withstand level of external insulation shall be determined by multiplying the needed insulation levels at the service location by an altitude correction factor, K_a (> 1) given in column (2) of Table 1. The dielectric withstand voltages of a fuse at a particular altitude may be determined by multiplying its rated insulation withstand levels by $1/K_a$ (< 1), given in column (3) of Table 1.

For altitudes between 1 000 m and 1 500 m and between 1 500 m and 3 000 m, the correction factors may be obtained by linear interpolation between the values in Table 1.

Table 1 – Altitude correction factors – Dielectric withstand

Maximum altitude m (1)	Correction factor for withstand voltages (K_a) (2)	Correction factor applied to rated withstand voltages ($1/K_a$) (3)
1 000	1,0	1,0
1 500	1,05	0,95
3 000	1,25	0,80

Where the dielectric characteristics are identical at any altitude, no special precautions need to be taken.

The current-carrying capability of a fuse may be determined for altitudes exceeding 1 000 m by applying the appropriate factors given in Table 2, column (2) to the rated current or allowable continuous current of the fuse.

For altitudes between 1 000 m and 1 500 m and between 1 500 m and 3 000 m, the correction factors may be obtained by linear interpolation between the values in Table 2.

Table 2 – Altitude correction factors – Current-carrying capability

Maximum altitude m (1)	Correction factor for current-carrying capability (2)
1 000	1,0
1 500	0,99
3 000	0,96

2.3 Environmental behaviour

Fuses complying with this standard are inert devices during normal service. It is also a requirement of 5.1.3 that no significant external emission takes place. Therefore, they are regarded as environmentally safe devices in service and operation.

3 Definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Electrical characteristics

3.1.1
rated value
value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system

NOTE 1 to entry: Examples of rated values usually stated for fuses include, voltage, current and breaking current.

[SOURCE: IEC 60050-441:2000, 441-18-35, modified –"used for specification purposes" and "system" added]

3.1.2
rating
set of rated values and operating conditions

[SOURCE: IEC 60050-441:2000, 441-18-36]

3.1.3
prospective current (of a circuit and with respect to a fuse)
current that would flow in the circuit if the fuse were replaced by a conductor of negligible impedance

NOTE 1 to entry: For the method to evaluate and to express the prospective current, see 6.6.2.1 and 6.6.2.2.

[SOURCE: IEC 60050-441:2000, 441-17-01, modified –"each pole of the switching device or" has been deleted and "is to be specified in the relevant publications" has been deleted and "see 6.6.2.1 and 6.6.2.2" has been added.]

3.1.4
prospective peak current
peak value of a prospective current during the transient period following initiation

NOTE 1 to entry: The definition assumes that the current is made by an ideal switching device, i.e. with instantaneous transition from infinite to zero impedance. For circuits where the current can follow several different paths, for example polyphase circuits, it further assumes that the current is made simultaneously in all poles, even if only the current in one pole is considered.

[SOURCE: IEC 60050-441:2000, 441-17-02]

3.1.5
prospective breaking current
the RMS value of the AC component of the prospective current, evaluated at a specified time

NOTE 1 to entry: This specified time is given in 6.6.2.3.

3.1.6
breaking capacity
value of prospective current that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

[SOURCE: IEC 60050-441:2000, 441-17-08, modified – "switching device or a fuse" replaced with "fuse-link" and Notes removed]

3.1.7
cut-off current;
let-through current
maximum instantaneous value of current attained during the breaking operation of a fuse

NOTE 1 to entry: This concept is of particular importance when the fuse operates in such a manner that the prospective peak current of the circuit is not reached.

[SOURCE: IEC 60050-441:2000, 441-17-12, modified – "a switching device or" deleted]

3.1.8
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

[SOURCE: IEC 60050-441:2000, 441-18-21]

3.1.9
arcing time
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

[SOURCE: IEC 60050-441:2000, 441-17-37, modified – references to "poles" removed.

3.1.10
operating time;
clearing time
sum of the pre-arcing time and the arcing time

[SOURCE: IEC 60050-441:2000, 441-18-22]

3.1.11
***I*²*t*;**
Joule integral
integral of the square of the current over a given time interval $t_0 - t_1$

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

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

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

NOTE 3 to entry: The energy in joules liberated in 1 Ω of resistance in a circuit protected by a fuse is equal to the value of the operating I^2t expressed in $A^2 \times s$.

[SOURCE: IEC 60050-441:2000, 441-18-23]

3.1.12
virtual time
value of Joule integral divided by the square of the value of the prospective current

NOTE 1 to entry: The values of virtual times usually stated for a fuse-link are the values of pre-arcing time and of operating time.

[SOURCE: IEC 60050-441:2000, 441-18-37]

3.1.13
time-current characteristic
curve giving the time, for example pre-arcing time or operating time, as a function of the prospective current under stated conditions of operation

[SOURCE: IEC 60050-441:2000, 441-17-13]

3.1.14
cut-off (current) characteristic;
let-through (current) characteristic
curve giving the cut-off current as a function of the RMS prospective current, under stated conditions of operation

NOTE 1 to entry: The values of the cut-off currents are the maximum values that can be reached whatever the degree of asymmetry.

[SOURCE: IEC 60050-441:2000, 441-17-14, modified – "RMS" added, and references relating to direct currents removed from the note to entry]

3.1.15
recovery voltage
voltage which appears across the terminals of a fuse after the breaking of the current

NOTE 1 to entry: This voltage may be considered in two successive intervals of time, one during which a transient voltage exists, followed by a second one during which the power frequency recovery voltage alone exists.

[SOURCE: IEC 60050-441:2000, 441-17-25, modified – "a pole of a switching device or" removed and "or the steady-state" removed from the Note to entry)]

382

383 **3.1.16**
384 **transient recovery voltage**
385 **TRV** (abbreviation)

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

387 NOTE 1 to entry: The transient recovery voltage may be oscillatory or non-oscillatory or a combination of these
388 depending on the characteristics of the circuit and the fuse. It includes the voltage shift of the neutral point of a
389 polyphase circuit.

390 NOTE 2 to entry: The transient recovery voltage in three-phase circuits is, unless otherwise stated, that across
391 the first fuse to clear, because this voltage is generally higher than that which appears across each of the other
392 two fuses.

393 [SOURCE: IEC 60050-441:2000, 441-17-26, modified – “switching device” and “pole” replaced
394 by “fuse” in the Notes to entry]

395 **3.1.17**
396 **power-frequency recovery voltage**
397 recovery voltage after the transient voltage phenomena have subsided

398 [SOURCE: IEC 60050-441:2000, 441-17-27]

399 **3.1.18**
400 **prospective transient recovery voltage** (of a circuit)
401 transient recovery voltage following the breaking of the prospective symmetrical current by an
402 ideal switching device

403 NOTE 1 to entry: The definition assumes that the fuse, for which the prospective transient recovery voltage is
404 sought, is replaced by an ideal switching device, i.e. having instantaneous transition from zero to infinite
405 impedance at the very instant of zero current, i.e. at the "natural" zero. For circuits where the current can follow
406 several different paths, for example a polyphase circuit, the definition further assumes that the breaking of the
407 current by the ideal switching device takes place only in the pole considered.

408 [SOURCE: IEC 60050-441:2000, 441-17-29, modified – “switching device or” removed from
409 note to entry]

410 **3.1.19**
411 **switching voltage**
412 maximum instantaneous value of voltage which appears across the terminals of a fuse during
413 its operation

414 NOTE 1 to entry: The switching voltage may be the arc voltage or may occur during the time of transient recovery
415 voltage.

416 [SOURCE: IEC 60050-441:2000, 441-18-31]

417 **3.1.20**
418 **minimum breaking current**
419 minimum value of prospective current that a fuse-link is capable of breaking at a stated
420 voltage under prescribed conditions of use and behaviour

421 [SOURCE: IEC 60050-441:2000, 441-18-29]

422 **3.1.21**
423 **power dissipation** (in a fuse-link)
424 power released in a fuse-link carrying a stated value of electric current under prescribed
425 conditions of use and behaviour

426 NOTE 1 to entry: Prescribed conditions of use and behaviour generally include a constant RMS value of the
427 electric current after steady-state temperature conditions are reached.

428 [SOURCE: IEC 60050-441:2000, 441-18-38]

429 **3.1.22**
430 **maximum breaking current**
431 maximum value of prospective current that a fuse-link is capable of breaking at a stated
432 voltage under prescribed conditions of use and behaviour

3.1.23

lightning impulse

voltage pulse of a specified shape applied during dielectric tests with a virtual front duration of the order of 1 µs and a time to half value of the order of 50 µs

Note 1 to entry: The lightning impulse is defined by the two figures giving these durations in microseconds; in particular the standard lightning impulse is 1,2/50 µs.

[SOURCE: IEC 60050-614:2016, 441-03-28]

3.1.24
basic impulse insulation level (BIL)
previously used term (still in common usage) for rated lightning impulse withstand voltage

3.2 Fuses and their component parts

3.2.1
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

[SOURCE: IEC 60050-441:2000, 441-18-01]

3.2.2
terminal
conducting part of a fuse provided for an electric connection to external circuits

NOTE 1 to entry: Terminals may be distinguished according to the kind of circuits for which they are intended (for example, main terminal, earth terminal, etc.), but also according to their design (for example, screw terminal, plug terminal, etc.).

3.2.3
fuse-base
fuse-mount
fixed part of a fuse provided with contacts and terminals

NOTE 1 to entry: The fuse-base comprises all the parts necessary for insulation (see Figure 1).

[SOURCE: IEC 60050-441:2000, 441-18-02, modified – Note 1 to entry added)]