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Edition 2.2 2015-02

CONSOLIDATED VERSION

colour inside

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

IEC 60127-1:2006-06+AMD1:2011-04+AMD2:2015-02 CSV(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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This Consolidated version of IEC 60127-1 bears the edition number 2.2. It consists of the second edition (2006-06) [documents 32C/387/FDIS and 32C/390/RVD], its amendment 1 (2011-04) [documents 32C/436/CDV and 32C/438/RVC] and its amendment 2 (2015-02) [documents 32C/490/CDV and 32C/505/RVC]. The technical content is identical to the base edition and its amendments.

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendments 1 and 2. Additions and deletions are displayed in red, with deletions being struck through. A separate Final version with all changes accepted is available in this publication.

This publication has been prepared for user convenience.

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

The major technical changes with regard to the first edition concern subclause 9.2.3 where the nature of the current source has been clarified; in addition, IEC 60038: *IEC standard voltages*, has been added to the list of normative references.

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

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 and universal modular fuse-links). All subsequent parts of the complete series should be read in conjunction with this Part 1.

IEC 60127 consists of the following parts, under the general heading *Miniature fuses*:

Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links
Part 2: Cartridge fuse-links
Part 3: Sub-miniature fuse-links
Part 4: Universal modular fuse-links (UMF) – Through-hole and surface mount types
Part 5: Guidelines for quality assessment of miniature fuse-links
Part 6: Fuse-holders for miniature fuse-links
Part 7: (Free for further documents)
Part 8: (Free for further documents)
Part 9: (Free for further documents)
Part 10: User guide for miniature fuses

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication 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 and universal modular fuse-links) for the protection of electric appliances, electronic equipment and component parts thereof normally intended to be used indoors.

This standard 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 standard 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 standard 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 standard (see IEC 60127-6).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60038, *IEC standard voltages*

IEC 60127-6:1994, *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 definitions apply.

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 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 ~~of rated breaking capacity not exceeding 2 kA and which has at least one of its principal dimensions not exceeding 10 mm~~ for the protection of electric appliances, electronic equipment and component parts thereof normally intended to be used indoors

~~NOTE Principal dimensions are length, width, height and diameter.~~

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 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

3.6
sub-miniature fuse-link
miniature fuse-link of which the case (body) has no principal dimension exceeding 10 mm

NOTE Principal dimensions are length, width, height and diameter.

3.7
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

3.8
fuse-link contact
conductive part of a fuse-link designed to engage with a fuse-base contact or with a fuse-carrier contact

3.9
fuse-holder
combination of a fuse-base with its fuse-carrier

3.10
fuse-base
fuse-mount
fixed part of a fuse provided with contacts and terminals for connection to the system

3.11
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

3.12
fuse-carrier
movable part of a fuse designed to carry a fuse-link

3.13
fuse-carrier contact
conductive part of a fuse-carrier connected to a fuse-link contact and designed to engage with a fuse-base contact

3.14
fuse-element
part of the fuse-link designed to melt when the fuse operates

3.15
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 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.

3.16
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.

3.17
time/current characteristics (of a fuse-link)
a) For a.c.: 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 r.m.s. value

b) For d.c.: curve giving, under stated conditions of operation, the value of time expressed as actual time as a function of the d.c. prospective current

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

3.18
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

3.19
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

3.20
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

3.21
arcing time
interval of time between the instant of the initiation of the arc and the instant of final arc extinction

3.22
operating time (total clearing time)
sum of the pre-arcing time and the arcing time

3.23
virtual time
value of I^2t divided by the value of the square of the value of the prospective current

NOTE 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.

3.24
***I*²*t* (joule integral)**
integral of the square of the current over a given time interval:

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

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

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

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

3.25
breaking capacity of a fuse-link
value (r.m.s. for a.c.) of prospective current that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

3.26
recovery voltage
voltage which appears across the terminals of a fuse after breaking of the current

NOTE 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.

3.27
maximum sustained 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 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 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 standard.

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

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

6.1 Each fuse-link shall be marked with:

a) Rated current in milliamperes for rated currents below 1 A, and in amperes 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.

b) Rated voltage in volts (V).

c) Maker's name or trade mark.

d) 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.

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 together with a reference to this standard and an indication of the appropriate standard sheet. The marking on the packing shall include the abbreviation A and mA.

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.

7 General notes on tests

Tests according to this standard are type tests.

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

7.1 Atmospheric conditions for testing

7.1.1 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.

7.1.2 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.

7.2 Type tests

7.2.1 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.

7.2.2 Based on the results of the test in item d) above, 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.

7.2.3

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 current, the fuse-links are deemed not to comply with this standard. 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 ~~more than~~ two failures occur, but not both in the same current, the fuse-link shall be deemed ~~not~~ to comply ~~with this standard~~ 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.

7.3 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.

7.4 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 a.c., 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, due to difference in design or element material, have different voltage drops and may 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 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 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 d.c. voltages in Table 6 of IEC 60038.

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 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 a.c. can be significantly different from the characteristic determined with d.c. 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 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 Operating conditions

Fuse-links shall operate satisfactorily without endangering the surroundings 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 a.c. 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 be lower with d.c. than with a.c. It is influenced by the circuit inductance and, with a.c., additionally by the instant of closing the circuit.

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

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

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

9.3.2 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.

9.3.3 Insulation resistance

After the breaking capacity test, the insulation resistance between the fuse-link terminations shall be measured with a d.c. 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.

9.3.4 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 standard.

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 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 ~~across the fuse-link after the test~~ 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.

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.

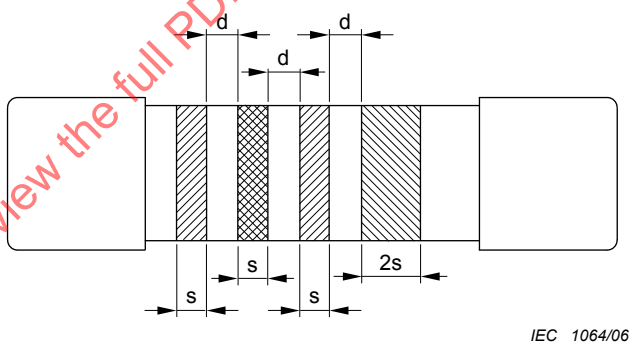
NOTE 1 In the case of transparent miniature fuse-links, the spacings still allow for the visibility of the fuse-element.

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 mA	First band colour	Second band colour	Third band		Fourth band time/current characteristic
			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

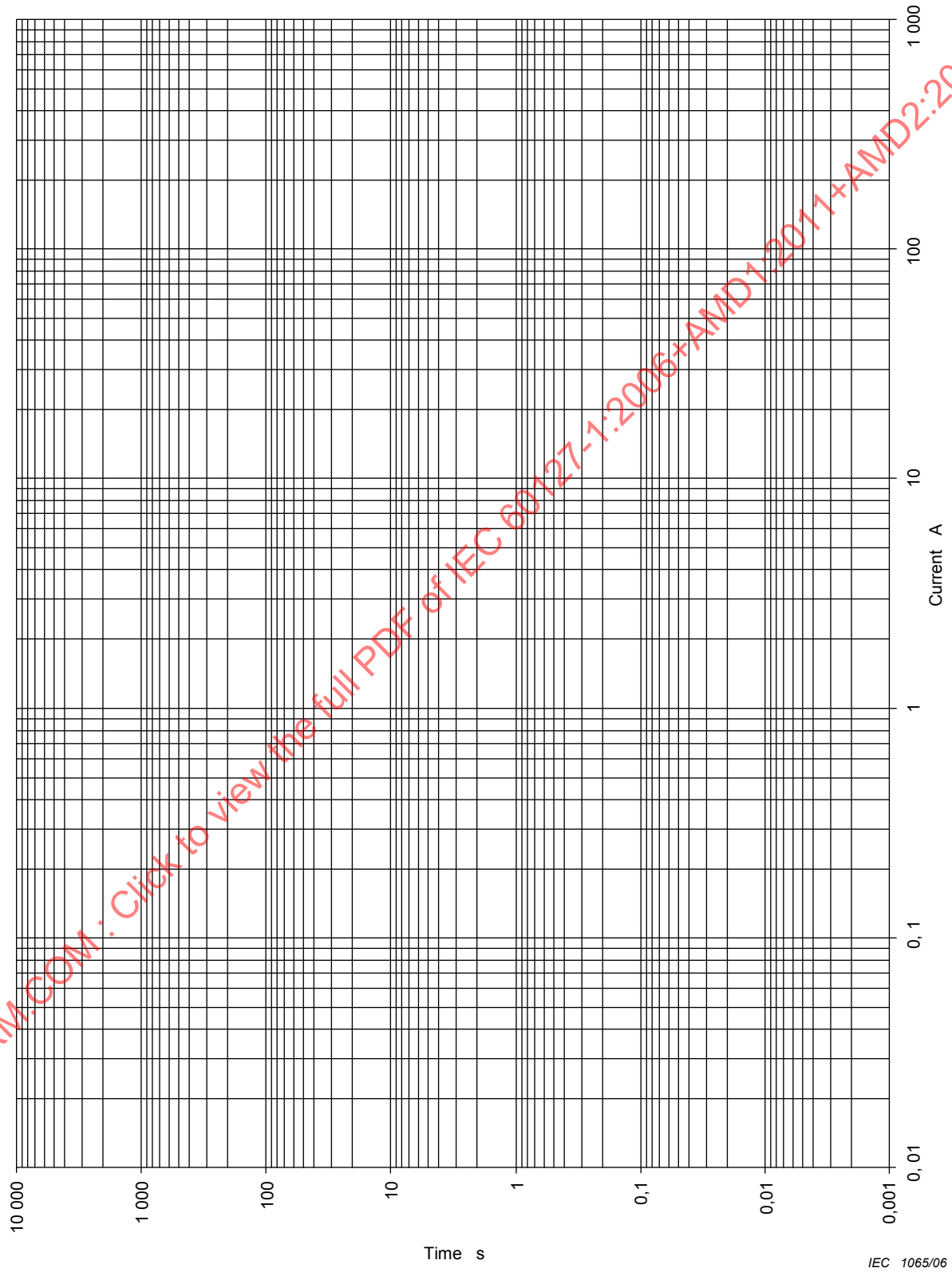


Figure B.1 – Example presentation of time/current characteristic, ratio 2:1

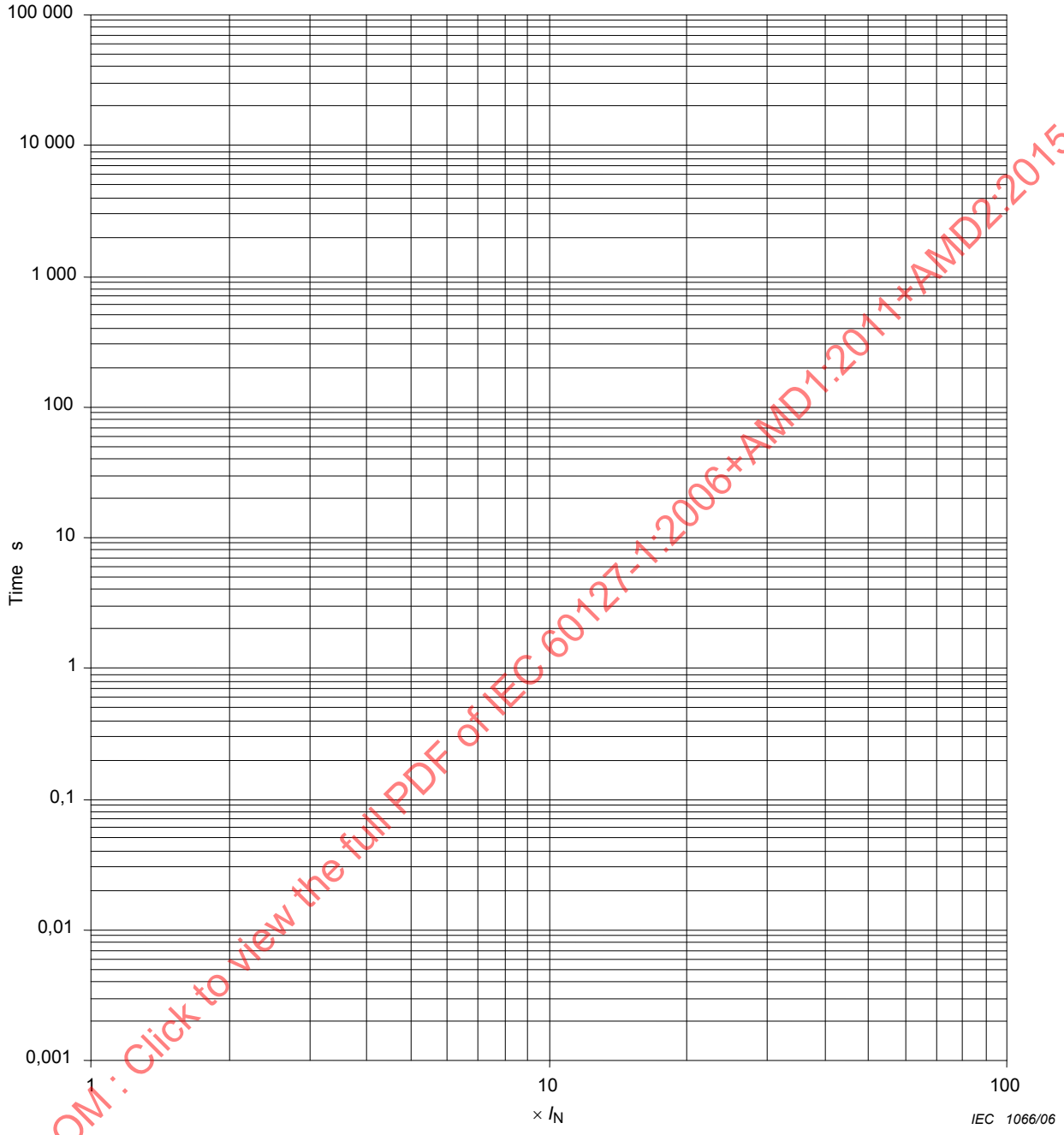


Figure B.2 – Example presentation of time/current characteristic, ratio 3:1

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;

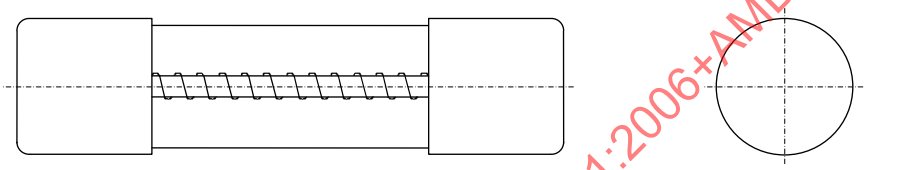
c) **body:** material and minimum wall thickness;

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.



IEC 1067/06

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 per-formed 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.

Bibliography

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

IEC 60425:1973, *Guide for the choice of colours to be used for the marking of capacitors and resistors*

IECEE 03:2005, *Rules of Procedure of the Scheme of the IECEE for Mutual Recognition of Conformity Assessment Certificates according to Standards for Electrical and Electronic Equipment and Components (CBFCS)*

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IEC 60127-1

Edition 2.2 2015-02

FINAL VERSION

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

IEC 60127-1:2006-06+AMD1:2011-04+AMD2:2015-02 CSV(en)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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This Consolidated version of IEC 60127-1 bears the edition number 2.2. It consists of the second edition (2006-06) [documents 32C/387/FDIS and 32C/390/RVD], its amendment 1 (2011-04) [documents 32C/436/CDV and 32C/438/RVC] and its amendment 2 (2015-02) [documents 32C/490/CDV and 32C/505/RVC]. The technical content is identical to the base edition and its amendments.

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

This publication has been prepared for user convenience.

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

The major technical changes with regard to the first edition concern subclause 9.2.3 where the nature of the current source has been clarified; in addition, IEC 60038: *IEC standard voltages*, has been added to the list of normative references.

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

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 and universal modular fuse-links). All subsequent parts of the complete series should be read in conjunction with this Part 1.

IEC 60127 consists of the following parts, under the general heading *Miniature fuses*:

Part 1: Definitions for miniature fuses and general requirements for miniature fuse-links
Part 2: Cartridge fuse-links
Part 3: Sub-miniature fuse-links
Part 4: Universal modular fuse-links (UMF) – Through-hole and surface mount types
Part 5: Guidelines for quality assessment of miniature fuse-links
Part 6: Fuse-holders for miniature fuse-links
Part 7: (Free for further documents)
Part 8: (Free for further documents)
Part 9: (Free for further documents)
Part 10: User guide for miniature fuses

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication 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 and universal modular fuse-links) for the protection of electric appliances, electronic equipment and component parts thereof normally intended to be used indoors.

This standard 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 standard 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 standard 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 standard (see IEC 60127-6).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60038, *IEC standard voltages*

IEC 60127-6:1994, *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 definitions apply.

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 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 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

3.6
sub-miniature fuse-link
miniature fuse-link of which the case (body) has no principal dimension exceeding 10 mm

NOTE Principal dimensions are length, width, height and diameter.

3.7
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

3.8
fuse-link contact
conductive part of a fuse-link designed to engage with a fuse-base contact or with a fuse-carrier contact

3.9
fuse-holder
combination of a fuse-base with its fuse-carrier

3.10
fuse-base
fuse-mount
fixed part of a fuse provided with contacts and terminals for connection to the system

3.11
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

3.12
fuse-carrier
movable part of a fuse designed to carry a fuse-link

3.13
fuse-carrier contact
conductive part of a fuse-carrier connected to a fuse-link contact and designed to engage with a fuse-base contact

3.14
fuse-element
part of the fuse-link designed to melt when the fuse operates

3.15
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 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.

3.16
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.

3.17
time/current characteristics (of a fuse-link)

a) For a.c.: 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 r.m.s. value

b) For d.c.: curve giving, under stated conditions of operation, the value of time expressed as actual time as a function of the d.c. prospective current

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

3.18
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

3.19
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

3.20
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

3.21
arcing time
interval of time between the instant of the initiation of the arc and the instant of final arc extinction

3.22
operating time (total clearing time)
sum of the pre-arcing time and the arcing time

3.23
virtual time
value of I^2t divided by the value of the square of the value of the prospective current

NOTE 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.

3.24
***I*²*t* (joule integral)**
integral of the square of the current over a given time interval:

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

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

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

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

3.25
breaking capacity of a fuse-link
value (r.m.s. for a.c.) of prospective current that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

3.26
recovery voltage
voltage which appears across the terminals of a fuse after breaking of the current

NOTE 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.

3.27
maximum sustained 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 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 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 standard.

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

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

6.1 Each fuse-link shall be marked with:

a) Rated current in milliamperes for rated currents below 1 A, and in amperes 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.

b) Rated voltage in volts (V).

c) Maker's name or trade mark.

d) 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.

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 together with a reference to this standard and an indication of the appropriate standard sheet. The marking on the packing shall include the abbreviation A and mA.

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.

7 General notes on tests

Tests according to this standard are type tests.

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

7.1 Atmospheric conditions for testing

7.1.1 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.

7.1.2 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.

7.2 Type tests

7.2.1 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.

7.2.2 Based on the results of the test in item d) above, 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.

7.2.3

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 current, the fuse-links are deemed not to comply with this standard. 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.

7.3 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.

7.4 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 a.c., 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, due to difference in design or element material, have different voltage drops and may 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 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 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 d.c. voltages in Table 6 of IEC 60038.

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 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 a.c. can be significantly different from the characteristic determined with d.c. 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 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 Operating conditions

Fuse-links shall operate satisfactorily without endangering the surroundings 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 a.c. 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 be lower with d.c. than with a.c. It is influenced by the circuit inductance and, with a.c., additionally by the instant of closing the circuit.

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

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

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

9.3.2 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.

9.3.3 Insulation resistance

After the breaking capacity test, the insulation resistance between the fuse-link terminations shall be measured with a d.c. 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.

9.3.4 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 standard.

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 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.

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.

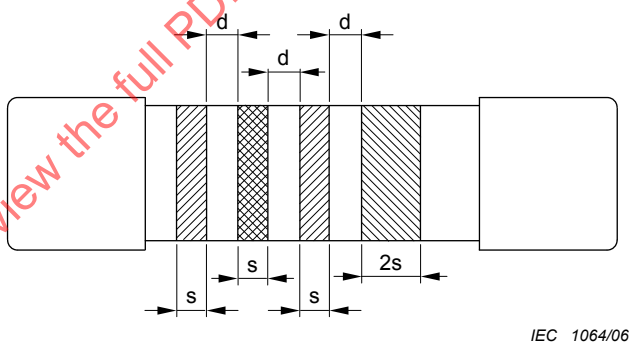
NOTE 1 In the case of transparent miniature fuse-links, the spacings still allow for the visibility of the fuse-element.

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