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REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

Miniature fuses –
Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links

IEC 60127-1:2023-10 RLV(en)

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 60127-1:2006+AMD1:2011+AMD2:2015 CSV. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 60127-1 has been prepared by subcommittee 32C: Miniature fuses, of IEC technical committee 32: Fuses. It is an International Standard.

This third edition cancels and replaces the second edition published in 2006, Amendment 1:2011 and Amendment 2:2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) modification of 6.3 to clarify the marking items;
b) modification of 9.3.1 to introduce a tolerance for the prospective current for the breaking capacity test;
c) deletion of contents of 9.6, Pulse test;
d) deletion of Annex C;
e) addition of new Annex C user guide for miniature fuse-links.

The text of this International Standard is based on the following documents:

Draft	Report on voting
32C/615/FDIS	32C/624/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60127 series, published under the general title *Miniature fuses*, can be found on the IEC website.

This Part 1 of the IEC 60127 series covers definitions, general requirements and tests applicable to all types of miniature fuses (e.g. cartridge fuse-links, sub-miniature fuse-links, universal modular fuse-links and miniature fuse-links for special applications). All subsequent parts of the complete series are to be read in conjunction with this Part 1.

IEC 60127 consists of the following parts:

IEC 60127-1, *Miniature fuses – Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links*

IEC 60127-2, *Miniature fuses – Part 2: Cartridge fuse-links*

IEC 60127-3, *Miniature fuses – Part 3: Sub-miniature fuse-links*

IEC 60127-4, *Miniature fuses – Part 4: Universal modular fuse-links (UMF) – Through-hole and surface mount types*

IEC 60127-5, *Miniature fuses – Part 5: Guidelines for quality assessment of miniature fuse-links*

IEC 60127-6, *Miniature fuses – Part 6: Fuse-holders for miniature fuse-links*

IEC 60127-7, *Miniature fuses – Part 7: Miniature fuse-links for special applications*

IEC 60127-8, *Miniature fuses – Part 8: Fuse resistors with particular overcurrent protection*

IEC 60127-9, (free for further documents)

IEC 60127-10, Moved to IEC 60127-1 as Annex C.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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MINIATURE FUSES –

Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links

1 Scope and object

This part of IEC 60127 covers the general requirements and tests applicable to all types of miniature fuse-links (e.g. cartridge fuse-links, sub-miniature fuse-links, universal modular fuse-links and miniature fuse-links for special applications) for the protection of electric appliances, electronic equipment and component parts thereof normally intended to be used indoors.

This document does not apply to fuses intended for the protection of low-voltage electrical installations. These are covered by IEC 60269, *Low Voltage Fuses*.

Specific details covering each major subdivision are given in subsequent parts.

This document does not apply to fuses for appliances intended to be used under special conditions, such as in a corrosive or explosive atmosphere.

The object of this document is

a) to establish uniform requirements for miniature fuses so as to protect appliances or parts of appliances in the most suitable way,
b) to define the performance of the fuses, so as to give guidance to designers of electrical appliances and electronic equipment and to ensure replacement of fuse-links by those of similar dimensions and characteristics,
c) to define methods of testing,
d) to define maximum sustained dissipation of fuse-links to ensure good compatibility of stated power acceptance when used with fuse-holders according to this document (see IEC 60127-6).

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 60038, *IEC standard voltages*

IEC 60127-6:~~1994~~2014, *Miniature fuses – Part 6: Fuse-holders for miniature fuse-links*
~~Amendment 1 (1996)~~
~~Amendment 2 (2003)~~

3 Terms and 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
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

Note 1 to entry: The fuse comprises all the parts that form the complete device.

3.2
miniature fuse
fuse in which the fuse-link is a miniature fuse-link

3.3
fuse-link
part of a fuse including the fuse-element(s) intended to be replaced after the fuse has operated

3.4
enclosed fuse-link
fuse-link in which the fuse-element is totally enclosed, so that during operation within its rating it cannot produce any harmful external effects, e.g. due to development of an arc, the release of gas or the ejection of flame or metallic particles

3.5
miniature fuse-link
enclosed fuse-link for the protection of electric appliances, electronic equipment and component parts thereof normally intended to be used indoors

3.5.1
cartridge fuse-link
enclosed miniature fuse-link of rated breaking capacity not exceeding 2 kA and which has at least one of its principle dimensions not exceeding 10 mm

Note 1 to entry: Principle dimensions are length, width, height and diameter.

3.5.2
miniature fuse-link for special applications
enclosed miniature fuse-link which is not covered in IEC 60127-2, IEC 60127-3 or IEC 60127-4 and of rated breaking capacity not exceeding 50 kA and having a width and height not exceeding 12 mm and a length not exceeding 50 mm

3.5.3
sub-miniature fuse-link
miniature fuse-link of which the case (body) has no principal dimension exceeding 10 mm

Note 1 to entry: Principal dimensions are length, width, height and diameter.

3.5.4
universal modular fuse-link
miniature fuse-link primarily adapted for direct electrical connection to printed circuit boards or other conductive substrates, incorporating features designed to provide a degree of non-interchangeability where necessary

3.6
fuse-link contact
conductive part of a fuse-link designed to engage with a fuse-base contact or with a fuse-carrier contact

3.7
fuse-holder
combination of a fuse-base with its fuse-carrier

3.8
fuse-base
fuse-mount
fixed part of a fuse provided with contacts and terminals for connection to the system

3.9
fuse-base contact
fuse-mount contact
conductive part of a fuse-base, connected to a terminal designed to engage with a fuse-carrier contact or with a fuse-link contact

3.10
fuse-carrier
movable part of a fuse designed to carry a fuse-link

3.11
fuse-carrier contact
conductive part of a fuse-carrier connected to a fuse-link contact and designed to engage with a fuse-base contact

3.12
fuse-element
part of the fuse-link designed to melt when the fuse operates

3.13
homogeneous series (of fuse-links)
series of fuse-links, 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 the series may be taken as representative of all the fuse-links of the series

Note 1 to entry: Fuse-links are considered as forming a homogeneous series when the characteristics comply with the following:

– the bodies have the same dimensions, material and method of manufacture;
– the caps or other end closures of the body have the same dimensions, materials and method of attachment and sealing;
– the granular filler, if any, of the body is of the same material and completeness of filling. It should be of the same size or any variation of the grain size with current rating should be monotonous;
– the fuse-elements are of the same material with the same principles of design and construction; any changes of fuse-element dimensions with current rating should be monotonous;
– the rated voltage is the same;
– for low-breaking capacity fuse-links it is only necessary to test the highest rated breaking capacity in a homogeneous series.

3.14
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 fuse is designed

Examples of rated values usually stated for fuses:

– voltage (U_N);

– current (I_N);

– breaking capacity.

3.15
time/current characteristics (of a fuse-link) for AC
curve giving, under stated conditions of operation, the value of time expressed as virtual time as a function of the prospective symmetrical current, expressed as the RMS value

Note 1 to entry: Time/current characteristics usually stated for a fuse-link relate to the pre-arcing time and the operating time.

3.15.1 time/current characteristics (of a fuse-link) for DC
curve giving, under stated conditions of operation, the value of time expressed as actual time as a function of the DC prospective current

Note 1 to entry: Time/current characteristics usually stated for a fuse-link relate to the pre-arcing time and the operating time.

3.16
conventional non-fusing current
value of current specified as that which the fuse-link is capable of carrying for a specified time (conventional time) without melting

3.17
prospective current (of a circuit and with respect to a fuse)
current that would flow in a circuit, if a fuse situated therein were replaced by a link of negligible impedance

3.18
pre-arcing time (melting time)
interval of time between the beginning of a current large enough to cause a break in the fuse-element and the instant when an arc is initiated

3.19
arcing time
interval of time between the instant of the initiation of the arc and the instant of final arc extinction

3.20
operating time (total clearing time)
sum of the pre-arcing time and the arcing time

3.21
virtual time
value of I^2t divided by the value of the square of the value of the prospective current

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

3.22
***I^2t* (joule integral)**
integral of the square of the current over a given time interval:

$$I^2t = \int_{t=0}^{t} i^2 dt$$

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 released 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^2s.

3.23
breaking capacity of a fuse-link
value (RMS for AC) of prospective current that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

3.24
recovery voltage
voltage which appears across the terminals of a fuse after 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 or the steady-state recovery voltage exists.

3.25
maximum sustained power dissipation
power dissipation of a fuse-link measured under prescribed conditions of measurement at the maximum current level that can be sustained for a minimum of 1 h or, as specified in the standard sheet for ratings above 6,3 A

Note 1 to entry: The figure for maximum sustained dissipation is used in connection with the maximum power acceptance of fuse-holders for miniature fuse-links in accordance with IEC 60127-6.

Note 2 to entry: These values are often exceeded for short periods of time immediately before the fuse-element melts. Values as high as twice the maximum sustained dissipation have been recorded.

4 General requirements

Fuse-links shall be so constructed that they are reliable and safe in operation and consistent in performance at any current up to and including the breaking capacity rating and at any voltage up to the rated voltage, when used within the limits of this document.

During normal use of the fuse-link and within the conditions given in this standard, no permanent arc, no external arcing, nor any flame that can endanger the surroundings, shall be produced. During the test for establishing the maximum sustained dissipation and after operation, the fuse-link shall not have suffered damage hindering its replacement and the marking shall still be legible.

In general, compliance is checked by carrying out all the tests specified.

5 Standard ratings

In the relevant standard sheets, values are given for

– rated voltage,
– rated current,
– rated breaking capacity.

6 Marking

6.1 Unless otherwise stated in subsequent parts, the requirements for marking are as follows:

Each fuse-link shall be marked with the below in the order given:

a) A symbol denoting the relative pre-arcing time/current characteristic as given in the relevant standard sheet. This symbol shall be placed before and adjacent to the rated current.

These symbols read as follows:

FF: denoting very quick acting
F: denoting quick acting
M: denoting medium time-lag
T: denoting time-lag
TT: denoting long time-lag.

b) Rated current in milliamperes (mA) for rated currents below 1 A, and in amperes (A) for rated currents of 1 A or more. ~~The marking of the rated current shall precede and be adjacent to the marking of the rated voltage.~~

To accommodate existing practice in some countries, for the time being, the current may also be indicated in fractions of ampere.

c) Rated voltage in volts (V).

d) ~~Maker's~~ Manufacturer's name or trade mark (does not need to follow order of marking).

6.2 Marking shall be indelible and easily legible.

Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked in water and again for 15 s with a piece of cloth soaked in petroleum spirit.

~~NOTE 1~~ For petroleum spirit the use of an aliphatic solvent hexane, with an aromatics content of maximum 0,1 % volume, a kauri-butanol value of 29, initial boiling point approximately 65 °C, dry-point approximately 69 °C and specific gravity of approximately 0,68 is recommended.

NOTE ~~2~~ In the case of colour coding, the test for indelibility need not be applied.

6.3 The marking according to 6.1 shall be printed on the packing label along with a reference to the subsequent IEC 60127 standard and appropriate standard sheet. It is optional to indicate IEC 60127-1 on the packing label. The marking on the packing label shall include the abbreviation A ~~and~~ or mA for the current rating of the fuse-link.

Compliance is checked by inspection.

6.4 Further identification of the current rating and the time/current characteristics by means of colour bands may be used.

Such an additional marking shall be in accordance with Annex A.

6.5 Where marking is impractical due to space limitations, the relevant information shall appear on the smallest package and in the manufacturer's technical literature.

7 General notes on tests

7.1 General

Tests according to this document are type tests.

It is recommended that where acceptance tests are required, they are chosen from the type tests in this document.

7.2 Atmospheric conditions for testing

7.2.1 Unless otherwise specified in subsequent parts, all tests shall be carried out under the following atmospheric conditions:

– temperature between 15 °C and 35 °C;
– relative humidity between 45 % and 75 %;
– air pressure between 8,6 × 10^4 Pa and 1,06 × 10^5 Pa.

Where the above-mentioned conditions have a significant influence, they shall be kept substantially constant during the tests.

Fuse-links shall be tested in the specified bases in free air, and be protected from draughts and direct heat radiation. The position of the fuse-holder shall be horizontal.

If temperature has a marked effect on the results of the tests, these shall be performed at a temperature of 23 °C ± 1 °C.

7.2.2 In every test report, the ambient temperature shall be stated. If the standard conditions for relative humidity or pressure are not fulfilled during tests, a note to this effect shall be added to the report.

Where tests are required at elevated temperatures, these tests shall be carried out at an ambient temperature of 70 °C ± 2 °C, unless otherwise specified.

7.3 Type tests

7.3.1 The number of fuse-links required shall be specified in subsequent parts.

Fuse-links shall be tested or inspected in accordance with the following subclauses:

a) Marking (see 6.1)
b) Dimensions (see 8.1)
c) Construction (see 8.2)
d) Voltage drop (see 9.1)

with such additional tests as are specified in subsequent parts.

7.3.2 Based on the results of the test in item 7.3.1 d), the fuse-links shall be sorted in descending order of voltage drop, and numbered consecutively, lower numbers being allocated to the fuse-links having the highest voltage drop. Tests from these fuse-links shall then be made in accordance with the relevant testing schedule.

If a test is to be repeated, spare fuse-links having approximately the same voltage drop as the original fuse-links shall be used for the repeat test.

7.3.3

a) No failure is allowed in any of the tests covered by Clauses 6 and 8, nor those described in 9.1, 9.2.2 and 9.7 and such additional clauses and subclauses as shall be specified in subsequent parts.

b) If in the tests covered by 9.2.1 and 9.3, two failures occur at any one test current, the fuse-links are deemed not to comply with this document. If, however, one failure occurs, the test shall be repeated on twice the number of fuse-links, at the same current and a second failure shall be a cause for rejection.

   If two failures occur, but not both in the same test, the fuse-link shall be deemed to comply provided that there are no further failures in repeat tests with twice the number of fuse-links.

   If two failures occur, but not both in the same current, the fuse-link shall be deemed to comply provided that there are no further failures in repeat tests with twice the number of fuse-links.

c) In each of the tests according to 9.4, 9.5 and 9.6, one failure is allowed. If two or more fuse-links fail in any one test, the fuse-links are deemed not to comply with this standard, unless otherwise specified in subsequent parts.

7.4 Fuse-bases for tests

For tests that require a fuse-base for mounting the fuse-links, a base according to the requirements specified in subsequent parts shall be used.

7.5 Nature of supply

The nature of the supply for the electrical tests is specified in the relevant clauses or in the relevant standard sheets in subsequent parts.

For AC, the test voltage is of substantially sinewave form with a frequency between 45 Hz and 62 Hz.

8 Dimensions and construction

8.1 Dimensions

The dimensions of the fuse-links shall comply with the relevant standard sheet, given in subsequent parts.

Compliance is checked by measurement.

8.2 Construction

The fuse-element shall be completely enclosed. Further details of the construction are given, as appropriate, in subsequent parts.

8.3 Terminations

Fuse-link contacts shall be made of non-corroding material or of material suitably protected against corrosion, and shall be effectively free from flux or other non-conducting substance on their outer surfaces.

Nickel or silver plating is deemed to be adequate protection for brass end caps.

Tests for firm attachment are given, where appropriate, in subsequent parts.

8.4 Alignment and configuration of terminations

Appropriate tests for alignment or position of pins, etc., as applicable, are given in subsequent parts.

8.5 Soldered joints

Externally visible soldered joints (e.g., on end caps) shall not melt during normal use and operation.

Compliance is checked by inspection of the soldered joints after the tests described in 9.2.1, 9.2.2, 9.4, 9.5 and 9.6.

9 Electrical requirements

9.1 Voltage drop

The voltage drop across the fuse-links at their rated current shall not exceed the maximum values given on the relevant standard sheet.

Individual values shall not deviate from the mean value determined for the model under test during type tests by more than 15 %.

~~NOTE 1 Attention is drawn to the fact that the second paragraph is based on the assumption that the fuse-links, which are submitted to a type test, belong to the same manufacturing batch. Where samples are drawn at random, the condition for the permitted deviation from the mean value need not be fulfilled.~~ If, due to the Peltier effect, different voltage drops are measured when the current through the fuse-link is reversed, the highest value shall be taken.

Compliance is checked by measuring the voltage drop when the fuse-link has carried its rated current for a time sufficient to reach temperature stability.

Direct current shall be used for this test; equipment shall be used which does not influence the result of the test significantly.

Temperature stability is considered to be reached when the voltage drop changes by less than 2 % of the previously observed value per minute. During this test, the current through the fuse-link shall not deviate by more than ±1 % from the rated current and the accuracy of the voltage drop measurement shall be within a tolerance of ±1 %.

~~NOTE 2~~ Problems can arise when fuse-links are used at voltages considerably lower than their rated voltage, mainly for low ratings. Due to the increase of the voltage drop when the element of a fuse-link approaches its melting point, care should be taken to ensure that there is sufficient circuit voltage available to cause the fuse-link to interrupt the current when an electrical fault occurs. Furthermore, fuse-links of the same type and rating ~~may~~ might, due to difference in design or element material, have different voltage drops and ~~may~~ might therefore not be interchangeable in practice when used in applications with low circuit voltages, especially in combination with fuse-links of lower rated currents.

9.2 Time/current characteristic

9.2.1 Time/current characteristic at normal ambient temperature

The time/current characteristic shall be within the limits specified in the relevant standard sheets.

Compliance is checked by measuring the pre-arcing time under the atmospheric conditions mentioned in 7.1.

The current through the fuse-link shall be adjusted to within ±1 % of the required value. The current stability during the test shall be maintained within ±1 % of the adjusted value. The voltage of the source shall not exceed the rated voltage of the fuse-link under test. The accuracy of the measurement of time shall be within a tolerance of ±5 % for times of less than 10 s and ±2 % for times of 10 s or more.

In the case of very short pre-arcing times at high levels of the current where constant current no longer can be maintained, the I^2t value should shall be measured and the virtual time be calculated.

9.2.2 Test at elevated temperature

When specified on the standard sheet, fuse-links shall also be tested for 1 h at an ambient temperature 70°C, unless otherwise specified, and with the multiple of the rated current as specified on the relevant standard sheet.

The current stability during the test shall be maintained within ±2,5 % of the adjusted value. The fuse-link shall not operate.

9.2.3 Test procedure

Direct current shall be used for these tests.

NOTE 1 Direct current is used because it is easier to control and eliminates the variation inherent with alternating current caused by the point on the voltage wave that switching occurs.

NOTE 2 Care should be taken that the arcing time is not included in the total time measured

The output voltage of the current source shall be sufficient to limit the variation of current during the pre-arcing time. Additionally, the output voltage shall not exceed a value declared by the manufacturer and chosen from the list of DC voltages in Table 6 of IEC 60038:2009.

The time constant of the circuit shall not exceed 3 % of the pre-arcing time.

Where there is a possible influence of the Peltier effect, care should shall be taken to reverse the direction of the current passing through the fuse-link for each successive sample.

NOTE 3 Where the influence of the Peltier effect is essentially due to the construction, the time/current characteristic should be tested with twice the number of fuse-links at 2,0 I_N or 2,1 I_N. The additional samples may be taken from the spare fuse-links.

Attention is drawn to the fact that, for certain types of fuse-links, the time/current characteristic with AC can be significantly different from the characteristic determined with DC and particularly with currents just exceeding the conventional non-fusing current.

Furthermore, it should be noted that due to the small thermal inertia of the fuse-elements for low currents, the characteristic of the fuse-links may might change considerably at very low frequencies.

9.2.4 Presentation of results

If the time/current characteristics with the current as independent variable are plotted, it is preferred that they are presented with logarithmic scales on both co-ordinate axes. The basis of the logarithmic scales shall be in the ratio 2:1 with the longer dimension on the abscissa.

If the multiple of the rated current is used as the independent variable, the ratio shall be 3:1.

NOTE Examples of such formats are given in Annex B.

9.3 Breaking capacity

9.3.1 General

When requested by the manufacturer, additional testing of breaking capacities to values (prospective current) higher than those stated in subsequent parts is permitted if all requirements of subsequent parts are met.

9.3.2 Operating conditions

Fuse-links shall operate satisfactorily without ~~endangering the surroundings~~ producing any harmful external effects (i.e. development of an external arc, release of gas or ejection of flame or metallic particles) when breaking prospective currents between the conventional non-fusing current and rated breaking capacity in accordance with the relevant standard sheets in subsequent parts.

The recovery voltage shall be between 1,02 and 1,05[1] times the rated voltage of the fuse-links and shall be maintained for 30 s after the fuse has operated.

Typical test circuits are given in subsequent parts.

For the breaking capacity test, the current shall be adjusted by changing the series resistance.

The impedance of the AC source shall be less than 10 % of the adjusted value of the total impedance of the applicable circuit.

Compliance is checked by either method A or method B.

1) **Method A** (individual ratings)
   a) rated breaking capacity;
   b) prospective currents of approximately 5, 10, 50 and 250 times the rated current, but not exceeding the rated breaking capacity as specified in the relevant standard sheet.

      The circuit shall be closed at (30 ± 5)° after the passage of voltage through zero.
2) **Method B** (homogeneous series)
   a) rated breaking capacity with random closing angle;
   b) fuse-links shall be tested at rated breaking capacity.

NOTE ~~1~~ The breaking capacity ~~may~~ can be lower with DC than with AC. It is influenced by the circuit inductance and, with AC, additionally by the instant of closing the circuit.

~~NOTE 2~~ The DC value, if required by the purchaser or user, should be specified by the manufacturer.

The prospective current of 5, 10, 50, 250 times the rated current as well as the rated breaking capacity shall be adjusted within a tolerance found in Table 1.

[1] This tolerance may be exceeded with the manufacturer's consent.

Table 1 – Prospective current/Breaking Capacity Tolerance

Prospective current / Rated Breaking Capacity (A)	Tolerance (%)
< 200	-0, +2
200 to 1 500	-0, +5
> 1 500	-0, +10

The tolerance in Table 1 may be exceeded with the manufacturer's consent.

More details of appropriate tests for the breaking capacity of each type of miniature fuse ~~may~~ can be found in the subsequent parts.

9.3.3 Criteria for satisfactory performance

In each of the tests, the fuse-link shall operate satisfactorily without any of the following phenomena:

– permanent arcing;

– ignition;

– bursting of the fuse-link.

Additional criteria for satisfactory performance of individual types of miniature fuse-links are given, where appropriate, in subsequent parts.

NOTE Changes in colour are not considered as a failure.

~~Criteria concerning switching overvoltages are under consideration.~~

9.3.4 Insulation resistance

After the breaking capacity test, the insulation resistance between the fuse-link terminations shall be measured with a DC voltage equal to twice the rated voltage of the fuse-link, but not less than 250 V. The resistance shall be not less than 0,1 MΩ.

9.3.5 Type test for fuse-links of homogeneous series

Fuse-links having the largest rated current shall be tested completely according to the relevant testing schedule for the maximum ampere rating of a homogeneous series given in the subsequent parts.

Fuse-links having the smallest rated current shall be tested according to the relevant testing schedule for the minimum ampere rating of a homogeneous series given in the subsequent parts.

9.4 Endurance tests

Fuse-links shall be so constructed as to prevent in extended normal use any electrical or mechanical failure impairing their compliance with this document.

Compliance is checked by the following test:

Direct current shall be used for this test, unless otherwise specified in subsequent parts.

a) A current specified in the relevant standard sheet is passed through the fuse-link for a period of 1 h. The current is then switched off for a period of 15 min. This cycle is repeated 100 times.

   The current stability during the test shall be maintained within ±1 % of the adjusted value.

The test ~~should~~ shall be run continuously, but where unavoidable, a single interruption is permitted.

b) A current specified in the relevant standard sheets is then passed through the fuse-link for 1 h, or, as specified in the standard sheet for ratings above 6,3 A. At the end of this test the voltage drop across the fuse-link is measured and used for the calculation of the maximum sustained power dissipation, where this is specified in subsequent parts.

c) Finally, the voltage drop across the fuse-link is measured again according to 9.1. The voltage drop shall not have increased by more than 10 % of the value measured before the test and shall not exceed the maximum value specified in the relevant standard sheet.

d) After the test, the marking shall still be legible and soldered joints on end caps, for example, shall not show any appreciable deterioration.

NOTE Changes in colour are not considered as a failure.

9.5 Maximum sustained dissipation

The values calculated from the measurement taken in accordance with 9.4 b) shall be within the limits specified in the relevant standard sheet.

9.6 ~~Pulse tests~~

~~Where pulse tests are required in subsequent parts, they shall be performed as follows:~~

~~**Pulse tests at normal ambient temperature**~~

~~Fuse-links shall be so constructed as to prevent, when subjected to current surges normally experienced in service, any electrical or mechanical failure impairing their compliance with this standard.~~

~~Compliance is checked by the following test:~~

~~a) A current pulse specified in the relevant standard sheet is passed through the fuse-link 1 000 times at the repetition rate specified in the relevant standard sheet. The fuse-link is then allowed to cool for at least 1 h at room temperature.~~

~~b) A current equal to the value specified in the relevant standard sheet is then passed through the fuse-link for the time recommended on the relevant standard sheet.~~

~~c) Finally, the voltage drop across the fuse-link after the test is measured again according to 9.1.~~

~~The voltage drop across the fuse-link after the test shall not have increased by more than 10 % of the value measured before the test.~~

~~d) After the test, the marking shall still be legible and soldered joints on end caps, for example, shall not show any appreciable deterioration.~~

~~NOTE Changes in colour are not considered as a failure.~~

Not applicable

9.7 Fuse-link temperature

Where temperature tests are required in subsequent parts, they shall be performed as follows:

The temperature rise, as measured at any location on the fuse-link enclosure or fuse-link terminations, shall not exceed 135 K when the fuse-link is tested as follows:

– the initial current shall be as specified in the relevant standard sheet;
– the initial current shall be applied for 15 min;

– after the first 15 min, the current shall be increased by 0,1 I_N every 15 min until the fuse-link operates;
– the temperature of the fuse-link shall be measured continuously;
– the point for measuring the temperature shall be the hottest location.

~~NOTE 1~~ Due to the difficulty of specifying the location of the hottest point, it should be determined during the initial 15 min.

~~NOTE 2~~ A thermocouple or other measuring methods that do not appreciably affect the temperature shall be used to measure the temperature rise.

The test base for mounting and connection of the fuse-link shall be in accordance with 7.3.

Annex A
(informative)

Colour coding for miniature fuse-links

Where colour bands are used for additional identification of the current rating and the time/current characteristics, the following system shall be applied:

a) The miniature fuse-links specified in the relevant standard sheets are provided with four colour bands, the first three identifying the rated current expressed in milliamperes and the last, broader, colour band identifying the time/current characteristics.

b) The colour bands shall extend over at least half the circumference of the fuse body and shall be evenly spaced and clearly separated as indicated in Figure A.1.

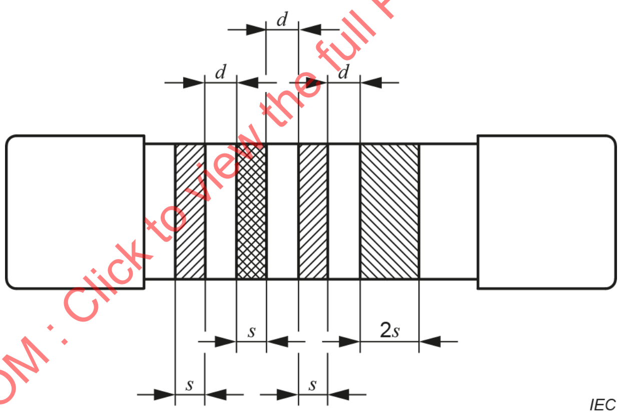
NOTE 1 In the case of transparent miniature fuse-links, the spacings still allow for the visibility of the fuse-element.

c) The IEC standards with regard to colour coding practices, i.e. IEC 60062 and IEC 60425, shall be used as far as applicable.

d) The colour code system given in Table A.1 shall be used.

NOTE 2 In Table A.1, both series R 10 and R 20 are given with their corresponding colour code. In order to keep the number of colour bands to a minimum, only the first two colour bands are used for identifying the first two digits.

e) In addition to the requirements given in 6.3, it is recommended to print the relevant colour coding of the contents on the packing also.



NOTE The values for *d* and *s* are given in subsequent parts.

Figure A.1 – Layout of colour bands

Table A.1 – Colour coding for miniature fuse-links

Rated current	First band colour	Second band colour	Third band		Fourth band time/current characteristic
mA			Colour	Multiplier	
25 *	Red	Green	Black	10^0	FF (0) = black
32 *	Orange	Red	«	10^0	F (2) = red
40 *	Yellow	Black	«	10^0	M (4) = yellow
50 *	Green	Black	«	10^0	T (6) = blue
56	Green	Blue	«	10^0	TT (8) = grey
63 *	Blue	Orange	«	10^0	
71	Violet	Brown	«	10^0	
80 *	Grey	Black	«	10^0	
90	White	Black	«	10^0	
100 *	Brown	Black	Brown	10^1	
112	Brown	Brown	«	10^1	
125 *	Brown	Red	«	10^1	
140	Brown	Yellow	«	10^1	
160 *	Brown	Blue	«	10^1	
180	Brown	Grey	«	10^1	
200 *	Red	Black	«	10^1	
224	Red	Red	«	10^1	
250 *	Red	Green	«	10^1	
280	Red	Grey	«	10^1	
315	Orange	Brown	«	10^1	
355	Orange	Green	«	10^1	
400 *	Yellow	Black	«	10^1	
450	Yellow	Green	«	10^1	
500 *	Green	Black	«	10^1	
560	Green	Blue	«	10^1	
630 *	Blue	Orange	«	10^1	
710	Violet	Brown	«	10^1	
800	Grey	Black	«	10^1	
900	White	Black	«	10^1	
1 000 *	Brown	Black	Red	10^2	
1 120	Brown	Brown	«	10^2	
1 250 *	Brown	Red	«	10^2	
1 400	Brown	Yellow	«	10^2	
1 600 *	Brown	Blue	«	10^2	
1 800	Brown	Grey	«	10^2	
2 000 *	Red	Black	«	10^2	
2 500 *	Red	Green	«	10^2	
3 150 *	Orange	Brown	«	10^2	
4 000 *	Yellow	Black	«	10^2	
5 000 *	Green	Black	«	10^2	
6 300 *	Blue	Orange	«	10^2	
8 000 *	Grey	Black	«	10^2	
10 000 *	Brown	Black	Orange	10^3	

* = R 10 series.

Colour bands indicating rated current based upon first two digits of R 10/R 20 series.

Annex B
(informative)

Example presentations of time/current characteristic

Example presentations of time/current characteristic are shown in Figure B.1 and Figure B.2.

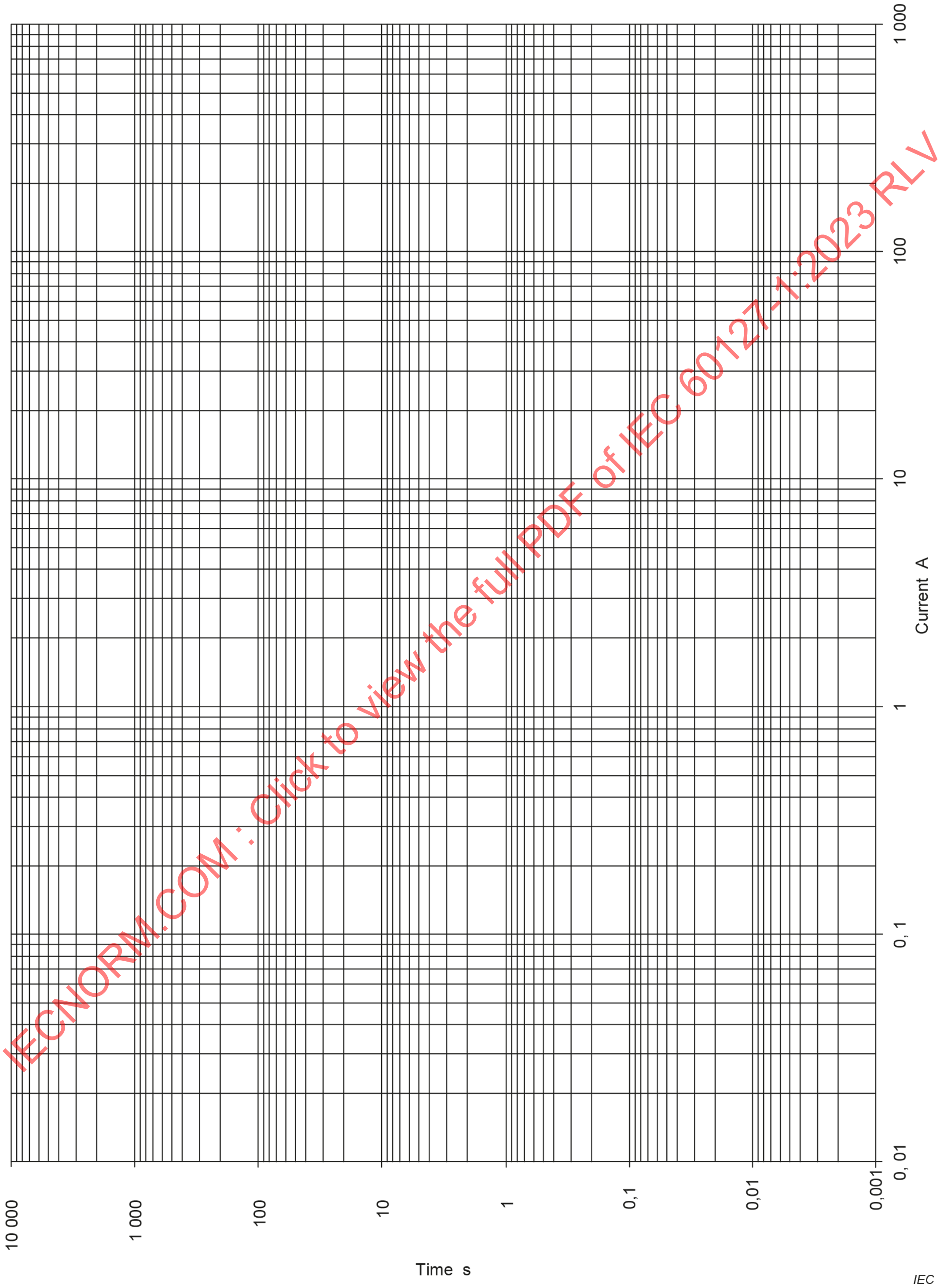


Figure B.1 – Example presentation of time/current characteristic, ratio 2:1

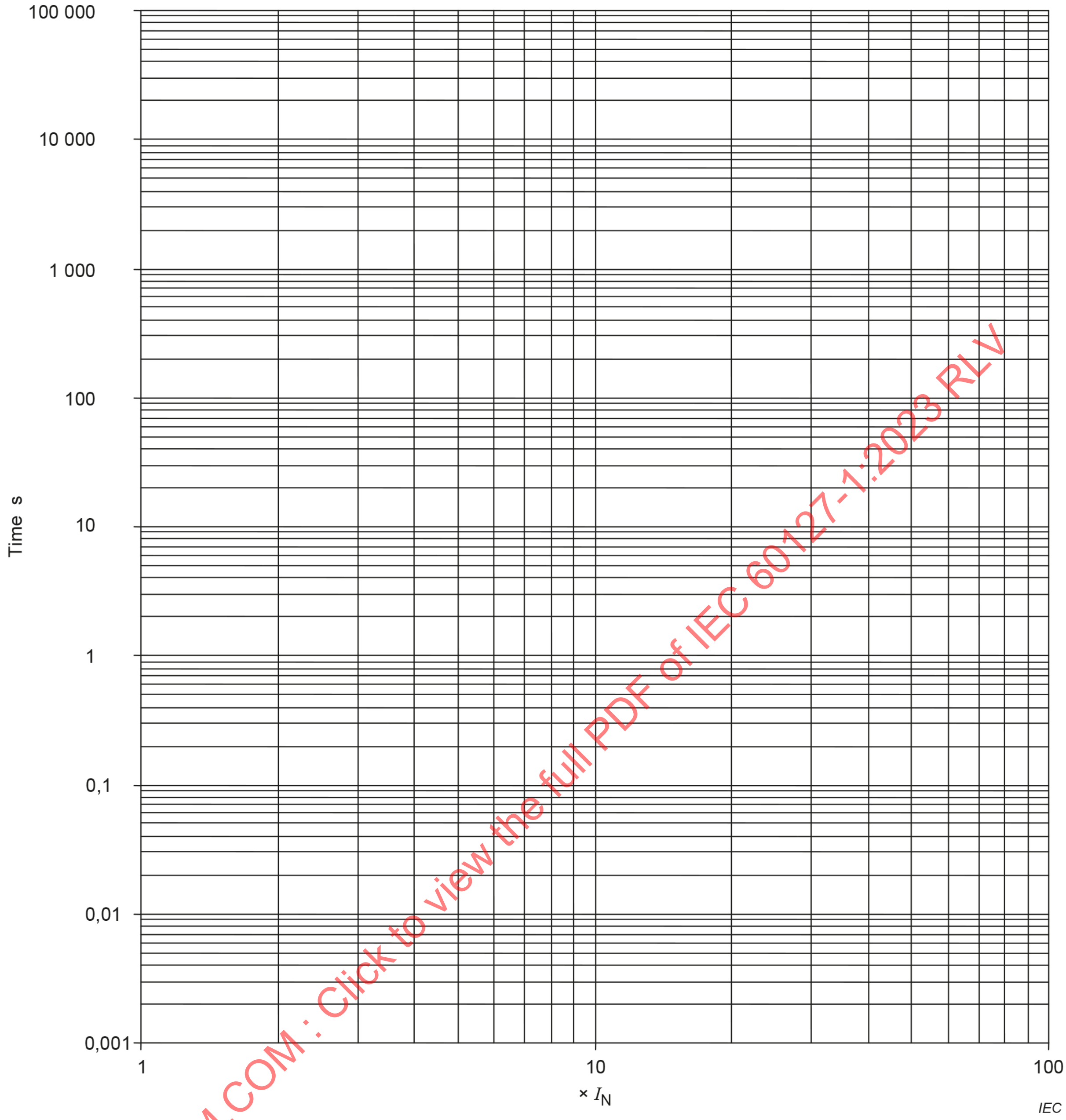


Figure B.2 – Example presentation of time/current characteristic, ratio 3:1

Annex C
(informative)

Audit testing and surveillance – Guidelines for the application of the principles of IECEE 03 (CB-FCS) to miniature fuse-links

~~C.1 Introductory remarks~~

~~This annex contains instructions for audit testing and surveillance of fuse-links. The tests and inspections described in this annex are optional. However, if they are carried out, it is essential that the requirements for audit testing and surveillance are met.~~

~~C.2 Overview~~

~~This annex describes the obligations of the fuse-link manufacturers and the National Certification Body (NCB) for audit testing and surveillance of fuse-link production.~~

~~It covers the preparation of the Conformity Assessment Report and the audit testing and surveillance considered to be the minimum requirements of the NCB. Such inspections, tests and measures are implemented by the NCB as an audit of the means that the manufacturer exercises to determine the conformance of products with the requirements of the appropriate parts of IEC 60127.~~

~~C.3 Terms of reference~~

~~For the purposes of this annex, the following definitions apply.~~

~~**C.3.1**~~
~~**applicant**~~
~~party who requests the conformity assessment, and controls the manufacturing of the product~~

~~**C.3.2**~~
~~**conformity assessment**~~
~~any activity concerned with determining directly or indirectly that relevant requirements are fulfilled~~

~~**C.3.3**~~
~~**significant sample**~~
~~sample taken to be representative of a homogeneous series of fuse-links~~

~~**C.3.4**~~
~~**Conformity Assessment Report**~~
~~a document containing product and factory conformity assessment information issued by Body A to the applicant~~

~~C.4 Conformity Assessment Report~~

~~C.4.1 Product description~~

~~The part of the Conformity Assessment Report regarding product description shall identify only those details of components and dimensions that have a major impact on the performance of the fuse-link. The following are examples of the type of details that may be used to prepare the descriptive part of the Conformity Assessment Report:~~

~~a) **fuse-element:** material, thickness, and diagram of overall shape for every ampere rating;~~

b) **time-delay section:** defines general terms such as spring-loaded, solder slug, etc.; gives details on fusing alloy material, dimensions and any other major components;

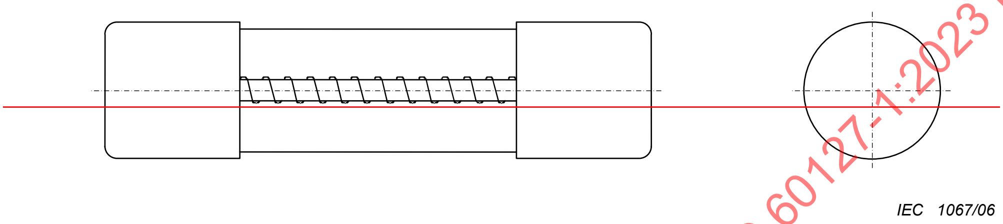
c) **body:** material and minimum wall thickness;

d) **filler:** generic description of filler material; grain size if applicable;

e) **contacts:** material and plating, method of securement, and key dimensions not covered by overall dimension requirements;

f) **miscellaneous:** description of other components which have a major impact on the fuse-link design and performance.

An example of a product description is included in Figure C.1.



Cylindrical fuse-links 20 mm long by 5 mm in diameter containing a wire element helically wound on a ceramic core. The wire element is soldered to the contacts at each end of the fuse-link.

i. **Contacts:** cylindrical end caps of plated or unplated copper alloy with a minimum wall thickness of 0,25 mm.

ii. **Core:** ceramic.

iii. **Fuse-element:** wire helically wound on a supporting core.

Ampere rating: 6,3 A

Wire diameter: 0,40 mm

Basic material: copper alloy

Plating material tin

iv. **Filler:** quartz sand; grain size 100 µm to 300 µm.

v. **Tube:** glass with a minimum wall thickness of 0,50 mm.

vi. **Miscellaneous items:** none.

Figure C.1 – Example of a fuse-link description

C.4.2 Identification of significant samples

When the reduced sampling plan is used, the Conformity Assessment Report shall identify the significant samples that are necessary for testing, chosen on the basis of their representation of a homogeneous series. If a certain fuse-link rating requires no testing or only a partial test programme due to similarities with another fuse-link which is already scheduled for tests, this shall be noted.

C.5 Use of the standard

The requirements of IEC 60127-1 and the relevant subsequent parts shall be applied for the audit testing and surveillance, except where information in the Conformity Assessment Report specifically overrides these requirements. Specific references are noted in Tables C.1 and C.2.

C.6 Audit test and surveillance programme options

Four programme options are available to verify the ability of the applicant to supply fuse-links that continue to meet the requirements of the relevant part of IEC 60127. The applicant shall choose one of these options. The programmes are not intended for combined use, though different programmes may be chosen for different fuse-link series.

Option 1: a complete test programme according to the relevant part of IEC 60127 shall be performed on every ampere rating of each fuse-link series. The complete programme shall be repeated at 10 year intervals according to C.6.1 below.

Option 2: a complete test programme according to the relevant part of IEC 60127 shall be performed on every ampere rating of each fuse-link series. The complete programme shall be repeated at 10 years intervals, and the applicant's quality control system shall be utilized according to C.6.2 below.

Option 3: a test programme which uses the homogeneous series (significant sample) approach shall be performed according to C.6.3 below.

Option 4: a test programme which uses the homogeneous series (significant sample) approach and the applicant's quality control system shall be performed according to C.6.4 below.

The following points apply to each option:

a) the scheduling of the audit testing and surveillance may be staggered;
b) the NCB shall be responsible for surveillance and audit activities;
c) the applicant shall give proof of continuous conformance with the requirements of the appropriate part of IEC 60127;
d) the selection of samples for audit testing and surveillance shall be random, if possible;
e) it is recommended that spare samples be selected for audit testing, in order to reduce the delay if additional tests are needed;
f) utilization by NCB of manufacturer's test facilities:
   1) **testing at manufacturer's premises (TMP):** tests may be carried out by the staff of a CB testing laboratory at the manufacturer's test laboratory under specific rules aimed at verifying compliance.

      Approval by the NCB of the manufacturer's laboratory is not necessary providing the laboratory is currently registered with a duly accredited certification body/registrar;
   2) **supervised manufacturer's testing (SMT):** tests may be carried out (wholly or in part) by the manufacturer's test laboratory providing it has been previously approved by the NCB under specific rules aimed at verifying compliance.

      Approval by the NCB of the manufacturer's laboratory is not necessary providing the laboratory is currently registered with a duly accredited certification body/registrar.

C.6.1 Audit testing and surveillance – Option 1

C.6.1.1 Audit testing

A complete test programme according to the relevant part of IEC 60127 shall be performed on every ampere rating of each fuse-link series. The complete programme shall be repeated at 10 year intervals. These audit tests may be witness testing, re-testing, TMP or SMT.

C.6.1.2 Surveillance

Routine inspection shall take place no less than once per year. The inspection shall review each product for consistency with the product description in the Conformity Assessment Report.

C.6.2 Audit testing and surveillance – Option 2

C.6.2.1 Additional obligations of the NCB

The NCB is required to assess the manufacturer's quality system. In addition, the manufacturer's quality system shall be reviewed to ensure that it includes the surveillance detailed below.

C.6.2.2 Additional obligations of the applicant

Applicants are required

a) to have a documented quality system in operation, which includes provisions for continuous conformance with the requirements of the relevant part of IEC 60127,

b) to include in their quality system the surveillance detailed in C.6.2.4.

C.6.2.3 Audit testing

A complete test programme according to the relevant part of IEC 60127 shall be performed on every ampere rating of each fuse-link series. The complete programme shall be repeated at 10 year intervals. These audit tests may be witness testing, re-testing, TMP, or SMT.

C.6.2.4 Surveillance

Routine inspection shall take place no less than once every two years. The inspection shall review each product for conformance with the product description in the Conformity Assessment Report. The inspection shall also comprise routine assessment of the operation of the quality plan and the quality system.

The applicant shall record all routine tests required by the applicant's quality system and make these records available for verification and review on the NCB's request.

The NCB shall inspect the results of all routine tests required by the applicant's quality system every two years.

C.6.3 Audit testing and surveillance – Option 3

A test programme utilizing the homogeneous series (significant sample) approach shall be performed.

C.6.3.1 Audit testing

A test programme according to the homogeneous series concepts of IEC 60127 shall be performed on significant samples in accordance with the schedule shown in Table C.1. These audit tests may be witness testing, re-testing, TMP, or SMT.

Table C.1 – Audit testing for option 3

Description		Subclause of IEC 60127-1	Sample numbers in decreasing value of voltage drop							
			1-6	7-12	13 14 15	16 17 18	19 20 21	22 23 24	25 26 27	28 29 30
Endurance test		9.4	A	s						
Rated breaking capacity		9.3			A	s				
Time/current characteristics	10 I_N	9.2.1					A	s		
	2 I_N or 2,1 I_N [a)]								A	s

A Tested annually.
s Spare fuse-links, only used if non-conforming results are obtained.
a) As specified in the relevant standard sheet.

C.6.3.2 Surveillance

Routine inspections shall take place no less than once per year. The inspection shall review each significant sample for conformance with the product description in the Conformity Assessment Report.

C.6.4 Audit testing and surveillance – Option 4

A test programme which uses the homogeneous series (significant sample) approach and the applicant's quality control system shall be performed.

C.6.4.1 Additional obligations of the NCB

The NCB is required to assess the manufacturer's quality system. In addition, the manufacturer's quality system shall be reviewed to ensure that it includes the surveillance and audit testing detailed below.

C.6.4.2 Additional obligations of the applicant

The applicant is required

a) to have a documented quality system in operation which includes provisions for continuous conformance with the requirements of the relevant part of IEC 60127;

b) to include in their quality system the surveillance detailed in C.6.4.4.

C.6.4.3 Audit testing

A test programme shall be performed in accordance with the schedule shown in Table C.2. These audit tests may be witness testing, re-testing, TMP, or SMT.

Table C.2 – Audit testing for option 4

Description		Subclause of IEC 60127-1	Sample numbers in decreasing value of voltage drop							
			1-6	7-12	13 14 15	16 17 18	19 20 21	22 23 24	25 26 27	28 29 30
Endurance test		9.4	B	s						
Rated breaking capacity		9.3			B	s				
Time/current characteristics	10 I_N	9.2.1					B	s		
	2 I_N or 2,1 I_N a)								B	s

B Tested every two years.

s Spare fuse-links, only used if non-conforming results are obtained.

a) As specified in the relevant standard sheet.

~~C.6.4.4 Surveillance~~

~~Routine inspections shall take place no less than once every two years. The inspection shall review each significant sample. The inspection shall also comprise routine assessment of the operation of the quality plan and the quality system.~~

~~The applicant shall record all routine tests required by the applicant's quality system and make these records available for verification and review on the NCB's request.~~

~~The NCB shall inspect the routine test results every two years.~~

~~C.7 Acceptability of audit test results~~

~~If more than one sample has non-conforming results during the audit testing, the fuse-link and all represented fuse-links shall be rejected.~~

~~If a single non-conforming result is obtained for a particular test during the audit testing, a second set of samples from the same lot shall be selected and subjected to the same test. The second set shall have the same number of samples as the first set. If any non-conforming results are obtained on the second set, the fuse-link and all represented fuse-links shall be rejected.~~

~~C.8 Acceptability of surveillance results~~

~~If any non-conforming results are obtained during the surveillance, the NCB shall consult with the manufacturer and applicant to determine whether the non-conformance is significant, and whether corrections need to be made, or type testing performed.~~

C.1 Overview

The contents of this annex were previously in IEC 60127-10. IEC 60127-10 contained the information found in this user guide but the IEC determined that it would be advantageous to the user of IEC 60127-1 to have this information as an informative annex rather than a separate part of the IEC 60127 series.

IEC 60127 is subdivided into parts. IEC 60127-1 contains the general requirements while IEC 60127-2, -3, -4 and -7 contain specific requirements for fuse-links and IEC 60127-6 contains specific requirements for fuse-holders.

C.2 General

This annex relates to miniature fuse-links for the protection of electric appliances, electronic equipment and component parts thereof, normally intended to be used indoors, as specified in IEC 60127-2, 60127-3, 60127-4 and 60127-7. IEC 60127-8 was not included in the original part 10. Additional details for this part are under consideration.

This annex does not apply to fuse-links for appliances intended to be used under special conditions, such as in a corrosive or explosive atmosphere.

The objective of this guide is to introduce the user to the important properties of miniature fuse-links and fuse-holders for miniature fuse-links and to give some guidance on applying them.

NOTE 1 If the current or voltage are outside of the scope of IEC 60127 series, refer to IEC 60269 series.

NOTE 2 Fuse-links of the same type and rating might, due to differences in design, have different voltage drops and different behaviours. Therefore, in practice, they may not be interchangeable when used in applications with low-voltage circuits, especially in combination with fuse-links of lower rated currents.

NOTE 3 Contact the manufacturer for further information.

C.3 Properties of miniature fuse-links

The miniature fuse-link provides protection against the effects of short circuits and sustained overloads, protecting components and conductors upstream of the fault and isolating the faulty branch of the circuit downstream of the fault. The opening of the fuse-link also acts as a diagnostic tool, helping to identify the location of the fault.

Some of the properties of miniature fuse-links include:

- Wide range of physical types of construction: miniature fuse-links are available in a wide choice of physical constructions. For example, there are fuse-links that can be fitted into clips and fuse-holders or plugged into sockets enabling easy replacement. There are also types which can be soldered on to printed wiring boards by through-hole mounting or surface mounting, using wave soldering or reflow soldering.
- Low cost and very small dimensions: miniature fuse-links provide very good circuit protection in a small package suitable for miniaturized equipment.
- Wide range of characteristics: miniature fuse-links are generally used within electronic equipment, where prospective short-circuit currents are below 1 500 A. In case of miniature fuse-links for special application, below 50 kA. Fuse-link s are available with a very wide range of characteristics, from (very) quick acting types to (long) time-lag types. The latter types are very useful because they can withstand inrush currents experienced during switching on, but will also open under sustained overloads.
- Discrimination (selectivity): standardized fuse-link characteristics and limitation of let-through energy ensure that a faulty circuit is isolated by the fuse-links without opening higher rated upstream fuse-links, avoiding disconnection of the supply to healthy circuits downstream.
- Reliability: miniature fuse-links carry operational currents continuously without any substantial change or deterioration in their characteristics, and give equal protection to that provided by a new fuse-link. During their long life, no maintenance is required.
- Tamper-proof reproducible characteristics: miniature fuse-links provide a package of protection tailor-made for the application. The same level of protection is then maintained by a replacement fuse-link of the same type and rating, fitted after the fault has been corrected. The extensive schedule of tests in the IEC 60127 series together with a quality system such as that described in IEC 60127-5 and a follow-up service by a National Certification Body, ensure that all aspects of fuse-link operation are accurately and safely reproduced at any location world-wide.
- Arc reduction: suitable fuse-links can disconnect faults so quickly that there is no time for an arc to become established at the fault location.

C.4 Different types of fuse-links

C.4.1 General

IEC 60127 makes reference to four families of fuse-links:

- IEC 60127-2 Cartridge fuse-links
- IEC 60127-3 Sub-miniature fuse-links
- IEC 60127-4 Universal Modular Fuse-links (UMF)
- IEC 60127-7 Miniature fuse-links for special applications
- IEC 60127-8 Fuse resistors with particular overcurrent protection

C.4.2 Time/current characteristics

These are terms that define how quickly a fuse-link will safely operate (open) at various overload current levels. Fuse-links conforming to the standard sheets in the various parts of IEC 60127 are characterized as follows:

- FF – Very quick acting
- F – Quick acting
- M – Medium time-lag
- T – Time-lag
- TT – Long time-lag

The individual standard sheets specify precise time gates for each overload current level, given as a multiple or percentage of the rated current (e.g. 2,10 or 210 %, 2,75 or 275 %). The fuse-element shall melt within the given time gate.

It should be noted that the characteristics of fuse-links conforming to other standards, such as CSA-C22.2 No. 248.14 – UL 248-14, could be quite different from the characteristics specified in IEC 60127 series. Additionally, these other standards might not specify the same characteristic definitions or precise time gates. Accordingly, the definition of terms such as very fast acting, fast acting, quick acting, normal acting, medium acting, medium blow, time lag, time delay and others are left to the individual fuse-link manufacturers, and can vary widely.

C.4.3 Breaking capacity

The breaking capacity of a fuse-link is the value of current that a fuse-link can safely interrupt at its rated voltage. It should be noted that a fuse-link may have multiple breaking capacities. For example, 100A for 250 VAC and 50A for 125 VDC. The breaking capacity assigned by the fuse-link manufacturer is usually that of the standard sheet, for a given voltage as well as other specified test conditions such as circuit power factor, closing angle, etc. In practice, a fuse-link shall not be used in a circuit that has a potential fault (short-circuit) current greater than the rated breaking capacity of the fuse-link. It is usually difficult to determine the actual maximum potential fault current of a circuit/application. Often it is an assumed theoretical value assigned by a safety agency. In some cases, the suitability of a fuse-link's breaking capacity is determined by testing the fuse-link in the end product, under short-circuit conditions.

C.4.4 Cartridge fuse-links (IEC 60127-2)

Two sizes of fuse-links are described: 5 mm × 20 mm and 6,3 mm × 32 mm. The details are specified in 10 standard sheets, as shown in Table C.1. The rated voltage is 250 V AC except for the following fuse-links:

- Fuse-links shown in standard sheet 4, which are rated 250 V for 50 mA through 2 A, 150 V for 2,5 A through 4 A and 60 V for 5 A through 10 A;
- Fuse-links shown in standard sheets 9 and 10, which are rated 500 V for 100 mA through 10 A.

Table C.1 – Summary of IEC 60127-2 Standard Sheets

Standard sheet	Dimensions mm	Characteristic F – Quick acting T – Time-lag	Rated breaking capacity
1	5 × 20	F	High (1 500 A)
2	5 × 20	F	Low (35 A or 10 I_N)*
3	5 × 20	T	Low (35 A or 10 I_N)*
4	6,3 × 32	F	Low (35 A or 10 I_N)*
5	5 × 20	T	High (1 500 A)
6	5 × 20	T	Enhanced (150 A)
7	6,3 × 32	F	Enhanced (200 A)
8	6,3 × 32	T	Enhanced (200 A)
9	6,3 × 32	F	High (1 500 A)
10	6,3 × 32	T	High (1 500 A)
* Whichever is greater.			

NOTE Already approved 5 × 20 mm fuse-links are available in pig-tail form (wire terminated) for direct connection to printed wiring boards.

C.4.5 Sub-miniature fuse-links (IEC 60127-3)

IEC 60127-3 consists of four standard sheets, as shown in Table C.2, all of which refer to low breaking capacity fuse-links. Two types of fuse-links are described, radial and axial, for use on printed wiring boards.

Table C.2 – Summary of IEC 60127-3 Standard Sheets

Standard sheet	Termination	Characteristic	Rated breaking capacity
1	radial	F	Low (50 A)
2	axial or radial	F	Low (50 A)
3	axial or radial	F	Low (35 A or 10 I_N)*
4	axial or radial	T	Low (35 A or 10 I_N)*
* Whichever is greater.			

The spacing of the fuse-link terminations are designed to permit easy installation on printed wiring boards having a grid system of holes located at 2,54 mm between centres. Care should be taken that creepage and clearance distances are maintained.

C.4.6 Universal Modular Fuse-links (IEC 60127-4)

Two types of fuse-link are described, through-hole types (standard sheet 1) with rated voltages of 32 V, 63 V, 125 V and 250 V and surface mount types (standard sheet 2) with rated voltage of 12,5 V, 25 V, 32 V, 50 V, 63 V, 125 V and 250 V. As shown in Table C.3.

Table C.3 – Summary of IEC 60127-4 Standard Sheets

Standard sheet	Rated voltage V	Terminal spacing, [b] mm	Characteristic	Rated breaking capacity
1 (Through-hole)	32	2,5	FF, F, T or TT	Low (35 A or 10 I_N)[a]
	63	2,5		
	125	5		Low (50 A or 10 I_N)[a]
	250	7,5		Low (100 A)
	250	10		Intermediate (500 A)
	250	12,5		High (1 500 A)
2 (Surface mount)	12,5	0,4		Low (35 A or 10 I_N)[a]
	25	0,45		
	32	0,48		
	50	0,53		
	63	1,1		
	125	1,3		Low (50 A or 10 I_N)*
	250	4		Low (100 A)
				Intermediate (500 A)
				High (1 500 A)

[a] Whichever is greater.

[b] For surface mounted fuse-links, minimum terminal spacing values apply.

This area of fuse-link design is developing rapidly. The standard acknowledges this by not being design restrictive, merely specifying maximum dimensions for physical size. To ensure that fuse-links from different manufacturers are interchangeable some investigation might be needed.

C.4.7 Miniature fuse-links for special applications (IEC 60127-7)

Miniature fuse-links for special applications are not intended to be replaced by the end-user of an electrical / electronic appliance.

Fuse-links for special applications are not covered within the scope of other parts of IEC 60127 series. For example, if a 5x20 mm fuse-link, which IEC 60127-2 would typically cover, falls outside of the scope of IEC 60127-2, then IEC 60127-7 may cover this fuse-link.

IEC 60127-7 is applicable to fuse-links with a rated voltage not exceeding 1 000 V, a rated current not exceeding 20 A and a rated breaking capacity not exceeding 50 kA. It does not apply to fuse-links completely covered by the subsequent parts of IEC 60269-1.

Miniature fuse-links for special applications can be intended to be mounted on printed circuit boards (surface mount, through-hole mount, axial or radial) or inserted in specifically designed fuse-holders.

The rated voltage, rated breaking capacity as well as the maximum pre-arcing times at (2,0 or 2,1) and 10 times the rated current shall be decided by fuse-link manufacturers within certain limitations.

Two test methods of the endurance test at normal ambient temperature and the fuse-link temperature respectively are specified in IEC 60127-7. The test method applied is defined by the manufacturer.

Only one standard sheet is utilized in IEC 60127-7 as it addresses all the different possibilities of fuse-links in special applications, as shown in Table C.4.

Table C.4 – Summary of IEC 60127-7 Standard Sheet

Standard sheet	Rated voltage V	Terminal spacing [a] mm	Characteristic	Rated breaking capacity
	12,5	0,4		
	25	0,45		
	32	0,48		
	50	0,53		
1	63	1,1	Defined by manufacturer	Defined by manufacturer
	125	1,3		
	250	2,5		
	500	To be determined		
	1000	To be determined		

[a] For surface mount fuse-links, minimum terminal spacing values apply.

C.5 Applications

C.5.1 Applications – Fuse-link selection criteria

Selection of a miniature fuse-link for a given application is usually dictated by three basic categories of criteria:

a) electrical requirements of the application;

b) conformance to published fuse-link safety standards;

c) mechanical properties/physical size.

It is necessary to first determine the electrical performance required of the fuse-link, as dictated by the application, and usually, safety agency test requirements for the end product. The electrical characteristics and breaking capacity needed for the application shall conform to a published safety standard. This conformance is usually confirmed by third party (safety agency) approval of the fuse-link.

Only after these criteria are met can the mechanical/dimensional attributes be considered.

C.5.2 Electrical criteria

The electrical ratings and performance required of a fuse-link are dictated by:

a) normal operating conditions of the end product, i.e. steady state current, supply voltage, ambient temperature, etc.;

b) foreseeable field fault conditions due to failures within the end product;

c) foreseeable field fault conditions due to power line crossing or other surges (e.g. lightning);

d) specified overload and short-circuit test conditions imposed by safety agencies on the end product.

The following information should be considered for each particular application:

1) The circuit-operating voltage and whether it is alternating current (AC) or direct current (DC).
2) Any transient conditions that exist, for example:
   i) the maximum inrush current at product "switch-on" (including its waveform and duration) that the fuse-link shall withstand without opening;
   ii) the anticipated usage pattern or duty cycle: will the end product be switched on once a day, once a week, once a year, etc. or continuously cycled?;
   iii) any pulse current surges due to secondary lightning surges (amplitude, waveform and number of cycles) that the fuse-link shall withstand without opening.
3) Normal operating conditions:
   i) maximum steady-state current that the fuse-link will be subjected to in service;
   ii) minimum/maximum ambient conditions.
4) Circuit protection performance required:
   i) minimum overload current at which the fuse-link shall operate, and the maximum time allowed to operate (open);
   ii) other critical overload level or time constraints that the fuse-link shall meet;
   iii) maximum short-circuit current and voltage that the fuse-link shall interrupt.

C.5.3 Mechanical/physical dimensions

Once the electrical requirements and any safety approval issues are determined, then the mechanical options can be addressed.

C.6 Protection by I^2t limitation and pulse operation

C.6.1 I^2t value

It should be noted that I^2t is not a parameter that is measured or verified in the IEC 60127 Series. Pre-arcing (melting) I^2t or 'Joule Integral' is a measure of the energy required to melt the fuse-element and is expressed as "ampere squared seconds" (A^2s). For sufficiently high currents, pre-arcing I^2t and the energy it represents is a constant value for each different fuse-element. Because every fuse-link type and rating has a different fuse-element, it is necessary to determine the I^2t for each. This I^2t value is a parameter of the fuse-link itself and is determined by the element material and configuration. This nominal pre-arcing I^2t is not only a constant value for each fuse-element design, but it is independent of voltage and substantially independent of temperature.

The operating I^2t is a measure of the let-through energy of the fuse-link and is the sum of the pre-arcing and arcing I^2t. The arcing I^2t is not determined solely by the fuse-link itself, but by the circuit's parameters.

operating I^2t = pre-arcing I^2t + arcing I^2t

C.6.2 Pulse operation

Usually, the pre-arcing I^2t is used to select a fuse-link for an application where it is necessary to sustain large current pulses of a short duration. These currents are common in many applications and are described by a variety of terms, such as "surge current", "start-up current", "inrush current" and other similar circuit "transients" that can be classified in the general category of "pulses". It is important to take into account the I^2t and repetition rate of the pulse. In order to avoid nuisance opening, it is necessary to select a fuse-link with a pre-arcing I^2t sufficiently larger than the pulse I^2t.

C.6.3 I^2t limitation

For protection of sensitive components, the operating I^2t is the important parameter. Components such as semi-conductors have a withstand rating which gives the amount of energy which they can handle without failure. For this application, unlike pulse operations, it is important to select a fuse-link that has an operating I^2t less than the component withstand rating.

Conclusion: select the I^2t value of the fuse-link so that

a) the I^2t inrush pulse is less than the pre-arcing I^2t value of the fuse-link;
b) the operating I^2t value of the fuse-link is less than the maximum I^2t value of the device that has to be protected.

The IEC suggests measuring I^2t at 10 I_N. This can lead to overstated values, particularly with time lag fuse-links whose operating time at 10 I_N is usually significantly greater than fast acting types. Published I^2t values are generally nominal and the manufacturers should be consulted if this parameter is critical to the design analysis.

C.7 Direct current (DC) applications

C.7.1 General information

While published fuse-link rating information is based on AC data and might not be applicable for DC applications, all fuse-links shall operate in both AC and DC circuits. However, the DC rated voltage and rated breaking capacity might be different from the AC ratings of the fuse-link. To select a fuse-link for DC applications, the circuit time constant shall be determined and the basic ratings for the fuse-link shall be verified for DC performance.

Typical DC applications include:

- batteries/accumulators which are comparatively low voltage (less than 50 V) but with potentially high fault currents;
- telecommunications or power supplies up to 125 V where the fault current is within the AC breaking capacity limit of the fuse-link;
- DC voltages above 125 V where additional testing might be necessary, particularly for breaking capacity.

Inductive and capacitive DC circuits need additional considerations because of the stored energy, characterized by the circuit time constant. This value is usually less than 2 ms for battery circuits and up to about 4 ms for other inductive circuits that can typically be protected by miniature fuse-links. This circuit characteristic can affect the operating time/current characteristics, rated voltage and breaking capacity performance of the fuse-link. Time-current curves are usually based on AC (RMS) or DC currents that are thermally equivalent.

C.7.2 Battery circuits

Batteries contain very little inductance. To select a fuse-link for a battery circuit, determine the circuit time constant and consider the following fuse-link information:

- time current data: develop from either AC (RMS) or DC current;
- DC voltage rating: equal to or greater than the DC circuit voltage;
- DC breaking capacity: equal to or greater than the circuit's available DC fault current. The time constant for the fuse-link breaking capacity test shall be equal to or exceed the time constant of the DC application circuit.

C.7.3 Inductive load circuits

Loads such as motors, solenoids and other coil-type loads can have a large amount of inductance. To select a fuse-link for these applications, follow the procedure for battery circuits.

C.8 Fuse-holders

C.8.1 Features

Allows replacement of the fuse-link without any auxiliary means and without opening the equipment (panel mounted fuse-holder).

C.8.2 Safety aspects

In view of the safety of electrical equipment, the selection of the most suitable fuse-holder is of great importance. Among other parameters, one has to make sure that the admissible power acceptances and temperatures defined by the fuse-holder manufacturer are followed.

To choose a fuse-holder based only on the rated current of a fuse-link can, especially at higher currents, cause unacceptable temperatures if the effect of the heat generated in the contacts of the fuse-holder has not been taken into consideration.

C.8.3 Selection of a fuse-holder

The following parameters shall be considered:

a) maximum sustained dissipation of the fuse-link;

b) rated power acceptance of the fuse-holder, temperatures surrounding the fuse-holder and operating current;

c) the difference between the ambient air temperature outside and inside the equipment;

d) heat dissipation/cooling, ventilation, heat influence of adjacent components.

The rated power acceptance is a measure of the maximum power dissipation that the fuse-holder can handle without exceeding its temperature rise limits. It is intended to be the power dissipation caused by an inserted dummy fuse-link at the rated current of the fuse-holder and at an ambient temperature of 23 °C.

The correlation between ambient air temperature and the rated power acceptance of a fuse-holder for one or several operating currents is demonstrated by derating curves published by the fuse-holder manufacturer.

To keep the power dissipation of the fuse-link inserted in the fuse-holder below the rated power acceptance of the fuse-holder, at the corresponding ambient air temperature and mounting conditions, it is necessary to observe the following two steps:

Step 1

Selection of the fuse-holder is based on the power acceptance at operating current and maximum ambient air temperature. The maximum sustained dissipation of the fuse-link shall be less than or equal to the admissible power acceptance of the fuse-holder.

Step 2

The reduction of the power acceptance of the fuse-holder (from step 1) based on the different conditions at the mounting place etc. shall be determined by the responsible design engineer.

Examples:

– ambient air temperature is considerably higher inside the equipment than outside;
– cross-section of the conductor;
– unfavourable heat dissipation;
– heat influence of adjacent components.

C.8.4 Exchange of fuse-links under load

A fuse-holder with an installed fuse-link shall not be used as a “switch” for turning the power on and off. In order to prevent damage to the fuse-holder, a fuse-link shall only be exchanged when the power in the circuit is switched off.

C.9 Performance on extra-low voltages

In a wide range of applications, miniature fuse-links provide reliable protection against fault current conditions, and have negligible influence on the circuit.

However, consideration should be given when fuse-links are used at extra-low voltages, i.e. in the range of 10 V, especially for fuse-links of low rated current. For a fuse-link having a rated current lower than 100 mA, its cold resistance can be between 1 Ω and 100 Ω, i.e. the impedance of the fuse-link can possibly be as high as the impedance of the circuit. The voltage drop of fuse-links having low rated current is relatively high; it is in the range of 1 V. In contrast to this, the power dissipation of approximately 0,5 W is negligible.

The typical relationship between voltage drop and power dissipation dependent on rated current is shown in Figure C.1.

Due to the non-linear increase of the voltage drop when the fuse-element approaches its melting point, care shall be taken to ensure that there is sufficient voltage available to cause the fuse-link to interrupt the current when an electrical fault occurs.

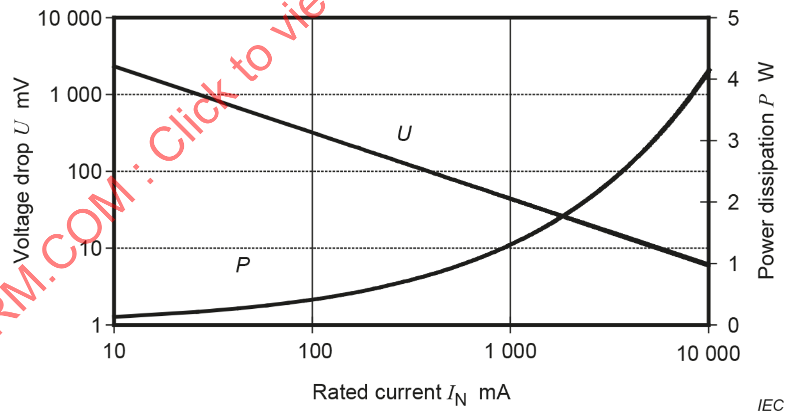


Figure C.1 – Example of power dissipation P and voltage drop U according to rated current I_N

The user should consider certain conditions, particularly the possible influence of the fuse-link on the circuit as a result of its resistance. It is not sufficient to take into account only the cold resistance that is measured at a lower current, i.e. 0,1 I_N, or the voltage drop measured at 1,0 I_N.

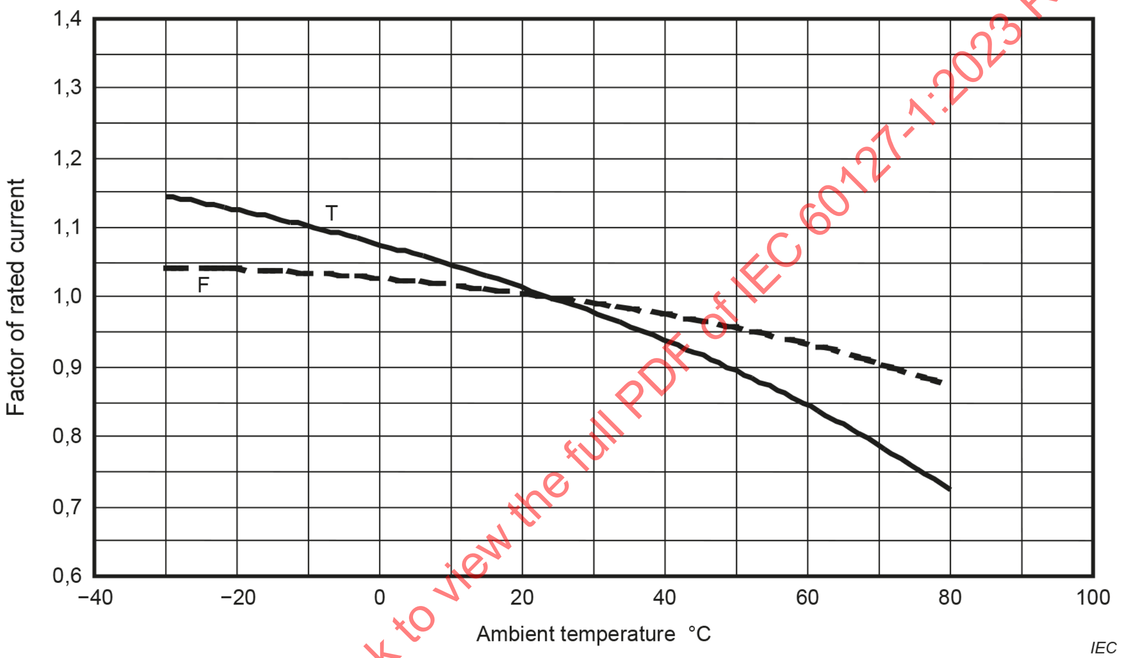
As a rule of thumb, the minimum operating voltage required for proper operation is approximately five to eight times the voltage drop of the fuse-link measured at 1,0 I_N.

C.10 Influence of ambient temperature

Fuse-links are temperature-sensitive devices which means that the temperature of the surroundings influences their characteristics. Due to this fact, rated values and the time/current characteristic are standardized at a temperature of 23 °C. Higher or lower temperatures can result in faster or slower reaction of the fuse-link.

Figure C.2 shows an example of the re-rating of the fuse-link rated current as a function of the ambient temperature.

The surrounding temperature and the specific manufacturers' designs also influence the power acceptance of a fuse-holder.



Key

F Quick acting

T Time-lag

Figure C.2 – Example of the re-rating of the fuse-link rated current

Bibliography

IEC 60062:~~2004~~2016, *Marking codes for resistors and capacitors*

IEC 60127-2:2014, *Miniature fuses – Part 2: Cartridge fuse-links*

IEC 60127-3:2015, *Miniature fuses – Part 3: Sub-miniature fuse-links*
IEC 60127-3:2015/AMD1:2020

IEC 60127-4:2005, *Miniature fuses – Part 4: Universal modular fuse-links (UMF) – Through-hole and surface mount types*
IEC 60127-4:2005/AMD1:2008
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IEC 60127-6:2014, *Miniature fuses – Part 6: Fuse-holders for miniature fuse-links*

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CSA C22.2 No. 248.14 ♦ UL 248-14, *Low-voltage fuses – Part 14: Supplemental fuses*

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IEC 60127-1

Edition 3.0 2023-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Miniature fuses –
Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links

Coupe-circuits miniatures –
Partie 1: Définitions pour coupe-circuits miniatures et exigences générales pour éléments de remplacement miniatures

IEC 60127-1:2023-10(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MINIATURE FUSES –

Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60127-1 has been prepared by subcommittee 32C: Miniature fuses, of IEC technical committee 32: Fuses. It is an International Standard.

This third edition cancels and replaces the second edition published in 2006, Amendment 1:2011 and Amendment 2:2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) modification of 6.3 to clarify the marking items;
b) modification of 9.3.1 to introduce a tolerance for the prospective current for the breaking capacity test;
c) deletion of contents of 9.6, Pulse test;
d) deletion of Annex C;
e) addition of new Annex C user guide for miniature fuse-links.

The text of this International Standard is based on the following documents:

Draft	Report on voting
32C/615/FDIS	32C/624/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60127 series, published under the general title *Miniature fuses*, can be found on the IEC website.

This Part 1 of the IEC 60127 series covers definitions, general requirements and tests applicable to all types of miniature fuses (e.g. cartridge fuse-links, sub-miniature fuse-links, universal modular fuse-links and miniature fuse-links for special applications). All subsequent parts of the complete series are to be read in conjunction with this Part 1.

IEC 60127 consists of the following parts:

IEC 60127-1, *Miniature fuses – Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links*

IEC 60127-2, *Miniature fuses – Part 2: Cartridge fuse-links*

IEC 60127-3, *Miniature fuses – Part 3: Sub-miniature fuse-links*

IEC 60127-4, *Miniature fuses – Part 4: Universal modular fuse-links (UMF) – Through-hole and surface mount types*

IEC 60127-5, *Miniature fuses – Part 5: Guidelines for quality assessment of miniature fuse-links*

IEC 60127-6, *Miniature fuses – Part 6: Fuse-holders for miniature fuse-links*

IEC 60127-7, *Miniature fuses – Part 7: Miniature fuse-links for special applications*

IEC 60127-8, *Miniature fuses – Part 8: Fuse resistors with particular overcurrent protection*

IEC 60127-9, (free for further documents)

IEC 60127-10, Moved to IEC 60127-1 as Annex C.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

MINIATURE FUSES –

Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links

1 Scope and object

This part of IEC 60127 covers the general requirements and tests applicable to all types of miniature fuse-links (e.g. cartridge fuse-links, sub-miniature fuse-links, universal modular fuse-links and miniature fuse-links for special applications) for the protection of electric appliances, electronic equipment and component parts thereof normally intended to be used indoors.

This document does not apply to fuses intended for the protection of low-voltage electrical installations. These are covered by IEC 60269, *Low Voltage Fuses*.

Specific details covering each major subdivision are given in subsequent parts.

This document does not apply to fuses for appliances intended to be used under special conditions, such as in a corrosive or explosive atmosphere.

The object of this document is

a) to establish uniform requirements for miniature fuses so as to protect appliances or parts of appliances in the most suitable way,
b) to define the performance of the fuses, so as to give guidance to designers of electrical appliances and electronic equipment and to ensure replacement of fuse-links by those of similar dimensions and characteristics,
c) to define methods of testing,
d) to define maximum sustained dissipation of fuse-links to ensure good compatibility of stated power acceptance when used with fuse-holders according to this document (see IEC 60127-6).

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 60038, *IEC standard voltages*

IEC 60127-6:2014, *Miniature fuses – Part 6: Fuse-holders for miniature fuse-links*

3 Terms and 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
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

Note 1 to entry: The fuse comprises all the parts that form the complete device.

3.2
miniature fuse
fuse in which the fuse-link is a miniature fuse-link

3.3
fuse-link
part of a fuse including the fuse-element(s) intended to be replaced after the fuse has operated

3.4
enclosed fuse-link
fuse-link in which the fuse-element is totally enclosed, so that during operation within its rating it cannot produce any harmful external effects, e.g. due to development of an arc, the release of gas or the ejection of flame or metallic particles

3.5
miniature fuse-link
enclosed fuse-link for the protection of electric appliances, electronic equipment and component parts thereof normally intended to be used indoors

3.5.1
cartridge fuse-link
enclosed miniature fuse-link of rated breaking capacity not exceeding 2 kA and which has at least one of its principle dimensions not exceeding 10 mm

Note 1 to entry: Principle dimensions are length, width, height and diameter.

3.5.2
miniature fuse-link for special applications
enclosed miniature fuse-link which is not covered in IEC 60127-2, IEC 60127-3 or IEC 60127-4 and of rated breaking capacity not exceeding 50 kA and having a width and height not exceeding 12 mm and a length not exceeding 50 mm

3.5.3
sub-miniature fuse-link
miniature fuse-link of which the case (body) has no principal dimension exceeding 10 mm

Note 1 to entry: Principal dimensions are length, width, height and diameter.

3.5.4
universal modular fuse-link
miniature fuse-link primarily adapted for direct electrical connection to printed circuit boards or other conductive substrates, incorporating features designed to provide a degree of non-interchangeability where necessary

3.6
fuse-link contact
conductive part of a fuse-link designed to engage with a fuse-base contact or with a fuse-carrier contact

3.7
fuse-holder
combination of a fuse-base with its fuse-carrier

3.8
fuse-base
fuse-mount
fixed part of a fuse provided with contacts and terminals for connection to the system

3.9
fuse-base contact
fuse-mount contact
conductive part of a fuse-base, connected to a terminal designed to engage with a fuse-carrier contact or with a fuse-link contact

3.10
fuse-carrier
movable part of a fuse designed to carry a fuse-link

3.11
fuse-carrier contact
conductive part of a fuse-carrier connected to a fuse-link contact and designed to engage with a fuse-base contact

3.12
fuse-element
part of the fuse-link designed to melt when the fuse operates

3.13
homogeneous series (of fuse-links)
series of fuse-links, 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 the series may be taken as representative of all the fuse-links of the series

Note 1 to entry: Fuse-links are considered as forming a homogeneous series when the characteristics comply with the following:

– the bodies have the same dimensions, material and method of manufacture;
– the caps or other end closures of the body have the same dimensions, materials and method of attachment and sealing;
– the granular filler, if any, of the body is of the same material and completeness of filling. It should be of the same size or any variation of the grain size with current rating should be monotonous;
– the fuse-elements are of the same material with the same principles of design and construction; any changes of fuse-element dimensions with current rating should be monotonous;
– the rated voltage is the same;
– for low-breaking capacity fuse-links it is only necessary to test the highest rated breaking capacity in a homogeneous series.

3.14
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 fuse is designed

Examples of rated values usually stated for fuses:

- voltage (U_N);
- current (I_N);
- breaking capacity.

3.15
time/current characteristics (of a fuse-link) for AC
curve giving, under stated conditions of operation, the value of time expressed as virtual time as a function of the prospective symmetrical current, expressed as the RMS value

Note 1 to entry: Time/current characteristics usually stated for a fuse-link relate to the pre-arcing time and the operating time.

3.15.1 time/current characteristics (of a fuse-link) for DC
curve giving, under stated conditions of operation, the value of time expressed as actual time as a function of the DC prospective current

Note 1 to entry: Time/current characteristics usually stated for a fuse-link relate to the pre-arcing time and the operating time.

3.16
conventional non-fusing current
value of current specified as that which the fuse-link is capable of carrying for a specified time (conventional time) without melting

3.17
prospective current (of a circuit and with respect to a fuse)
current that would flow in a circuit, if a fuse situated therein were replaced by a link of negligible impedance

3.18
pre-arcing time (melting time)
interval of time between the beginning of a current large enough to cause a break in the fuse-element and the instant when an arc is initiated

3.19
arcing time
interval of time between the instant of the initiation of the arc and the instant of final arc extinction

3.20
operating time (total clearing time)
sum of the pre-arcing time and the arcing time

3.21
virtual time
value of I^2t divided by the value of the square of the value of the prospective current

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

3.22
I^2t (joule integral)
integral of the square of the current over a given time interval:

$$I^2t = \int_{t=0}^{t} i^2 dt$$

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 released 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^2s.

3.23
breaking capacity of a fuse-link
value (RMS for AC) of prospective current that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

3.24
recovery voltage
voltage which appears across the terminals of a fuse after 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 or the steady-state recovery voltage exists.

3.25
maximum sustained power dissipation
power dissipation of a fuse-link measured under prescribed conditions of measurement at the maximum current level that can be sustained for a minimum of 1 h or, as specified in the standard sheet for ratings above 6,3 A

Note 1 to entry: The figure for maximum sustained dissipation is used in connection with the maximum power acceptance of fuse-holders for miniature fuse-links in accordance with IEC 60127-6.

Note 2 to entry: These values are often exceeded for short periods of time immediately before the fuse-element melts. Values as high as twice the maximum sustained dissipation have been recorded.

4 General requirements

Fuse-links shall be so constructed that they are reliable and safe in operation and consistent in performance at any current up to and including the breaking capacity rating and at any voltage up to the rated voltage, when used within the limits of this document.

During normal use of the fuse-link and within the conditions given in this standard, no permanent arc, no external arcing, nor any flame that can endanger the surroundings, shall be produced. During the test for establishing the maximum sustained dissipation and after operation, the fuse-link shall not have suffered damage hindering its replacement and the marking shall still be legible.

In general, compliance is checked by carrying out all the tests specified.

5 Standard ratings

In the relevant standard sheets, values are given for

– rated voltage,
– rated current,
– rated breaking capacity.

6 Marking

6.1 Unless otherwise stated in subsequent parts, the requirements for marking are as follows:

Each fuse-link shall be marked with the below in the order given:

a) A symbol denoting the relative pre-arcing time/current characteristic as given in the relevant standard sheet. This symbol shall be placed before and adjacent to the rated current.

These symbols read as follows:

FF: denoting very quick acting
F: denoting quick acting
M: denoting medium time-lag
T: denoting time-lag
TT: denoting long time-lag.

b) Rated current in milliamperes (mA) for rated currents below 1 A, and in amperes (A) for rated currents of 1 A or more.

To accommodate existing practice in some countries, for the time being, the current may also be indicated in fractions of ampere.

c) Rated voltage in volts (V).

d) Manufacturer's name or trade mark (does not need to follow order of marking).

6.2 Marking shall be indelible and easily legible.

Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked in water and again for 15 s with a piece of cloth soaked in petroleum spirit.

For petroleum spirit the use of an aliphatic solvent hexane, with an aromatics content of maximum 0,1 % volume, a kauri-butanol value of 29, initial boiling point approximately 65 °C, dry-point approximately 69 °C and specific gravity of approximately 0,68 is recommended.

NOTE In the case of colour coding, the test for indelibility need not be applied.

6.3 The marking according to 6.1 shall be printed on the packing label along with a reference to the subsequent IEC 60127 standard and appropriate standard sheet. It is optional to indicate IEC 60127-1 on the packing label. The marking on the packing label shall include the abbreviation A or mA for the current rating of the fuse-link.

Compliance is checked by inspection.

6.4 Further identification of the current rating and the time/current characteristics by means of colour bands may be used.

Such an additional marking shall be in accordance with Annex A.

6.5 Where marking is impractical due to space limitations, the relevant information shall appear on the smallest package and in the manufacturer's technical literature.

7 General notes on tests

7.1 General

Tests according to this document are type tests.

It is recommended that where acceptance tests are required, they are chosen from the type tests in this document.

7.2 Atmospheric conditions for testing

7.2.1 Unless otherwise specified in subsequent parts, all tests shall be carried out under the following atmospheric conditions:

– temperature between 15 °C and 35 °C;
– relative humidity between 45 % and 75 %;
– air pressure between $8,6 \times 10^4$ Pa and $1,06 \times 10^5$ Pa.

Where the above-mentioned conditions have a significant influence, they shall be kept substantially constant during the tests.

Fuse-links shall be tested in the specified bases in free air, and be protected from draughts and direct heat radiation. The position of the fuse-holder shall be horizontal.

If temperature has a marked effect on the results of the tests, these shall be performed at a temperature of 23 °C ± 1 °C.

7.2.2 In every test report, the ambient temperature shall be stated. If the standard conditions for relative humidity or pressure are not fulfilled during tests, a note to this effect shall be added to the report.

Where tests are required at elevated temperatures, these tests shall be carried out at an ambient temperature of 70 °C ± 2 °C, unless otherwise specified.

7.3 Type tests

7.3.1 The number of fuse-links required shall be specified in subsequent parts.

Fuse-links shall be tested or inspected in accordance with the following subclauses:

a) Marking (see 6.1)
b) Dimensions (see 8.1)
c) Construction (see 8.2)
d) Voltage drop (see 9.1)

with such additional tests as are specified in subsequent parts.

7.3.2 Based on the results of the test in item 7.3.1 d), the fuse-links shall be sorted in descending order of voltage drop, and numbered consecutively, lower numbers being allocated to the fuse-links having the highest voltage drop. Tests from these fuse-links shall then be made in accordance with the relevant testing schedule.

If a test is to be repeated, spare fuse-links having approximately the same voltage drop as the original fuse-links shall be used for the repeat test.

7.3.3

a) No failure is allowed in any of the tests covered by Clauses 6 and 8, nor those described in 9.1, 9.2.2 and 9.7 and such additional clauses and subclauses as shall be specified in subsequent parts.

b) If in the tests covered by 9.2.1 and 9.3, two failures occur at any one test current, the fuse-links are deemed not to comply with this document. If, however, one failure occurs, the test shall be repeated on twice the number of fuse-links, at the same current and a second failure shall be a cause for rejection.

   If two failures occur, but not both in the same test, the fuse-link shall be deemed to comply provided that there are no further failures in repeat tests with twice the number of fuse-links.

   If two failures occur, but not both in the same current, the fuse-link shall be deemed to comply provided that there are no further failures in repeat tests with twice the number of fuse-links.

c) In each of the tests according to 9.4, 9.5 and 9.6, one failure is allowed. If two or more fuse-links fail in any one test, the fuse-links are deemed not to comply with this standard, unless otherwise specified in subsequent parts.

7.4 Fuse-bases for tests

For tests that require a fuse-base for mounting the fuse-links, a base according to the requirements specified in subsequent parts shall be used.

7.5 Nature of supply

The nature of the supply for the electrical tests is specified in the relevant clauses or in the relevant standard sheets in subsequent parts.

For AC, the test voltage is of substantially sinewave form with a frequency between 45 Hz and 62 Hz.

8 Dimensions and construction

8.1 Dimensions

The dimensions of the fuse-links shall comply with the relevant standard sheet, given in subsequent parts.

Compliance is checked by measurement.

8.2 Construction

The fuse-element shall be completely enclosed. Further details of the construction are given, as appropriate, in subsequent parts.

8.3 Terminations

Fuse-link contacts shall be made of non-corroding material or of material suitably protected against corrosion, and shall be effectively free from flux or other non-conducting substance on their outer surfaces.

Nickel or silver plating is deemed to be adequate protection for brass end caps.

Tests for firm attachment are given, where appropriate, in subsequent parts.

8.4 Alignment and configuration of terminations

Appropriate tests for alignment or position of pins, etc., as applicable, are given in subsequent parts.

8.5 Soldered joints

Externally visible soldered joints (e.g., on end caps) shall not melt during normal use and operation.

Compliance is checked by inspection of the soldered joints after the tests described in 9.2.1, 9.2.2, 9.4, 9.5 and 9.6.

9 Electrical requirements

9.1 Voltage drop

The voltage drop across the fuse-links at their rated current shall not exceed the maximum values given on the relevant standard sheet.

Individual values shall not deviate from the mean value determined for the model under test during type tests by more than 15 %.

If, due to the Peltier effect, different voltage drops are measured when the current through the fuse-link is reversed, the highest value shall be taken.

Compliance is checked by measuring the voltage drop when the fuse-link has carried its rated current for a time sufficient to reach temperature stability.

Direct current shall be used for this test; equipment shall be used which does not influence the result of the test significantly.

Temperature stability is considered to be reached when the voltage drop changes by less than 2 % of the previously observed value per minute. During this test, the current through the fuse-link shall not deviate by more than ±1 % from the rated current and the accuracy of the voltage drop measurement shall be within a tolerance of ±1 %.

Problems can arise when fuse-links are used at voltages considerably lower than their rated voltage, mainly for low ratings. Due to the increase of the voltage drop when the element of a fuse-link approaches its melting point, care should be taken to ensure that there is sufficient circuit voltage available to cause the fuse-link to interrupt the current when an electrical fault occurs. Furthermore, fuse-links of the same type and rating might, due to difference in design or element material, have different voltage drops and might therefore not be interchangeable in practice when used in applications with low circuit voltages, especially in combination with fuse-links of lower rated currents.

9.2 Time/current characteristic

9.2.1 Time/current characteristic at normal ambient temperature

The time/current characteristic shall be within the limits specified in the relevant standard sheets.

Compliance is checked by measuring the pre-arcing time under the atmospheric conditions mentioned in 7.1.

The current through the fuse-link shall be adjusted to within ±1 % of the required value. The current stability during the test shall be maintained within ±1 % of the adjusted value. The voltage of the source shall not exceed the rated voltage of the fuse-link under test. The accuracy of the measurement of time shall be within a tolerance of ±5 % for times of less than 10 s and ±2 % for times of 10 s or more.

In the case of very short pre-arcing times at high levels of the current where constant current no longer can be maintained, the I^2t value shall be measured and the virtual time be calculated.

9.2.2 Test at elevated temperature

When specified on the standard sheet, fuse-links shall also be tested for 1 h at 70ºC, unless otherwise specified, and with the multiple of the rated current as specified on the relevant standard sheet.

The current stability during the test shall be maintained within ±2,5 % of the adjusted value. The fuse-link shall not operate.

9.2.3 Test procedure

Direct current shall be used for these tests.

NOTE 1 Direct current is used because it is easier to control and eliminates the variation inherent with alternating current caused by the point on the voltage wave that switching occurs.

Care should be taken that the arcing time is not included in the total time measured

The output voltage of the current source shall be sufficient to limit the variation of current during the pre-arcing time. Additionally, the output voltage shall not exceed a value declared by the manufacturer and chosen from the list of DC voltages in Table 6 of IEC 60038:2009.

The time constant of the circuit shall not exceed 3 % of the pre-arcing time.

Where there is a possible influence of the Peltier effect, care shall be taken to reverse the direction of the current passing through the fuse-link for each successive sample.

Where the influence of the Peltier effect is essentially due to the construction, the time/current characteristic should be tested with twice the number of fuse-links at 2,0 I_N or 2,1 I_N. The additional samples may be taken from the spare fuse-links.

Attention is drawn to the fact that, for certain types of fuse-links, the time/current characteristic with AC can be significantly different from the characteristic determined with DC and particularly with currents just exceeding the conventional non-fusing current.

Furthermore, due to the small thermal inertia of the fuse-elements for low currents, the characteristic of the fuse-links might change considerably at very low frequencies.

9.2.4 Presentation of results

If the time/current characteristics with the current as independent variable are plotted, it is preferred that they are presented with logarithmic scales on both co-ordinate axes. The basis of the logarithmic scales shall be in the ratio 2:1 with the longer dimension on the abscissa.

If the multiple of the rated current is used as the independent variable, the ratio shall be 3:1.

NOTE Examples of such formats are given in Annex B.

9.3 Breaking capacity

9.3.1 General

When requested by the manufacturer, additional testing of breaking capacities to values (prospective current) higher than those stated in subsequent parts is permitted if all requirements of subsequent parts are met.

9.3.2 Operating conditions

Fuse-links shall operate satisfactorily without producing any harmful external effects (i.e. development of an external arc, release of gas or ejection of flame or metallic particles) when breaking prospective currents between the conventional non-fusing current and rated breaking capacity in accordance with the relevant standard sheets in subsequent parts.

The recovery voltage shall be between 1,02 and 1,05[1] times the rated voltage of the fuse-links and shall be maintained for 30 s after the fuse has operated.

Typical test circuits are given in subsequent parts.

For the breaking capacity test, the current shall be adjusted by changing the series resistance.

The impedance of the AC source shall be less than 10 % of the adjusted value of the total impedance of the applicable circuit.

Compliance is checked by either method A or method B.

1) **Method A** (individual ratings)
   a) rated breaking capacity;
   b) prospective currents of approximately 5, 10, 50 and 250 times the rated current, but not exceeding the rated breaking capacity as specified in the relevant standard sheet.

      The circuit shall be closed at (30 ± 5)° after the passage of voltage through zero.
2) **Method B** (homogeneous series)
   a) rated breaking capacity with random closing angle;
   b) fuse-links shall be tested at rated breaking capacity.

NOTE The breaking capacity can be lower with DC than with AC. It is influenced by the circuit inductance and, with AC, additionally by the instant of closing the circuit.

The DC value, if required by the purchaser or user, should be specified by the manufacturer.

The prospective current of 5, 10, 50, 250 times the rated current as well as the rated breaking capacity shall be adjusted within a tolerance found in Table 1.

Table 1 – Prospective current/Breaking Capacity Tolerance

Prospective current / Rated Breaking Capacity (A)	**Tolerance** (%)
< 200	-0, +2
200 to 1 500	-0, +5
> 1 500	-0, +10

[1] This tolerance may be exceeded with the manufacturer's consent.

The tolerance in Table 1 may be exceeded with the manufacturer's consent.

More details of appropriate tests for the breaking capacity of each type of miniature fuse can be found in the subsequent parts.

9.3.3 Criteria for satisfactory performance

In each of the tests, the fuse-link shall operate satisfactorily without any of the following phenomena:

– permanent arcing;
– ignition;
– bursting of the fuse-link.

Additional criteria for satisfactory performance of individual types of miniature fuse-links are given, where appropriate, in subsequent parts.

NOTE Changes in colour are not considered as a failure.

9.3.4 Insulation resistance

After the breaking capacity test, the insulation resistance between the fuse-link terminations shall be measured with a DC voltage equal to twice the rated voltage of the fuse-link, but not less than 250 V. The resistance shall be not less than 0,1 MΩ.

9.3.5 Type test for fuse-links of homogeneous series

Fuse-links having the largest rated current shall be tested completely according to the relevant testing schedule for the maximum ampere rating of a homogeneous series given in the subsequent parts.

Fuse-links having the smallest rated current shall be tested according to the relevant testing schedule for the minimum ampere rating of a homogeneous series given in the subsequent parts.

9.4 Endurance tests

Fuse-links shall be so constructed as to prevent in extended normal use any electrical or mechanical failure impairing their compliance with this document.

Compliance is checked by the following test:

Direct current shall be used for this test, unless otherwise specified in subsequent parts.

a) A current specified in the relevant standard sheet is passed through the fuse-link for a period of 1 h. The current is then switched off for a period of 15 min. This cycle is repeated 100 times.

   The current stability during the test shall be maintained within ±1 % of the adjusted value.

   The test shall be run continuously, but where unavoidable, a single interruption is permitted.

b) A current specified in the relevant standard sheets is then passed through the fuse-link for 1 h, or, as specified in the standard sheet for ratings above 6,3 A. At the end of this test the voltage drop across the fuse-link is measured and used for the calculation of the maximum sustained power dissipation, where this is specified in subsequent parts.

c) Finally, the voltage drop across the fuse-link is measured again according to 9.1. The voltage drop shall not have increased by more than 10 % of the value measured before the test and shall not exceed the maximum value specified in the relevant standard sheet.

d) After the test, the marking shall still be legible and soldered joints on end caps, for example, shall not show any appreciable deterioration.

NOTE Changes in colour are not considered as a failure.

9.5 Maximum sustained dissipation

The values calculated from the measurement taken in accordance with 9.4 b) shall be within the limits specified in the relevant standard sheet.

9.6 Not applicable

9.7 Fuse-link temperature

Where temperature tests are required in subsequent parts, they shall be performed as follows:

The temperature rise, as measured at any location on the fuse-link enclosure or fuse-link terminations, shall not exceed 135 K when the fuse-link is tested as follows:

– the initial current shall be as specified in the relevant standard sheet;
– the initial current shall be applied for 15 min;
– after the first 15 min, the current shall be increased by 0,1 I_N every 15 min until the fuse-link operates;
– the temperature of the fuse-link shall be measured continuously;
– the point for measuring the temperature shall be the hottest location.

Due to the difficulty of specifying the location of the hottest point, it should be determined during the initial 15 min.

A thermocouple or other measuring methods that do not appreciably affect the temperature shall be used to measure the temperature rise.

The test base for mounting and connection of the fuse-link shall be in accordance with 7.3.

Annex A
(informative)

Colour coding for miniature fuse-links

Where colour bands are used for additional identification of the current rating and the time/current characteristics, the following system shall be applied:

a) The miniature fuse-links specified in the relevant standard sheets are provided with four colour bands, the first three identifying the rated current expressed in milliamperes and the last, broader, colour band identifying the time/current characteristics.

b) The colour bands shall extend over at least half the circumference of the fuse body and shall be evenly spaced and clearly separated as indicated in Figure A.1.

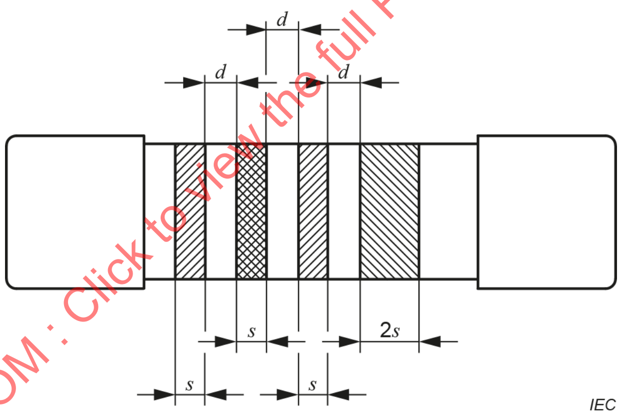
NOTE 1 In the case of transparent miniature fuse-links, the spacings still allow for the visibility of the fuse-element.

c) The IEC standards with regard to colour coding practices, i.e. IEC 60062 and IEC 60425, shall be used as far as applicable.

d) The colour code system given in Table A.1 shall be used.

NOTE 2 In Table A.1, both series R 10 and R 20 are given with their corresponding colour code. In order to keep the number of colour bands to a minimum, only the first two colour bands are used for identifying the first two digits.

e) In addition to the requirements given in 6.3, it is recommended to print the relevant colour coding of the contents on the packing also.



NOTE The values for *d* and *s* are given in subsequent parts.

Figure A.1 – Layout of colour bands

Table A.1 – Colour coding for miniature fuse-links

Rated current mA	First band colour	Second band colour	Third band Colour	Third band Multiplier	Fourth band time/current characteristic
25 *	Red	Green	Black	10^0	FF (0) = black
32 *	Orange	Red	«	10^0	F (2) = red
40 *	Yellow	Black	«	10^0	M (4) = yellow
50 *	Green	Black	«	10^0	T (6) = blue
56	Green	Blue	«	10^0	TT (8) = grey
63 *	Blue	Orange	«	10^0	
71	Violet	Brown	«	10^0	
80 *	Grey	Black	«	10^0	
90	White	Black	«	10^0	
100 *	Brown	Black	Brown	10^1	
112	Brown	Brown	«	10^1	
125 *	Brown	Red	«	10^1	
140	Brown	Yellow	«	10^1	
160 *	Brown	Blue	«	10^1	
180	Brown	Grey	«	10^1	
200 *	Red	Black	«	10^1	
224	Red	Red	«	10^1	
250 *	Red	Green	«	10^1	
280	Red	Grey	«	10^1	
315	Orange	Brown	«	10^1	
355	Orange	Green	«	10^1	
400 *	Yellow	Black	«	10^1	
450	Yellow	Green	«	10^1	
500 *	Green	Black	«	10^1	
560	Green	Blue	«	10^1	
630 *	Blue	Orange	«	10^1	
710	Violet	Brown	«	10^1	
800	Grey	Black	«	10^1	
900	White	Black	«	10^1	
1 000 *	Brown	Black	Red	10^2	
1 120	Brown	Brown	«	10^2	
1 250 *	Brown	Red	«	10^2	
1 400	Brown	Yellow	«	10^2	
1 600 *	Brown	Blue	«	10^2	
1 800	Brown	Grey	«	10^2	
2 000 *	Red	Black	«	10^2	
2 500 *	Red	Green	«	10^2	
3 150 *	Orange	Brown	«	10^2	
4 000 *	Yellow	Black	«	10^2	
5 000 *	Green	Black	«	10^2	
6 300 *	Blue	Orange	«	10^2	
8 000 *	Grey	Black	«	10^2	
10 000 *	Brown	Black	Orange	10^3	

* = R 10 series.

Colour bands indicating rated current based upon first two digits of R 10/R 20 series.

Annex B
(informative)

Example presentations of time/current characteristic

Example presentations of time/current characteristic are shown in Figure B.1 and Figure B.2.

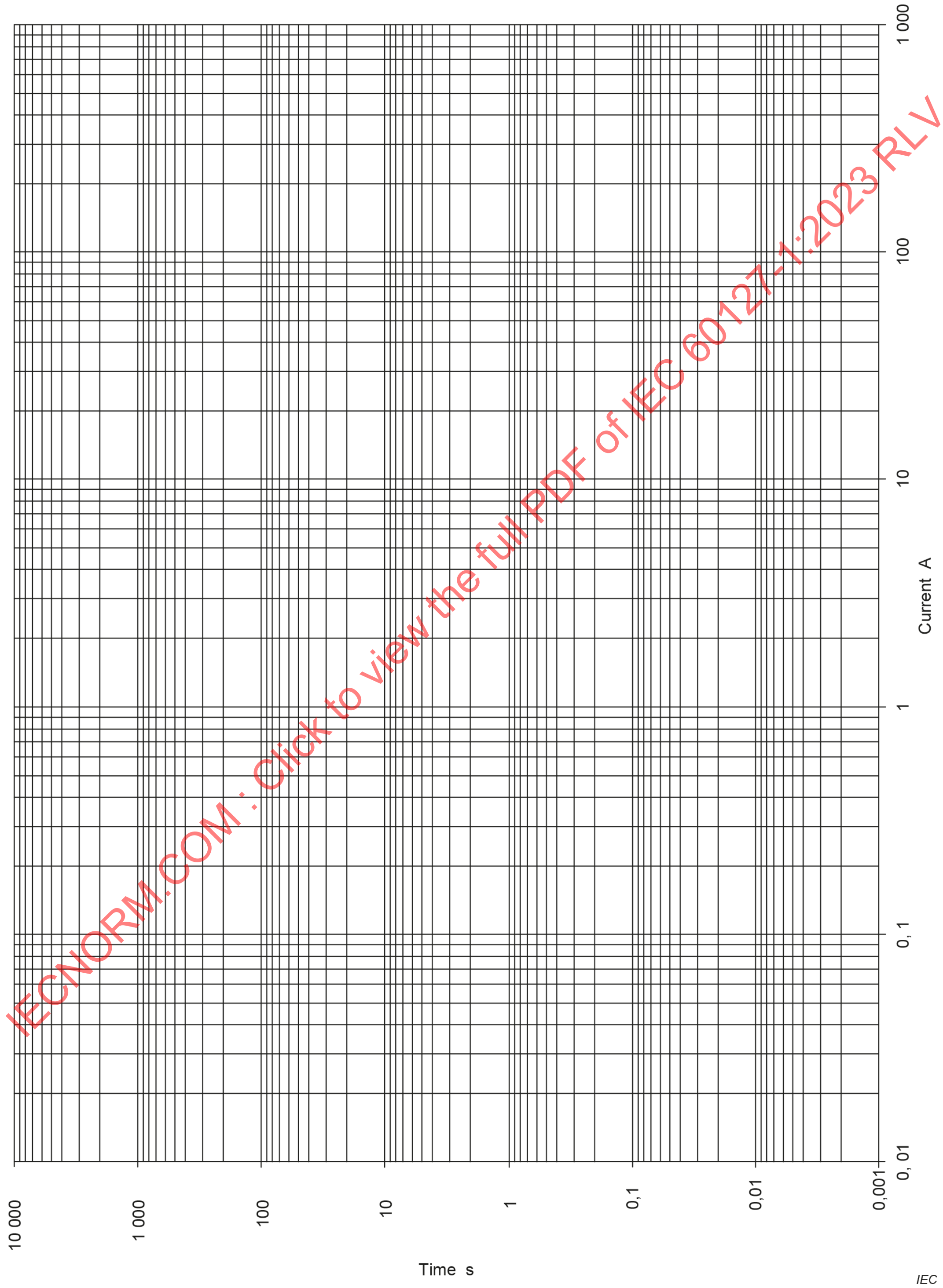


Figure B.1 – Example presentation of time/current characteristic, ratio 2:1

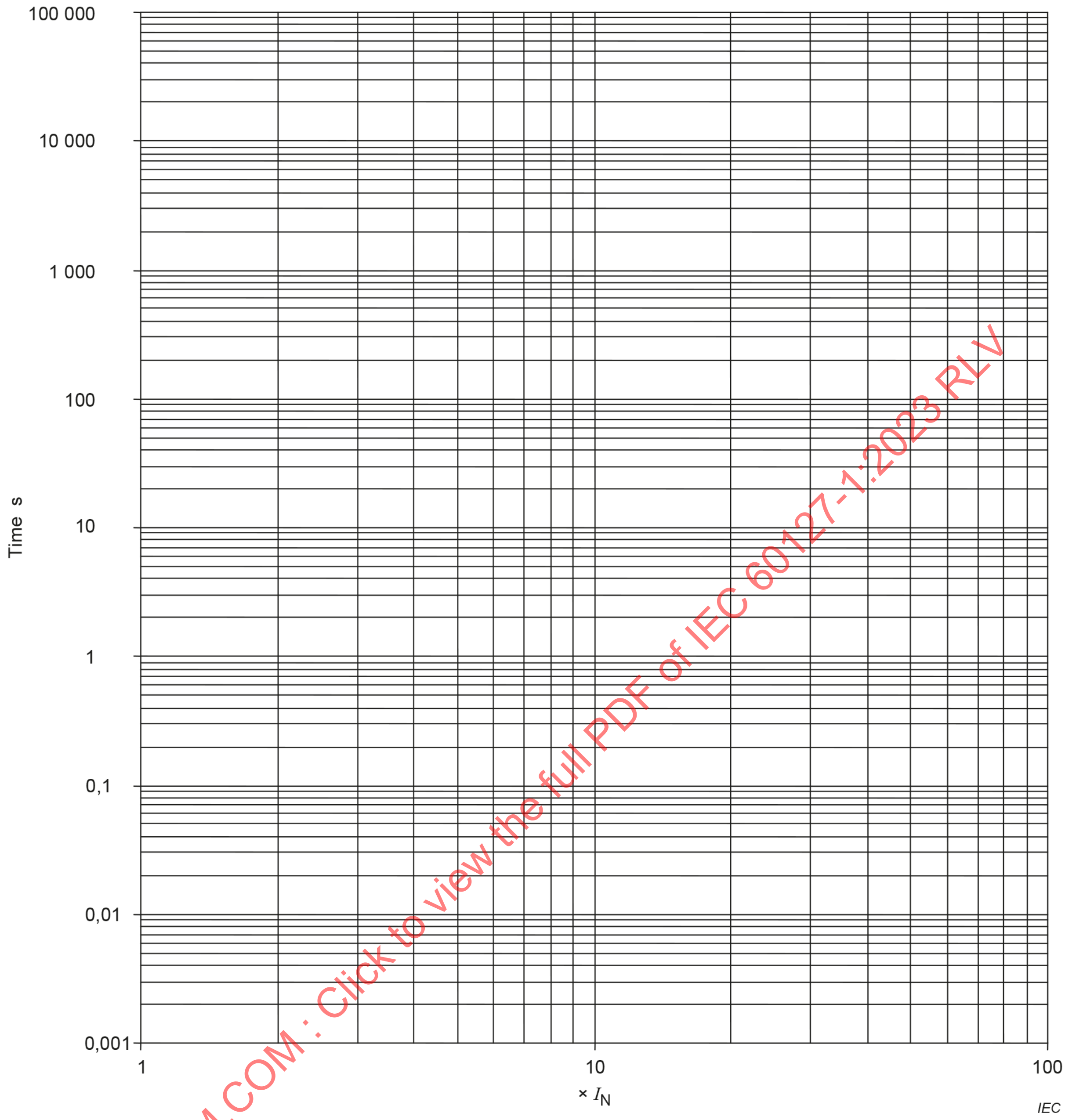


Figure B.2 – Example presentation of time/current characteristic, ratio 3:1

Annex C
(informative)

Audit testing and surveillance – Guidelines for the application of the principles of IECEE 03 (CB-FCS) to miniature fuse-links

C.1 Overview

The contents of this annex were previously in IEC 60127-10. IEC 60127-10 contained the information found in this user guide but the IEC determined that it would be advantageous to the user of IEC 60127-1 to have this information as an informative annex rather than a separate part of the IEC 60127 series.

IEC 60127 is subdivided into parts. IEC 60127-1 contains the general requirements while IEC 60127-2, -3, -4 and -7 contain specific requirements for fuse-links and IEC 60127-6 contains specific requirements for fuse-holders.

C.2 General

This annex relates to miniature fuse-links for the protection of electric appliances, electronic equipment and component parts thereof, normally intended to be used indoors, as specified in IEC 60127-2, 60127-3, 60127-4 and 60127-7. IEC 60127-8 was not included in the original part 10. Additional details for this part are under consideration.

This annex does not apply to fuse-links for appliances intended to be used under special conditions, such as in a corrosive or explosive atmosphere.

The objective of this guide is to introduce the user to the important properties of miniature fuse-links and fuse-holders for miniature fuse-links and to give some guidance on applying them.

NOTE 1 If the current or voltage are outside of the scope of IEC 60127 series, refer to IEC 60269 series.

NOTE 2 Fuse-links of the same type and rating might, due to differences in design, have different voltage drops and different behaviours. Therefore, in practice, they may not be interchangeable when used in applications with low-voltage circuits, especially in combination with fuse-links of lower rated currents.

NOTE 3 Contact the manufacturer for further information.

C.3 Properties of miniature fuse-links

The miniature fuse-link provides protection against the effects of short circuits and sustained overloads, protecting components and conductors upstream of the fault and isolating the faulty branch of the circuit downstream of the fault. The opening of the fuse-link also acts as a diagnostic tool, helping to identify the location of the fault.

Some of the properties of miniature fuse-links include:

- Wide range of physical types of construction: miniature fuse-links are available in a wide choice of physical constructions. For example, there are fuse-links that can be fitted into clips and fuse-holders or plugged into sockets enabling easy replacement. There are also types which can be soldered on to printed wiring boards by through-hole mounting or surface mounting, using wave soldering or reflow soldering.
- Low cost and very small dimensions: miniature fuse-links provide very good circuit protection in a small package suitable for miniaturized equipment.

- Wide range of characteristics: miniature fuse-links are generally used within electronic equipment, where prospective short-circuit currents are below 1 500 A. In case of miniature fuse-links for special application, below 50 kA. Fuse-link s are available with a very wide range of characteristics, from (very) quick acting types to (long) time-lag types. The latter types are very useful because they can withstand inrush currents experienced during switching on, but will also open under sustained overloads.
- Discrimination (selectivity): standardized fuse-link characteristics and limitation of let-through energy ensure that a faulty circuit is isolated by the fuse-links without opening higher rated upstream fuse-links, avoiding disconnection of the supply to healthy circuits downstream.
- Reliability: miniature fuse-links carry operational currents continuously without any substantial change or deterioration in their characteristics, and give equal protection to that provided by a new fuse-link. During their long life, no maintenance is required.
- Tamper-proof reproducible characteristics: miniature fuse-links provide a package of protection tailor-made for the application. The same level of protection is then maintained by a replacement fuse-link of the same type and rating, fitted after the fault has been corrected. The extensive schedule of tests in the IEC 60127 series together with a quality system such as that described in IEC 60127-5 and a follow-up service by a National Certification Body, ensure that all aspects of fuse-link operation are accurately and safely reproduced at any location world-wide.
- Arc reduction: suitable fuse-links can disconnect faults so quickly that there is no time for an arc to become established at the fault location.

C.4 Different types of fuse-links

C.4.1 General

IEC 60127 makes reference to four families of fuse-links:

- IEC 60127-2 Cartridge fuse-links
- IEC 60127-3 Sub-miniature fuse-links
- IEC 60127-4 Universal Modular Fuse-links (UMF)
- IEC 60127-7 Miniature fuse-links for special applications
- IEC 60127-8 Fuse resistors with particular overcurrent protection

C.4.2 Time/current characteristics

These are terms that define how quickly a fuse-link will safely operate (open) at various overload current levels. Fuse-links conforming to the standard sheets in the various parts of IEC 60127 are characterized as follows:

- FF – Very quick acting
- F – Quick acting
- M – Medium time-lag
- T – Time-lag
- TT – Long time-lag

The individual standard sheets specify precise time gates for each overload current level, given as a multiple or percentage of the rated current (e.g. 2,10 or 210 %, 2,75 or 275 %). The fuse-element shall melt within the given time gate.

It should be noted that the characteristics of fuse-links conforming to other standards, such as CSA-C22.2 No. 248.14 – UL 248-14, could be quite different from the characteristics specified in IEC 60127 series. Additionally, these other standards might not specify the same characteristic definitions or precise time gates. Accordingly, the definition of terms such as very fast acting, fast acting, quick acting, normal acting, medium acting, medium blow, time lag, time delay and others are left to the individual fuse-link manufacturers, and can vary widely.

C.4.3 Breaking capacity

The breaking capacity of a fuse-link is the value of current that a fuse-link can safely interrupt at its rated voltage. It should be noted that a fuse-link may have multiple breaking capacities. For example, 100A for 250 VAC and 50A for 125 VDC. The breaking capacity assigned by the fuse-link manufacturer is usually that of the standard sheet, for a given voltage as well as other specified test conditions such as circuit power factor, closing angle, etc. In practice, a fuse-link shall not be used in a circuit that has a potential fault (short-circuit) current greater than the rated breaking capacity of the fuse-link. It is usually difficult to determine the actual maximum potential fault current of a circuit/application. Often it is an assumed theoretical value assigned by a safety agency. In some cases, the suitability of a fuse-link's breaking capacity is determined by testing the fuse-link in the end product, under short-circuit conditions.

C.4.4 Cartridge fuse-links (IEC 60127-2)

Two sizes of fuse-links are described: 5 mm × 20 mm and 6,3 mm × 32 mm. The details are specified in 10 standard sheets, as shown in Table C.1. The rated voltage is 250 V AC except for the following fuse-links:

- Fuse-links shown in standard sheet 4, which are rated 250 V for 50 mA through 2 A, 150 V for 2,5 A through 4 A and 60 V for 5 A through 10 A;
- Fuse-links shown in standard sheets 9 and 10, which are rated 500 V for 100 mA through 10 A.

Table C.1 – Summary of IEC 60127-2 Standard Sheets

Standard sheet	Dimensions mm	Characteristic F – Quick acting T – Time-lag	Rated breaking capacity
1	5 × 20	F	High (1 500 A)
2	5 × 20	F	Low (35 A or 10 I_N)*
3	5 × 20	T	Low (35 A or 10 I_N)*
4	6,3 × 32	F	Low (35 A or 10 I_N)*
5	5 × 20	T	High (1 500 A)
6	5 × 20	T	Enhanced (150 A)
7	6,3 × 32	F	Enhanced (200 A)
8	6,3 × 32	T	Enhanced (200 A)
9	6,3 × 32	F	High (1 500 A)
10	6,3 × 32	T	High (1 500 A)

* Whichever is greater.

NOTE Already approved 5 × 20 mm fuse-links are available in pig-tail form (wire terminated) for direct connection to printed wiring boards.

C.4.5 Sub-miniature fuse-links (IEC 60127-3)

IEC 60127-3 consists of four standard sheets, as shown in Table C.2, all of which refer to low breaking capacity fuse-links. Two types of fuse-links are described, radial and axial, for use on printed wiring boards.

Table C.2 – Summary of IEC 60127-3 Standard Sheets

Standard sheet	Termination	Characteristic	Rated breaking capacity
1	radial	F	Low (50 A)
2	axial or radial	F	Low (50 A)
3	axial or radial	F	Low (35 A or 10 I_N)*
4	axial or radial	T	Low (35 A or 10 I_N)*

* Whichever is greater.

The spacing of the fuse-link terminations are designed to permit easy installation on printed wiring boards having a grid system of holes located at 2,54 mm between centres. Care should be taken that creepage and clearance distances are maintained.

C.4.6 Universal Modular Fuse-links (IEC 60127-4)

Two types of fuse-link are described, through-hole types (standard sheet 1) with rated voltages of 32 V, 63 V, 125 V and 250 V and surface mount types (standard sheet 2) with rated voltage of 12,5 V, 25 V, 32 V, 50 V, 63 V, 125 V and 250 V. As shown in Table C.3.

Table C.3 – Summary of IEC 60127-4 Standard Sheets

<table>
<tr><th>Standard sheet</th><th>Rated voltage
V</th><th>Terminal spacing, [b]
mm</th><th>Characteristic</th><th>Rated breaking capacity</th></tr>
<tr><td rowspan="6">1
(Through-hole)</td><td>32</td><td>2,5</td><td rowspan="13">FF, F, T or TT</td><td rowspan="2">Low (35 A or 10 I_N)[a]</td></tr>
<tr><td>63</td><td>2,5</td></tr>
<tr><td>125</td><td>5</td><td>Low (50 A or 10 I_N)[a]</td></tr>
<tr><td>250</td><td>7,5</td><td>Low (100 A)</td></tr>
<tr><td>250</td><td>10</td><td>Intermediate (500 A)</td></tr>
<tr><td>250</td><td>12,5</td><td>High (1 500 A)</td></tr>
<tr><td rowspan="7">2
(Surface mount)</td><td>12,5</td><td>0,4</td><td rowspan="5">Low (35 A or 10 I_N)[a]</td></tr>
<tr><td>25</td><td>0,45</td></tr>
<tr><td>32</td><td>0,48</td></tr>
<tr><td>50</td><td>0,53</td></tr>
<tr><td>63</td><td>1,1</td></tr>
<tr><td>125</td><td>1,3</td><td>Low (50 A or 10 I_N)*</td></tr>
<tr><td>250</td><td>4</td><td>Low (100 A)
Intermediate (500 A)
High (1 500 A)</td></tr>
</table>

[a] Whichever is greater.

[b] For surface mounted fuse-links, minimum terminal spacing values apply.

This area of fuse-link design is developing rapidly. The standard acknowledges this by not being design restrictive, merely specifying maximum dimensions for physical size. To ensure that fuse-links from different manufacturers are interchangeable some investigation might be needed.

C.4.7 Miniature fuse-links for special applications (IEC 60127-7)

Miniature fuse-links for special applications are not intended to be replaced by the end-user of an electrical / electronic appliance.

Fuse-links for special applications are not covered within the scope of other parts of IEC 60127 series. For example, if a 5x20 mm fuse-link, which IEC 60127-2 would typically cover, falls outside of the scope of IEC 60127-2, then IEC 60127-7 may cover this fuse-link.

IEC 60127-7 is applicable to fuse-links with a rated voltage not exceeding 1 000 V, a rated current not exceeding 20 A and a rated breaking capacity not exceeding 50 kA. It does not apply to fuse-links completely covered by the subsequent parts of IEC 60269-1.

Miniature fuse-links for special applications can be intended to be mounted on printed circuit boards (surface mount, through-hole mount, axial or radial) or inserted in specifically designed fuse-holders.

The rated voltage, rated breaking capacity as well as the maximum pre-arcing times at (2,0 or 2,1) and 10 times the rated current shall be decided by fuse-link manufacturers within certain limitations.

Two test methods of the endurance test at normal ambient temperature and the fuse-link temperature respectively are specified in IEC 60127-7. The test method applied is defined by the manufacturer.

Only one standard sheet is utilized in IEC 60127-7 as it addresses all the different possibilities of fuse-links in special applications, as shown in Table C.4.

Table C.4 – Summary of IEC 60127-7 Standard Sheet

Standard sheet	Rated voltage V	Terminal spacing [a] mm	Characteristic	Rated breaking capacity
1	12,5	0,4	Defined by manufacturer	Defined by manufacturer
	25	0,45		
	32	0,48		
	50	0,53		
	63	1,1		
	125	1,3		
	250	2,5		
	500	To be determined		
	1000	To be determined		

[a] For surface mount fuse-links, minimum terminal spacing values apply.

C.5 Applications

C.5.1 Applications – Fuse-link selection criteria

Selection of a miniature fuse-link for a given application is usually dictated by three basic categories of criteria:

a) electrical requirements of the application;

b) conformance to published fuse-link safety standards;

c) mechanical properties/physical size.

It is necessary to first determine the electrical performance required of the fuse-link, as dictated by the application, and usually, safety agency test requirements for the end product. The electrical characteristics and breaking capacity needed for the application shall conform to a published safety standard. This conformance is usually confirmed by third party (safety agency) approval of the fuse-link.

Only after these criteria are met can the mechanical/dimensional attributes be considered.

C.5.2 Electrical criteria

The electrical ratings and performance required of a fuse-link are dictated by:

a) normal operating conditions of the end product, i.e. steady state current, supply voltage, ambient temperature, etc.;

b) foreseeable field fault conditions due to failures within the end product;

c) foreseeable field fault conditions due to power line crossing or other surges (e.g. lightning);

d) specified overload and short-circuit test conditions imposed by safety agencies on the end product.

The following information should be considered for each particular application:

1) The circuit-operating voltage and whether it is alternating current (AC) or direct current (DC).
2) Any transient conditions that exist, for example:
   i) the maximum inrush current at product “switch-on” (including its waveform and duration) that the fuse-link shall withstand without opening;
   ii) the anticipated usage pattern or duty cycle: will the end product be switched on once a day, once a week, once a year, etc. or continuously cycled?;
   iii) any pulse current surges due to secondary lightning surges (amplitude, waveform and number of cycles) that the fuse-link shall withstand without opening.
3) Normal operating conditions:
   i) maximum steady-state current that the fuse-link will be subjected to in service;
   ii) minimum/maximum ambient conditions.
4) Circuit protection performance required:
   i) minimum overload current at which the fuse-link shall operate, and the maximum time allowed to operate (open);
   ii) other critical overload level or time constraints that the fuse-link shall meet;
   iii) maximum short-circuit current and voltage that the fuse-link shall interrupt.

C.5.3 Mechanical/physical dimensions

Once the electrical requirements and any safety approval issues are determined, then the mechanical options can be addressed.

C.6 Protection by I^2t limitation and pulse operation

C.6.1 I^2t value

It should be noted that I^2t is not a parameter that is measured or verified in the IEC 60127 Series. Pre-arcing (melting) I^2t or 'Joule Integral' is a measure of the energy required to melt the fuse-element and is expressed as "ampere squared seconds" (A^2s). For sufficiently high currents, pre-arcing I^2t and the energy it represents is a constant value for each different fuse-element. Because every fuse-link type and rating has a different fuse-element, it is necessary to determine the I^2t for each. This I^2t value is a parameter of the fuse-link itself and is determined by the element material and configuration. This nominal pre-arcing I^2t is not only a constant value for each fuse-element design, but it is independent of voltage and substantially independent of temperature.

The operating I^2t is a measure of the let-through energy of the fuse-link and is the sum of the pre-arcing and arcing I^2t. The arcing I^2t is not determined solely by the fuse-link itself, but by the circuit's parameters.

operating I^2t = pre-arcing I^2t + arcing I^2t

C.6.2 Pulse operation

Usually, the pre-arcing I^2t is used to select a fuse-link for an application where it is necessary to sustain large current pulses of a short duration. These currents are common in many applications and are described by a variety of terms, such as "surge current", "start-up current", "inrush current" and other similar circuit "transients" that can be classified in the general category of "pulses". It is important to take into account the I^2t and repetition rate of the pulse. In order to avoid nuisance opening, it is necessary to select a fuse-link with a pre-arcing I^2t sufficiently larger than the pulse I^2t.

C.6.3 I^2t limitation

For protection of sensitive components, the operating I^2t is the important parameter. Components such as semi-conductors have a withstand rating which gives the amount of energy which they can handle without failure. For this application, unlike pulse operations, it is important to select a fuse-link that has an operating I^2t less than the component withstand rating.

Conclusion: select the I^2t value of the fuse-link so that

a) the I^2t inrush pulse is less than the pre-arcing I^2t value of the fuse-link;

b) the operating I^2t value of the fuse-link is less than the maximum I^2t value of the device that has to be protected.

The IEC suggests measuring I^2t at 10 I_N. This can lead to overstated values, particularly with time lag fuse-links whose operating time at 10 I_N is usually significantly greater than fast acting types. Published I^2t values are generally nominal and the manufacturers should be consulted if this parameter is critical to the design analysis.

C.7 Direct current (DC) applications

C.7.1 General information

While published fuse-link rating information is based on AC data and might not be applicable for DC applications, all fuse-links shall operate in both AC and DC circuits. However, the DC rated voltage and rated breaking capacity might be different from the AC ratings of the fuse-link. To select a fuse-link for DC applications, the circuit time constant shall be determined and the basic ratings for the fuse-link shall be verified for DC performance.

Typical DC applications include:

- batteries/accumulators which are comparatively low voltage (less than 50 V) but with potentially high fault currents;
- telecommunications or power supplies up to 125 V where the fault current is within the AC breaking capacity limit of the fuse-link;
- DC voltages above 125 V where additional testing might be necessary, particularly for breaking capacity.

Inductive and capacitive DC circuits need additional considerations because of the stored energy, characterized by the circuit time constant. This value is usually less than 2 ms for battery circuits and up to about 4 ms for other inductive circuits that can typically be protected by miniature fuse-links. This circuit characteristic can affect the operating time/current characteristics, rated voltage and breaking capacity performance of the fuse-link. Time-current curves are usually based on AC (RMS) or DC currents that are thermally equivalent.

C.7.2 Battery circuits

Batteries contain very little inductance. To select a fuse-link for a battery circuit, determine the circuit time constant and consider the following fuse-link information:

- time current data: develop from either AC (RMS) or DC current;
- DC voltage rating: equal to or greater than the DC circuit voltage;
- DC breaking capacity: equal to or greater than the circuit's available DC fault current. The time constant for the fuse-link breaking capacity test shall be equal to or exceed the time constant of the DC application circuit.

C.7.3 Inductive load circuits

Loads such as motors, solenoids and other coil-type loads can have a large amount of inductance. To select a fuse-link for these applications, follow the procedure for battery circuits.

C.8 Fuse-holders

C.8.1 Features

Allows replacement of the fuse-link without any auxiliary means and without opening the equipment (panel mounted fuse-holder).

C.8.2 Safety aspects

In view of the safety of electrical equipment, the selection of the most suitable fuse-holder is of great importance. Among other parameters, one has to make sure that the admissible power acceptances and temperatures defined by the fuse-holder manufacturer are followed.

To choose a fuse-holder based only on the rated current of a fuse-link can, especially at higher currents, cause unacceptable temperatures if the effect of the heat generated in the contacts of the fuse-holder has not been taken into consideration.

C.8.3 Selection of a fuse-holder

The following parameters shall be considered:

a) maximum sustained dissipation of the fuse-link;

b) rated power acceptance of the fuse-holder, temperatures surrounding the fuse-holder and operating current;

c) the difference between the ambient air temperature outside and inside the equipment;

d) heat dissipation/cooling, ventilation, heat influence of adjacent components.

The rated power acceptance is a measure of the maximum power dissipation that the fuse-holder can handle without exceeding its temperature rise limits. It is intended to be the power dissipation caused by an inserted dummy fuse-link at the rated current of the fuse-holder and at an ambient temperature of 23 °C.

The correlation between ambient air temperature and the rated power acceptance of a fuse-holder for one or several operating currents is demonstrated by derating curves published by the fuse-holder manufacturer.

To keep the power dissipation of the fuse-link inserted in the fuse-holder below the rated power acceptance of the fuse-holder, at the corresponding ambient air temperature and mounting conditions, it is necessary to observe the following two steps:

Step 1

Selection of the fuse-holder is based on the power acceptance at operating current and maximum ambient air temperature. The maximum sustained dissipation of the fuse-link shall be less than or equal to the admissible power acceptance of the fuse-holder.

Step 2

The reduction of the power acceptance of the fuse-holder (from step 1) based on the different conditions at the mounting place etc. shall be determined by the responsible design engineer.

Examples:

– ambient air temperature is considerably higher inside the equipment than outside;

– cross-section of the conductor;

– unfavourable heat dissipation;

– heat influence of adjacent components.

C.8.4 Exchange of fuse-links under load

A fuse-holder with an installed fuse-link shall not be used as a “switch” for turning the power on and off. In order to prevent damage to the fuse-holder, a fuse-link shall only be exchanged when the power in the circuit is switched off.

C.9 Performance on extra-low voltages

In a wide range of applications, miniature fuse-links provide reliable protection against fault current conditions, and have negligible influence on the circuit.

However, consideration should be given when fuse-links are used at extra-low voltages, i.e. in the range of 10 V, especially for fuse-links of low rated current. For a fuse-link having a rated current lower than 100 mA, its cold resistance can be between 1 Ω and 100 Ω, i.e. the impedance of the fuse-link can possibly be as high as the impedance of the circuit. The voltage drop of fuse-links having low rated current is relatively high; it is in the range of 1 V. In contrast to this, the power dissipation of approximately 0,5 W is negligible.

The typical relationship between voltage drop and power dissipation dependent on rated current is shown in Figure C.1.

Due to the non-linear increase of the voltage drop when the fuse-element approaches its melting point, care shall be taken to ensure that there is sufficient voltage available to cause the fuse-link to interrupt the current when an electrical fault occurs.

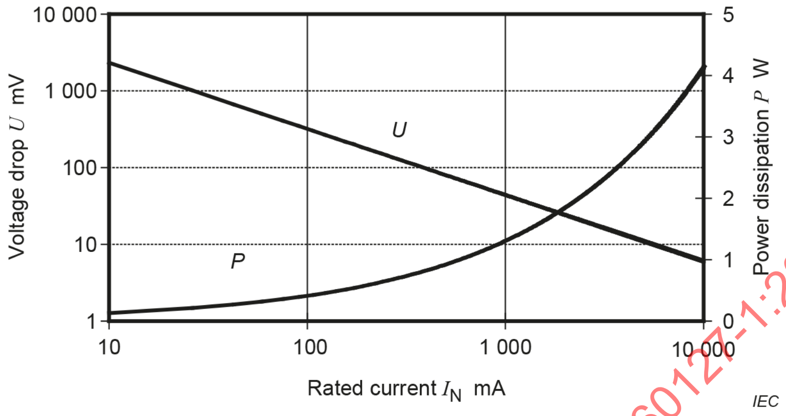


Figure C.1 – Example of power dissipation P and voltage drop U according to rated current I_N

The user should consider certain conditions, particularly the possible influence of the fuse-link on the circuit as a result of its resistance. It is not sufficient to take into account only the cold resistance that is measured at a lower current, i.e. 0,1 I_N, or the voltage drop measured at 1,0 I_N.

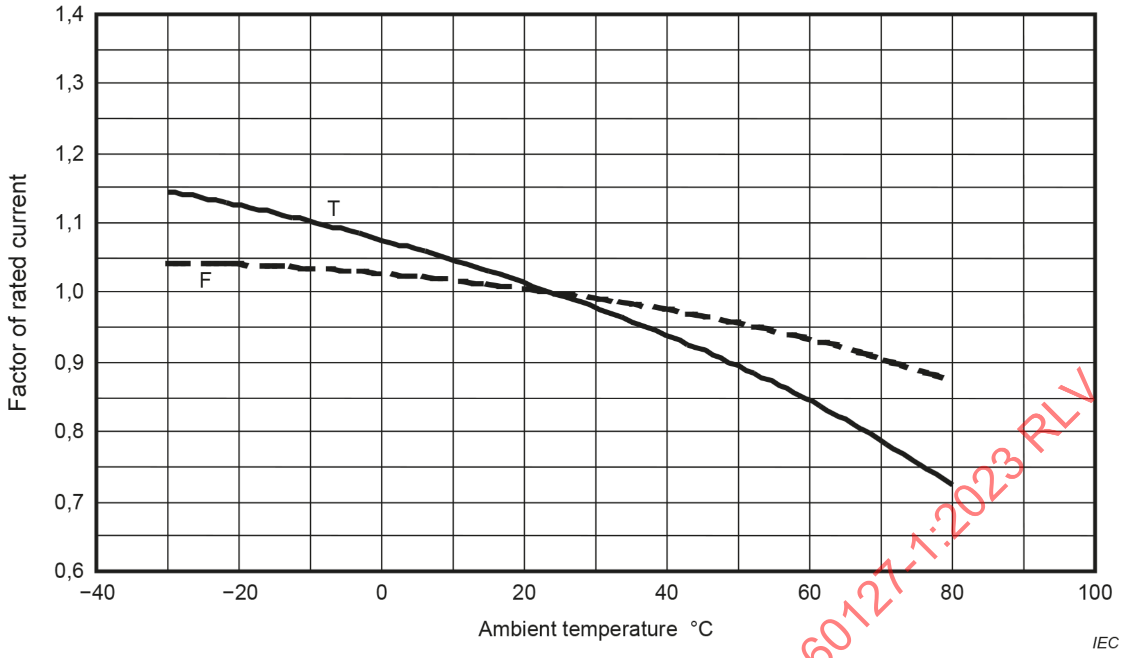
As a rule of thumb, the minimum operating voltage required for proper operation is approximately five to eight times the voltage drop of the fuse-link measured at 1,0 I_N.

C.10 Influence of ambient temperature

Fuse-links are temperature-sensitive devices which means that the temperature of the surroundings influences their characteristics. Due to this fact, rated values and the time/current characteristic are standardized at a temperature of 23 °C. Higher or lower temperatures can result in faster or slower reaction of the fuse-link.

Figure C.2 shows an example of the re-rating of the fuse-link rated current as a function of the ambient temperature.

The surrounding temperature and the specific manufacturers' designs also influence the power acceptance of a fuse-holder.



Key

F Quick acting

T Time-lag

Figure C.2 – Example of the re-rating of the fuse-link rated current

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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COUPE-CIRCUITS MINIATURES –

Partie 1: Définitions pour coupe-circuits miniatures et exigences générales pour éléments de remplacement miniatures

AVANT-PROPOS

1) La Commission Électrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. À cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
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L'IEC 60127-1 a été établie par le sous-comité 32C: Coupe-circuits à fusibles miniatures, du comité d'études 32: Coupe-circuits à fusible. Il s'agit d'une Norme internationale.

Cette troisième édition annule et remplace la deuxième édition (parue en 2006), l'Amendement 1:2011 et l'Amendement 2:2015. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) modification du 6.3 afin de clarifier les éléments de marquage;
b) modification du 9.3.1 afin d'intégrer une tolérance relative au courant présumé applicable à l'essai de pouvoir de coupure;

c) suppression du contenu du 9.6, Essai en impulsions;

d) suppression de l’Annexe C;

e) ajout d’une nouvelle Annex C, Guide d'utilisation pour éléments de remplacement miniatures.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
32C/615/FDIS	32C/624/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

Une liste de toutes les parties de la série IEC 60127, publiées sous le titre général *Coupe-circuits miniatures*, peut être consultée sur le site web de l'IEC.

La présente partie 1 de la série IEC 60127 couvre les définitions, les exigences générales et les essais applicables à tous les types de coupe-circuits miniatures (par exemple, éléments de remplacement à cartouches, éléments de remplacement subminiatures, éléments de remplacement modulaires universels et éléments de remplacement miniatures pour applications spéciales). Toutes les parties subséquentes de la série complète doivent être lues conjointement avec la présente partie 1.

L’IEC 60127 comprend les parties suivantes:

IEC 60127-1, *Miniature fuses – Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links* (disponible en anglais seulement)

IEC 60127-2, *Coupe-circuit miniatures – Partie 2: Cartouches*

IEC 60127-3, *Coupe-circuit miniatures – Partie 3: Éléments de remplacement subminiatures*

IEC 60127-4, *Coupe-circuit miniatures – Partie 4: Éléments de remplacement modulaires universels (UMF) – Types de montage en surface et montage par trous*

IEC 60127-5, *Coupe-circuit miniatures – Partie 5: Lignes directrices pour l'évaluation de la qualité des éléments de remplacement miniatures*

IEC 60127-6, *Coupe-circuit miniatures – Partie 6: Ensembles-porteurs pour cartouches de coupe-circuits miniatures*

IEC 60127-7, *Coupe-circuit miniatures – Partie 7: Éléments de remplacement miniatures pour applications spéciales*

IEC 60127-8, *Coupe-circuit miniatures – Partie 8: Résistances de protection avec protection particulière contre les surintensités*

IEC 60127-9, (libre pour d’autres documents)

IEC 60127-10, intégrée à l'IEC 60127-1 sous forme d'Annex C.

Le comité a décidé que le contenu du présent document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé,
- remplacé par une édition révisée, ou
- amendé.

COUPE-CIRCUITS MINIATURES –

Partie 1: Définitions pour coupe-circuits miniatures et exigences générales pour éléments de remplacement miniatures

1 Domaine d'application et objet

La présente partie de l'IEC 60127 couvre les exigences générales et les essais applicables à tous les types d'éléments de remplacement miniatures (par exemple, éléments de remplacement à cartouches, éléments de remplacement subminiatures, éléments de remplacement modulaires universels et éléments de remplacement miniatures pour applications spéciales) employés pour la protection des appareils électriques, du matériel électronique et de leurs constituants, normalement destinés à être utilisés à l'intérieur.

Le présent document ne s'applique pas aux coupe-circuits destinés à la protection des installations électriques à basse tension. Ces derniers sont couverts par l'IEC 60269, *Fusibles basse tension*.

Des informations détaillées spécifiques concernant chaque subdivision principale sont indiquées dans les parties subséquentes.

Le présent document ne s'applique pas aux coupe-circuits placés dans des appareils destinés à être utilisés dans des conditions particulières, telles qu'une atmosphère corrosive ou explosive.

Le présent document a pour objet

a) d'établir des exigences uniformes pour les coupe-circuits miniatures de manière à assurer la protection des appareils ou des parties d'appareils de la façon la plus appropriée;
b) de définir les caractéristiques des coupe-circuits de manière à fournir des recommandations aux concepteurs d'appareils électriques et de matériel électronique, et à assurer le remplacement des éléments de remplacement par d'autres de dimensions et de caractéristiques identiques;
c) de définir des méthodes d'essai;
d) de définir la puissance dissipée maximale des éléments de remplacement pour assurer une bonne compatibilité de la puissance admissible indiquée avec celle des ensembles-porteurs selon le présent document (voir l'IEC 60127-6).

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60038:2009, *Tensions normales de la CEI*

IEC 60127-6:2014, *Coupe-circuit miniatures – Partie 6: Ensembles-porteurs pour cartouches de coupe-circuits miniatures*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

3.1
coupe-circuit à fusible (coupe-circuit)
appareil dont la fonction est d'ouvrir, par la fusion d'un ou de plusieurs de ses éléments spécialement conçus et dimensionnés à cet effet, le circuit dans lequel il est inséré par interruption du courant lorsque celui-ci dépasse une valeur donnée pendant une durée suffisante

Note 1 à l'article: Le coupe-circuit comprend toutes les parties qui constituent l'appareil complet.

3.2
coupe-circuit miniature
coupe-circuit dans lequel l'élément de remplacement est un élément de remplacement miniature

3.3
élément de remplacement
partie d'un coupe-circuit qui comprend l'élément ou les éléments fusibles, destinée à être remplacée après fonctionnement du coupe-circuit

3.4
élément de remplacement à fusion enfermée
élément de remplacement dont l'élément fusible est totalement enfermé de sorte qu'au cours du fonctionnement dans la limite de ses caractéristiques assignées, il ne peut provoquer aucun effet nuisible externe, par exemple, effet dû au développement d'un arc, à l'émission de gaz ou à la projection de flammes ou de particules métalliques

3.5
élément de remplacement miniature
élément de remplacement à fusion enfermée pour la protection des appareils électriques, du matériel électronique et de leurs constituants normalement destinés à être utilisés à l'intérieur

3.5.1
élément de remplacement à cartouches
élément de remplacement miniature à fusion enfermée dont le pouvoir de coupure assigné ne dépasse pas 2 kA et dont l'une au moins des dimensions principales ne dépasse pas 10 mm

Note 1 à l'article: Les dimensions principales sont la longueur, la largeur, la hauteur et le diamètre.

3.5.2
élément de remplacement miniature pour applications spéciales
élément de remplacement miniature enfermé non couvert par l'IEC 60127-2, l'IEC 60127-3 ou l'IEC 60127-4 et dont le pouvoir de coupure assigné ne dépasse pas 50 kA, dont la largeur et la hauteur ne dépassent pas 12 mm et dont la longueur ne dépasse pas 50 mm

3.5.3
élément de remplacement subminiature
élément de remplacement miniature dont aucune dimension principale du boîtier (corps) ne dépasse 10 mm

Note 1 à l'article: Les dimensions principales sont la longueur, la largeur, la hauteur et le diamètre.

3.5.4
élément de remplacement modulaire universel
élément de remplacement miniature adapté principalement pour la connexion électrique directe sur des circuits imprimés ou autres substrats conducteurs, et qui comprend des caractéristiques qui assurent un certain degré de non-interchangeabilité si nécessaire

3.6
contact de l'élément de remplacement
partie conductrice d'un élément de remplacement destinée à s'engager avec un contact du socle ou du porte-fusible

3.7
ensemble-porteur
combinaison d'un socle et de son porte-fusible

3.8
socle
partie fixe d'un coupe-circuit équipée de contacts et de bornes pour le raccordement au circuit

3.9
contact du socle
partie conductrice d'un socle, connectée à une borne, destinée à s'engager avec un contact du porte-fusible ou de l'élément de remplacement

3.10
porte-fusible
partie mobile d'un coupe-circuit destinée à recevoir un élément de remplacement

3.11
contact du porte-fusible
partie conductrice d'un porte-fusible connectée à un contact de l'élément de remplacement et destinée à s'engager avec un contact du socle

3.12
élément fusible
partie de l'élément de remplacement destinée à fondre lors du fonctionnement du coupe-circuit

3.13
série homogène (d'éléments de remplacement)
série d'éléments de remplacement dont chacun ne diffère de l'autre que par des caractéristiques telles que, pour un essai donné, l'essai d'un seul ou d'un nombre réduit d'éléments de remplacement déterminés de la série peut être considéré comme représentatif de tous les éléments de remplacement de la série

Note 1 à l'article: Les éléments de remplacement sont réputés constituer une série homogène quand leurs caractéristiques satisfont aux points suivants:

– les corps sont de mêmes dimensions, de même matériau et de même méthode de fabrication;
– les capsules ou autres extrémités de fermeture du corps sont de mêmes dimensions, de même matériau et de même méthode de fixation et de scellement;
– le cas échéant, la matière de remplissage du corps est du même matériau et assure le même remplissage. Il convient qu'elle soit de la même taille ou que toute variation de taille de grain en fonction de son courant assigné soit monotone;

– les éléments fusibles sont du même matériau avec les mêmes principes de conception et de construction; il convient que toute modification des dimensions de l'élément fusible en fonction de son courant assigné soit monotone.

– la tension assignée est identique;

– pour les éléments de remplacement à bas pouvoir de coupure, il est nécessaire de vérifier par essai uniquement le pouvoir de coupure assigné le plus élevé de la série homogène.

3.14
caractéristique assignée
terme général employé pour désigner les valeurs caractéristiques qui définissent ensemble les conditions de fonctionnement sur lesquelles les essais sont fondés et pour lesquelles le coupe-circuit est conçu

Exemples de valeurs assignées généralement indiquées pour des coupe-circuits:

– tension (U_N);

– courant (I_N);

– pouvoir de coupure

3.15
caractéristiques temps/courant (d'un élément de remplacement) pour le courant alternatif
courbe qui indique, pour des conditions indiquées de fonctionnement, la valeur du temps exprimée en durée virtuelle en fonction du courant présumé symétrique, exprimé en valeur efficace

Note 1 à l'article: Les caractéristiques temps/courant habituellement indiquées pour un élément de remplacement se rapportent à la durée de préarc et à la durée de fonctionnement.

3.15.1
caractéristiques temps/courant (d'un élément de remplacement) pour le courant continu
courbe qui indique, pour des conditions indiquées de fonctionnement, la valeur du temps exprimée en durée réelle en fonction du courant présumé continu

Note 1 à l'article: Les caractéristiques temps/courant habituellement indiquées pour un élément de remplacement se rapportent à la durée de préarc et à la durée de fonctionnement.

3.16
courant conventionnel de non-fusion
valeur spécifiée du courant que peut supporter sans fondre l'élément de remplacement pendant un intervalle de temps spécifié (temps conventionnel)

3.17
courant présumé (d'un circuit dans le cas d'un court-circuit)
courant qui circule dans le circuit si le coupe-circuit inséré dans ce dernier est remplacé par un conducteur d'impédance négligeable

3.18
durée de préarc (durée de fusion)
intervalle de temps qui s'écoule entre le début de circulation d'un courant suffisant pour provoquer une coupure dans l'élément fusible et l'instant d'amorçage d'un arc

3.19
durée d'arc
intervalle de temps entre l'instant d'amorçage de l'arc et l'instant de l'extinction finale de l'arc

3.20
durée de fonctionnement (durée totale de coupure)
somme de la durée de préarc et de la durée d'arc

3.21
durée virtuelle
valeur de I^2t divisée par le carré de la valeur du courant présumé

Note 1 à l'article: Les valeurs des durées virtuelles, généralement indiquées pour un élément de remplacement, sont les valeurs des durées de préarc et de fonctionnement.

3.22
***I^2t* (intégrale de Joule)**
intégrale du carré du courant pour un intervalle de temps donné

$$I^2t = \int_{t=0}^{t} i^2 dt$$

Note 1 à l'article: La valeur I^2t de préarc est l'intégrale I^2t pour la durée de préarc du fusible.

Note 2 à l'article: La valeur I^2t de fonctionnement est l'intégrale I^2t pour la durée de fonctionnement du fusible.

Note 3 à l'article: Dans un circuit protégé par un fusible, l'énergie en joules libérée dans une portion avec une résistance de 1 Ω est égale à la valeur I^2t de fonctionnement exprimée en A^2s.

3.23
pouvoir de coupure d'un élément de remplacement
valeur (efficace en courant alternatif) du courant présumé qu'un élément de remplacement est capable d'interrompre sous une tension indiquée dans des conditions prescrites d’utilisation et de comportement

3.24
tension de rétablissement
tension qui apparaît aux bornes d'un coupe-circuit après la coupure du courant

Note 1 à l'article: Cette tension peut être prise en considération pendant deux intervalles de temps consécutifs, l'un durant lequel existe une tension transitoire, suivi d'un second intervalle durant lequel existe la tension de rétablissement à fréquence industrielle ou en régime établi.

3.25
puissance dissipée maximale en régime continu
puissance dissipée d'un élément de remplacement mesurée dans des conditions de mesure prescrites au courant maximal supportable pendant 1 h au moins, ou, comme cela est spécifié dans la feuille de norme pour des caractéristiques assignées supérieures à 6,3 A

Note 1 à l'article: La valeur de puissance dissipée maximale en régime continu est utilisée en relation avec la puissance maximale admissible des ensembles-porteurs pour coupe-circuits miniatures conformément à l’IEC 60127-6.

Note 2 à l'article: Ces valeurs sont souvent dépassées pendant de courtes périodes immédiatement avant la fusion de l'élément fusible. Des valeurs qui atteignent deux fois la valeur de la puissance dissipée maximale en régime continu ont été enregistrées.

4 Exigences générales

Les éléments de remplacement doivent être construits de façon que leur fonctionnement soit fiable et sûr et que leurs caractéristiques restent constantes pour tout courant inférieur ou égal au pouvoir de coupure assigné et pour toute tension jusqu'à la tension assignée, lorsqu'ils sont utilisés dans les limites fixées par le présent document.

Lorsque les éléments de remplacement sont utilisés normalement et dans les conditions fixées par la présente norme, leur fonctionnement ne doit générer ni arc permanent, ni arc extérieur, ni flamme susceptibles de présenter un danger pour l'entourage. Pendant l'essai qui établit la puissance dissipée maximale et après fonctionnement, l'élément de remplacement ne doit avoir subi aucun dommage susceptible d'empêcher son remplacement, et le marquage doit être encore lisible.

En règle générale, la conformité est vérifiée par l'exécution de la totalité des essais spécifiés.

5 Caractéristiques assignées

Les feuilles de norme appropriées comprennent des valeurs concernant

- la tension assignée;
- le courant assigné;
- le pouvoir de coupure assigné.

6 Marquage

6.1 Sauf spécification contraire dans les parties subséquentes, les exigences de marquage sont les suivantes:

Chaque élément de remplacement doit porter les indications ci-dessous dans l'ordre indiqué:

a) un symbole qui indique la caractéristique relative durée de préarc/courant telle qu'elle figure dans la feuille de norme appropriée. Ce symbole doit être placé avant et à côté du courant assigné.

   Ces symboles se présentent comme suit:

   FF: à fusion très rapide;

   F: à fusion rapide;

   M: à fusion semi-temporisée;

   T: à fusion temporisée;

   TT: à fusion très temporisée.

b) le courant assigné en milliampères (mA) pour des courants assignés inférieurs à 1 A, et en ampères (A) pour des courants assignés de 1 A ou plus.

   Pour tenir compte de la pratique en vigueur dans certains pays, le courant peut aussi, pour le moment, être indiqué en fractions d'ampère;

c) tension assignée en volts (V);

d) nom ou marque du fabricant (il n'est pas nécessaire qu'il ou elle suive l'ordre de marquage).

6.2 Le marquage doit être indélébile et facilement lisible.

La conformité est vérifiée par examen et par frottement du marquage à la main une première fois pendant 15 s avec un chiffon imbibé d'eau et une seconde fois pendant 15 s avec un chiffon imbibé d'essence minérale.

L'emploi d'un solvant aliphatique hexane (avec une teneur maximale en carbures aromatiques de 0,1 % en volume, un indice de kauributanol de 29, une température d'ébullition initiale d'environ 65 °C, un point sec d'environ 69 °C et une densité d'environ 0,68) est recommandé comme essence minérale.

NOTE Dans le cas d'un code de couleurs, il n'est pas nécessaire d'appliquer l'essai d'indélébilité.

6.3 Le marquage conforme à 6.1 doit être porté sur l'étiquette d'emballage ainsi qu'une référence à la prochaine norme IEC 60127 et une indication de la feuille de norme appropriée. La mention IEC 60127-1 sur l'étiquette d'emballage est facultative. Le marquage sur l'étiquette d'emballage doit inclure l'abréviation A ou mA pour le courant assigné de l'élément de remplacement.

La conformité est vérifiée par examen.

6.4 Une identification supplémentaire du courant assigné et des caractéristiques temps/courant, à l'aide de bandes de couleur, peut être utilisée.

Ce marquage complémentaire doit être conforme à l'Annex A.

6.5 Lorsque le marquage ne peut être réalisé du fait d'un manque d'espace, les informations pertinentes doivent figurer sur le plus petit emballage et dans la documentation technique du fabricant.

7 Généralités sur les essais

7.1 Généralités

Les essais mentionnés dans le présent document sont des essais de type.

Lorsque des essais de réception sont exigés, il est recommandé de les choisir parmi les essais de type du présent document.

7.2 Conditions atmosphériques pour les essais

7.2.1 Sauf spécification contraire dans les parties subséquentes, tous les essais doivent être effectués dans les conditions atmosphériques suivantes:

– température comprise entre 15 °C et 35 °C;
– humidité relative comprise entre 45 % et 75 %;
– pression de l'air comprise entre $8,6 \times 10^4$ Pa et $1,06 \times 10^5$ Pa.

Lorsque les conditions ci-dessus exercent une influence significative, elles doivent être maintenues pratiquement constantes pendant les essais.

Les éléments de remplacement doivent être soumis à l'essai, avec les socles spécifiés, à l'air libre et à l'abri des courants d'air et de tout rayonnement direct de chaleur. L'ensemble-porteur doit être en position horizontale.

Si la température exerce un effet marqué sur les résultats des essais, ceux-ci doivent être réalisés à une température de 23 °C ± 1 °C.

7.2.2 Dans chaque rapport d'essai, la température ambiante doit être mentionnée. Si les conditions normales d'humidité relative ou de pression ne sont pas remplies au cours des essais, une note à ce sujet doit être ajoutée au rapport d'essai.

Lorsque des essais à des températures élevées sont exigés, ces essais doivent être effectués à une température ambiante de 70 °C ± 2 °C, sauf spécification contraire.

7.3 Essais de type

7.3.1 Le nombre d'éléments de remplacement exigés doit être spécifié dans les parties subséquentes.

Les éléments de remplacement doivent être soumis à l’essai ou examinés conformément aux paragraphes suivants:

a) marquage (voir 6.1);

b) dimensions (voir 8.1);

c) construction (voir 8.2);

d) chute de tension (voir 9.1).

et aux essais supplémentaires spécifiés dans les parties subséquentes.

7.3.2 Selon les résultats de l'essai du point 7.3.1 d), ci-dessus, les éléments de remplacement doivent être classés et numérotés dans l'ordre décroissant d'après la valeur de leur chute de tension. Les numéros les plus bas sont affectés aux éléments de remplacement dont la chute de tension est la plus élevée. Ces éléments de remplacement doivent être ensuite soumis aux essais, conformément au plan d'essai correspondant.

Si un essai doit être répété, des éléments de remplacement de rechange doivent être utilisés qui présentent une chute de tension sensiblement égale à celle des éléments de remplacement qui ont servi pour l'essai original.

7.3.3

a) Aucune défaillance n'est admise dans les essais spécifiés aux Articles 6 et 8 et en 9.1, 9.2.2 et 9.7, ainsi qu'aux articles et paragraphes supplémentaires qui doivent être tels qu'ils sont spécifiés dans les parties subséquentes.

b) Si, dans les essais de 9.2.1 et 9.3, deux défaillances se produisent sous l'un quelconque des courants d'essai, les éléments de remplacement sont considérés comme non conformes au présent document. Si, toutefois, une seule défaillance se produit, l'essai doit être répété avec un nombre double d'éléments de remplacement sous le même courant et, au cours de ce nouvel essai, toute autre défaillance doit être source de rejet.

   Si deux défaillances se produisent, toutefois pas dans le même essai, l'élément de remplacement doit être considéré comme conforme, à condition qu'aucune autre défaillance ne se produise en répétant les essais avec un nombre double d'éléments de remplacement.

   Si deux défaillances se produisent, toutefois pas sous le même courant, l'élément de remplacement doit être considéré comme conforme, à condition qu'aucune autre défaillance ne se produise en répétant les essais avec un nombre double d'éléments de remplacement.

c) Dans tous les essais de 9.4, 9.5 et 9.6, une seule défaillance est admise. Deux éléments de remplacement ou plus qui présentent une défaillance dans l'un quelconque des essais, les éléments de remplacement sont considérés comme non conformes à la présente norme, sauf spécification contraire dans les parties subséquentes.

7.4 Socles d'essai

Une base conforme aux exigences spécifiées dans les parties subséquentes doit être utilisée pour les essais qui exigent un socle pour le montage des éléments de remplacement.

7.5 Nature de l'alimentation

La nature de l'alimentation utilisée pour les essais électriques est spécifiée dans les articles correspondants ou dans les feuilles de norme appropriées des parties subséquentes.

Pour un courant alternatif, la tension d'essai est pratiquement sinusoïdale et de fréquence comprise entre 45 Hz et 62 Hz.

8 Dimensions et construction

8.1 Dimensions

Les dimensions des éléments de remplacement doivent être conformes à la feuille de norme appropriée indiquée dans les parties subséquentes.

La conformité est vérifiée par mesurage.

8.2 Construction

L'élément fusible doit être complètement enfermé. Le cas échéant, des informations détaillées supplémentaires de la construction sont données dans les parties subséquentes.

8.3 Sorties

Les contacts de l'élément de remplacement doivent être en une matière qui ne se corrode pas ou en une matière convenablement protégée contre la corrosion; aucun décapant ni aucune substance isolante ne doivent recouvrir les surfaces extérieures des sorties.

Un dépôt de nickel ou d'argent est considéré comme une protection suffisante pour les capsules en laiton.

Le cas échéant, des essais concernant la fixation rigide sont spécifiés dans les parties subséquentes.

8.4 Disposition et configuration des sorties

Des essais appropriés concernant la disposition ou la position des fiches, etc. sont spécifiés, le cas échéant, dans les parties subséquentes.

8.5 Soudures

Les soudures visibles extérieurement (par exemple, celles des capsules) ne doivent pas fondre en usage et en fonctionnement normaux.

La conformité est vérifiée par l'examen des soudures, après les essais décrits en 9.2.1, 9.2.2, 9.4, 9.5 et 9.6.

9 Exigences électriques

9.1 Chute de tension

La chute de tension dans les éléments de remplacement, lorsqu'ils sont parcourus par leur courant assigné, ne doit pas dépasser les valeurs maximales indiquées dans la feuille de norme appropriée.

Les valeurs individuelles ne doivent pas varier de plus de 15 % de la valeur moyenne déterminée, pour le modèle en essai, au cours des essais de type.

Si, sous l'influence de l'effet Peltier, des chutes de tension différentes sont mesurées lorsque le courant qui traverse l'élément de remplacement est inversé, la valeur la plus élevée doit être prise.

La conformité est vérifiée par le mesurage de la chute de tension lorsque l'élément de remplacement est soumis à son courant assigné pendant une durée suffisante pour atteindre la stabilité de la température.

Cet essai doit être effectué en courant continu. Un matériel qui n'influe pas de manière significative sur le résultat de l'essai doit être utilisé.

La stabilité de la température est considérée comme atteinte lorsque la variation de la chute de tension est inférieure à 2 % de la valeur par minute observée précédemment. Pendant cet essai, le courant qui traverse l'élément de remplacement ne doit pas s'écarter de plus de ±1 % du courant assigné et l'exactitude de mesure de la chute de tension doit se situer dans des limites de tolérance de ±1 %.

Des problèmes peuvent survenir lorsque des éléments de remplacement sont utilisés sous des tensions considérablement inférieures à leur tension assignée, principalement pour de faibles caractéristiques assignées. Du fait de l'augmentation de la chute de tension lorsque l'élément de remplacement est proche de son point de fusion, il convient de vérifier que la tension du circuit est suffisante pour permettre à l'élément de remplacement de couper le courant en cas de défaut électrique. De plus, des éléments de remplacement de même type et de même caractéristique assignée peuvent avoir des chutes de tension différentes du fait de leur construction ou d'éléments fusibles différents. Ces éléments de remplacement peuvent par conséquent ne pas être interchangeables en pratique lorsqu'ils sont utilisés dans des applications avec de faibles tensions d'alimentation, particulièrement en combinaison avec des éléments de remplacement de courants assignés plus faibles.

9.2 Caractéristique temps/courant

9.2.1 Caractéristique temps/courant à la température ambiante normale

La caractéristique temps/courant doit se situer dans les limites spécifiées dans les feuilles de norme appropriées.

La conformité est vérifiée par le mesurage de la durée de préarc dans les conditions atmosphériques mentionnées en 7.1.

La valeur du courant qui traverse l'élément de remplacement doit être réglée à ±1 % près de la valeur exigée. La stabilité du courant pendant l'essai doit être maintenue à la valeur réglée à ±1 % près. La tension de la source ne doit pas dépasser la tension assignée de l'élément de remplacement en essai. La tolérance relative à l'exactitude de mesure de la durée doit être de ±5 % lorsqu'elle est inférieure à 10 s et de ±2 % lorsqu'elle est égale ou supérieure à 10 s.

Dans le cas de très courtes durées de préarc pour des valeurs élevées du courant, avec lesquelles il n'est plus possible de maintenir un courant constant, la valeur de I^2t doit être mesurée et la durée virtuelle doit être calculée.

9.2.2 Essai à température élevée

Lorsque la feuille de norme le spécifie, les éléments de remplacement doivent également être soumis à l'essai pendant 1 h à la température de 70 °C, sauf spécification contraire, et au multiple du courant assigné indiqué sur la feuille de norme appropriée.

La stabilité du courant pendant l'essai doit être maintenue à ±2,5 % de la valeur réglée. L'élément de remplacement ne doit pas fonctionner.

9.2.3 Méthode d'essai

Ces essais doivent être effectués en courant continu.

NOTE 1 Le courant continu est utilisé parce qu'il est plus facile de contrôler et d'éliminer la variation inhérente au courant alternatif causé par le point sur l'onde de tension qui produit la commutation.

Il convient de veiller à ce que la durée d'arc ne soit pas comprise dans la durée totale mesurée.