BRITISH STANDARD

BS EN 60127-10:2002

IEC 60127-10:2001

Miniature fuses —

Part 10: User guide for miniature fuses

The European Standard EN 60127-10:2002 has the status of a British Standard

ICS 29.120.50

National foreword

This British Standard is the official English language version of EN 60127-10:2002. It is identical to IEC 60127-10:2001.

The UK participation in its preparation was entrusted to Technical Committee PEL/32, Fuses, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement these international or European publications may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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EUROPEAN STANDARD **EN 60127-10**

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English version

Miniature fuses
Part 10: User guide for miniature fuses
(IEC 60127-10:2001)

Coupe-circuit miniatures
Part 10: Guide d'utilisation
pour coupe-circuit miniatures
(CEI 60127-10:2001)

Geräteschutzsicherungen
Teil 10: Leitfaden für die Anwendung
von Geräteschutzsicherungen
(IEC 60127-10:2001)

This European Standard was approved by CENELEC on 2002-02-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 32C/294/FDIS, future edition 1 of IEC 60127-10, prepared by SC 32C, Miniature fuses, of IEC TC 32, Fuses, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60127-10 on 2002-02-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2002-11-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2005-02-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annex ZA is normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60127-10:2001 was approved by CENELEC as a European Standard without any modification.

CONTENTS

INTRODUCTION

The users of miniature fuses express the wish that all standards, recommendations and other documents relating to miniature fuses should have the same publication number in order to facilitate reference to fuses in other specifications, for example, equipment specifications.

Furthermore, a single publication number and subdivision into parts would facilitate the establishment of new standards, because clauses and subclauses containing general requirements need not be repeated.

The new IEC 60127 series is thus subdivided as follows:

IEC 60127, *Miniature fuses* (general title)

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)

Part 5: Guidelines for quality assessment of miniature fuse-links

Part 6: Fuse-holders for miniature cartridge 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

MINIATURE FUSES –

Part 10: User guide for miniature fuses

1 Scope

This part of IEC 60127 relates to miniature fuses 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 and 60127-4.

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

It relates to fuse-holders for miniature fuse-links according to IEC 60127-6.

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

NOTE 1 If the performance of IEC 60127 fuses proves inadequate, refer to IEC 60269.

NOTE 2 Fuse-links of the same type and rating may, 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-circuit voltages, especially in combination with fuse-links of lower rated currents.

NOTE 3 Contact the manufacturer for further information.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60127. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60127 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60127-2:1989, *Miniature fuses – Part 2: Cartridge fuse-links*

IEC 60127-3:1988, *Miniature fuses – Part 3: Sub-miniature fuse-links*

IEC 60127-4:1996, *Miniatures fuses – Part 4: Universal Modular Fuse-links (UMF)*

IEC 60127-6:1994, *Miniature fuses – Part 6: Fuse-holders for miniature cartridge fuse-links*

IEC 60269 (all parts), *Low-voltage fuses*

3 Properties of miniature fuses

The miniature fuse 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. These properties include:

- **Wide range of physical types of construction:** miniature fuses 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 fuses provide very good circuit protection in a small package suitable for miniaturized equipment.
- **Wide range of characteristics:** miniature fuses are generally used within electronic equipment, where prospective short-circuit currents are below 1 500 A. Fuses 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 characteristics and limitation of let-through energy ensure that a faulty circuit is isolated by the fuse without opening higher rated upstream fuses, avoiding disconnection of the supply to healthy circuits downstream.
- **Reliability:** miniature fuses carry operational currents continuously without any substantial change or deterioration in their characteristics, and give equal protection to that provided by a new fuse. During their long life, no maintenance is required.
- **Tamper-proof reproducible characteristics:** miniature fuses 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 operation are accurately and safely reproduced at any location world-wide.
- **Arc dissipation:** suitable fuses can disconnect faults so quickly that there is no time for an arc to become established at the fault location.

4 Different types of fuse-links

IEC 60127 makes reference to three 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)

4.1 Characteristics

These are terms that define how quickly a fuse-link will operate (open) at various overload current levels. Fuses 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 of the rated current. The fuse-element must melt within the given time gate.

It should be noted that the characteristics of fuses conforming to other standards, such as CSA-C22.2 No. 248.14 ♦ UL 248-14 [1][1], could be quite different from the IEC 60127 characteristics. Additionally, these other standards may 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 manufacturers, and can vary widely.

4.2 Breaking capacity

The breaking capacity of a fuse is the value of current that a fuse can safely interrupt at its rated voltage. The value assigned by the fuse manufacturer is usually that prescribed in the standard sheet, for a given voltage and other specified test conditions such as circuit power factor, closing angle, etc. In practice, a fuse shall not be used in a circuit that has a potential fault (short-circuit) current greater than the rated breaking capacity of the fuse. 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's breaking capacity is determined by testing the fuse in the end product, under short-circuit conditions.

4.3 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 six standard sheets. The rated voltage is 250 V a.c. except for those 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 6,3 A through 10 A.

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[1] References in square brackets refer to the bibliography.

Standard sheet	Dimensions mm	Characteristic	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)
* Whichever is greater.			

NOTE These fuse-links are available in wire terminated form for direct connection to printed wiring boards (excluding standard sheet 4).

4.4 Sub-miniature fuse-links (IEC 60127-3)

This standard consists of four standard sheets, 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.

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

4.5 Universal Modular Fuse-links (IEC 60127-4)

Two types of fuse-link are described, through-hole types (standard sheet 1) and surface mount types (standard sheet 2) with rated voltages of 32 V, 63 V, 125 V and 250 V.

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	FF, F, T or TT	Low (35 A or 10 I_N)[a]
	125	5	FF, F, T or TT	Low (50 A or 10 I_N)[a]
	250	7,5	FF, F, T or TT	Low (100 A)
	250	10	FF, F, T or TT	Intermediate (500 A)
	250	12,5	FF, F, T or TT	High (1 500 A)
2 (Surface mount)	32	1,5	FF, F, T or TT	Low (35 A or 10 I_N)[a]
	63	2	FF, F, T or TT	Low (35 A or 10 I_N)[a]
	125	2,5	FF, F, T or TT	Low (50 A or 10 I_N)*
	250	4	FF, F, T or TT	Low (100 A)
	250	4	FF, F, T or TT	Intermediate (500 A)
	250	4	FF, F, T or TT	High (1 500 A)

[a] Whichever is greater.

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

This area of fuse 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 may be needed.

5 Applications

5.1 Applications – Fuse selection criteria

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

a) electrical requirements of the application;

b) conformance to published fuse safety standards;

c) mechanical properties/physical size.

It is necessary to first determine the electrical performance required of the fuse, 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.

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

5.2 Electrical criteria

The electrical ratings and performance required of a fuse 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 (a.c.) or direct current (d.c.).

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 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 shall withstand without opening.

3) Normal operating conditions:

   i) maximum steady-state current that the fuse will be subjected to in service;

   ii) minimum/maximum ambient conditions.

4) Circuit protection performance required:

   i) minimum overload current at which the fuse shall operate, and the maximum time allowed to operate (open);

   ii) other critical overload level or time constraints that the fuse shall meet;

   iii) maximum short-circuit current and voltage that the fuse shall interrupt.

5.3 Mechanical/physical dimensions

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

6 Protection by I^2t limitation and pulse operation

6.1 I^2t value

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 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 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 and is the sum of the pre-arcing and arcing I^2t. The arcing I^2t is not determined solely by the fuse itself, but by the circuit's parameters.

6.2 Pulse operation

Usually, the pre-arcing I^2t is used to select a fuse 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 with a pre-arcing I^2t sufficiently larger than the pulse I^2t.

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 that has an operating I^2t less than the component withstand rating.

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

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

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

NOTE IEC subcommittee 32C suggest 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 factory should be consulted if this parameter is critical to the design analysis.

7 Direct current (d.c.) applications

7.1 General information

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

Typical d.c. 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 a.c. breaking capacity limit of the fuse-link;
- d.c. voltages above 125 V where additional testing may be necessary, particularly for breaking capacity.

Inductive and capacitive d.c. 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 fuses. This circuit characteristic may affect the operating time/current characteristics, rated voltage and breaking capacity performance of the fuse. Time-current curves are usually based on a.c. (r.m.s.) or d.c. currents that are thermally equivalent.

7.2 Battery circuits

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

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

7.3 Inductive load circuits

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

8 Fuse-holders

8.1 Features

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

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 may, 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.

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:

8.3.1 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.

8.3.2 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.

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.

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 may possibly be as high as the impedance of the circuit. The voltage drop of low-rated fuse-links 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 1 below.

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.

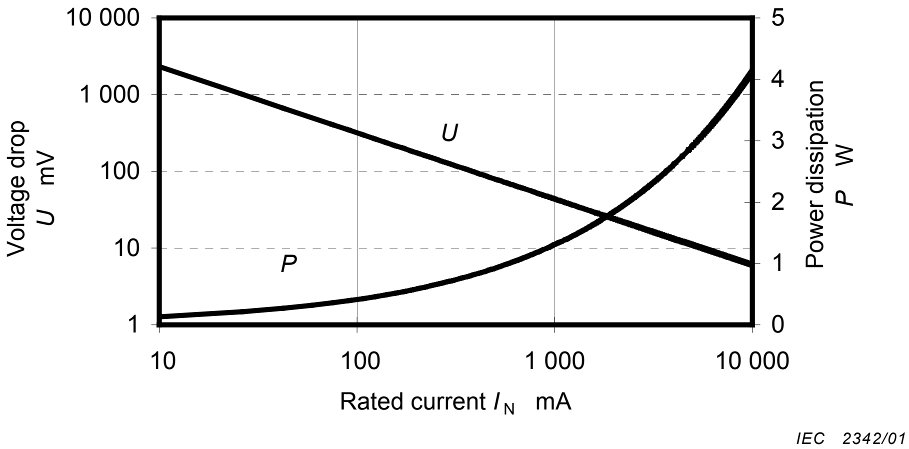


Figure 1 – Example of power dissipation *P* and voltage drop *U* according to rated current I_N

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.

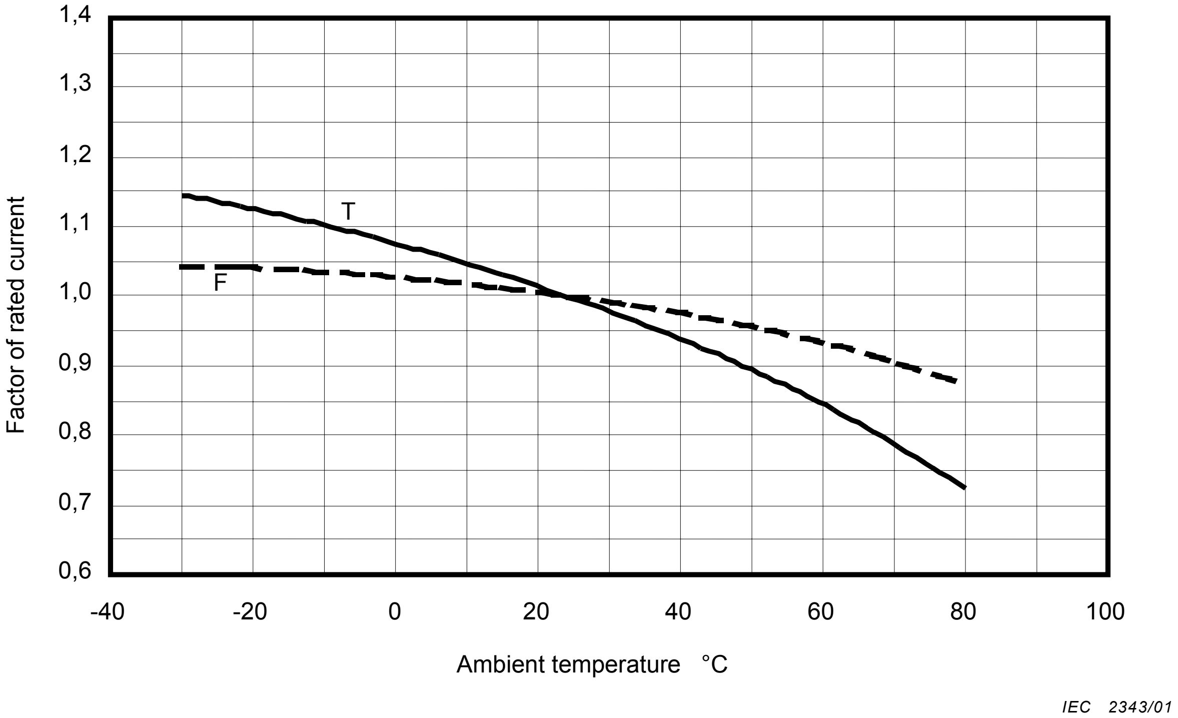
As a rule of thumb, the minimum operating voltage required for proper operation is approximately five to eight times the voltage drop of the fuse-link measured at 1,0 I_N.

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 may result in faster or slower reaction of the fuse-link.

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

Bibliography

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

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60127-2 + corr. March	1989 1990	Miniature fuses Part 2: Cartridge fuse-links	EN 60127-2	1991
IEC 60127-3	1988	Part 3: Sub-miniature fuse-links	EN 60127-3 [1)] + corr. June	1996 1996
IEC 60127-4	1996	Part 4: Universal Modular Fuse-links (UMF)	EN 60127-4	1996
IEC 60127-6	1994	Part 6: Fuse-holders for miniature fuse-links	EN 60127-6	1994
IEC 60269	Series	Low-voltage fuses	EN 60269	Series

[1)] EN 60127-3 includes A1:1991 and its corrigendum October 1994 to IEC 60127-3.

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