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

Fusibles basse tension - Partie 5: Lignes directrices pour l'application des fusibles basse tension

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colour inside

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

Fusibles basse tension –
Partie 5: Lignes directrices pour l'application des fusibles basse tension

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LOW-VOLTAGE FUSES –

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

FOREWORD

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The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 60269-5, which is a technical report, has been prepared by subcommittee 32B: Low-voltage fuses, of IEC technical committee 32: Fuses.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

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

a) recommendations for fuse operations in high altitudes added
b) more details for operational voltages added
c) recommendations for photovoltaic system protection added
d) numerous details improved

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
32B/621A/DTR	32B/624/RVC

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

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

A list of all parts of the IEC 60269 series, under the general title: *Low-voltage fuses*, can be found on the IEC website.

The committee has decided that the contents of this publication 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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Fuses protect many types of equipment and switchgear against the effects of over-current which can be dramatic:

– thermal damage of conductors or bus-bars;
– vaporisation of metal;
– ionisation of gases;
– arcing, fire, explosion,
– insulation damage.

Apart from being hazardous to personnel, significant economic losses can result from downtime and the repairs required to restore damaged equipment.

Modern fuses are common overcurrent protective devices in use today, and as such provide an excellent cost effective solution to eliminate or minimize the effects of overcurrent.

LOW-VOLTAGE FUSES –

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

1 Scope

This technical report, which serves as an application guide for low-voltage fuses, shows how current-limiting fuses are easy to apply to protect today's complex and sensitive electrical and electronic equipment. This guidance specifically covers low-voltage fuses up to 1 000 V a.c. and 1 500 V d.c. designed and manufactured in accordance with IEC 60269 series. This guidance provides important facts about as well as information on the application of fuses.

2 Normative references

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

IEC 60050 (all parts), *International Electrotechnical Vocabulary*. Available from http://www.electropedia.org/

IEC/TR 60146-6, *Semiconductor convertors – Part 6: Application guide for the protection of semiconductor convertors against overcurrent by fuses*

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

IEC 60269-1:2006, *Low-voltage fuses – Part 1: General requirements*

IEC 60269-2, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Examples of standardized systems of fuses A to K*

IEC 60269-3, *Low-voltage fuses – Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household or similar applications) – Examples of standardized systems of fuses A to F*

IEC 60269-4:2009, *Low-voltage fuses – Part 4: Supplementary requirements for fuse-links for the protection of semiconductor devices*

IEC 60269-6, *Low-voltage fuses – Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-4-43:2008, *Low-voltage electrical installations – Part 4-43: Protection for safety – Protection against overcurrent*

IEC 60364-5-52, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60947 (all parts), *Low-voltage switchgear and controlgear*

IEC 60947-3:2008, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-4-1:2009, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC/TR 61912-1:2007, *Low-voltage switchgear and controlgear – Overcurrent protective devices – Part 1: Application of short-circuit ratings*

3 Terms and definitions

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

3.1
switch (mechanical)
mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions, which may include specified operating overload conditions and also carrying, for a specified time, currents under specified abnormal conditions such as those of short-circuits

Note 1 to entry: A switch may be capable of making but not breaking, short-circuit currents.

[SOURCE: IEC 60050-441:1984, 441-14-10]

3.2
disconnector
mechanical switching device that, in the open position, complies with the requirements specified for isolating function

Note 1 to entry: Some disconnectors may not be capable of switching load.

[SOURCE: IEC 60050-441:1984, 441-14-05, modified (modified definition and Note 1 to entry added)]

3.3
fuse-combination unit
combination of a mechanical switching device and one or more fuses in a composite unit, assembled by the manufacturer or in accordance with his instructions

[SOURCE: IEC 60050-441:1984, 441-14-04, modified (Note removed)]

3.4
switch-fuse
switch in which one or more poles have a fuse in series in a composite unit

[SOURCE: IEC 60050-441:1984, 441-14-14]

3.4.1
single-break and double-break
switch-fuse must be single break (it opens the circuit on one side of the fuse link) or double break (it opens the circuit on both sides of the fuse link)

3.5
fuse-switch
switch in which a fuse-link or a fuse-carrier with fuse-link forms the moving contact

[SOURCE: IEC 60050-441:1984, 441-14-17]

3.5.1
single-break and double-break
fuse-switch must be single break (it opens the circuit on one side of the fuse link) or double break (it opens the circuit on both sides of the fuse link)

3.6
Switching device SD
device designed to make or break the current in one or more electric circuits

Note 1 to entry: A switching device may perform one or both of these operations.

[SOURCE: IEC 60050-441:1984, 441-14-01, modified (Note 1 to entry added)]

3.7
short-circuit protective device SCPD
device intended to protect a circuit or parts of a circuit against short-circuits by interrupting them

3.8
overload protection
protection intended to operate in the event of overload on the protected section

[SOURCE: IEC 60050-448:1995, 448-14-31]

3.9
overload
operating conditions in an electrically undamaged circuit, which cause an over-current

[SOURCE: IEC 60050-441:1984, 441-11-08]

3.10
overcurrent
current exceeding the rated current

[SOURCE: IEC 60050-442:1998, 442-01-20]

3.11
rated conditional short-circuit current (of a switching device)
I_q
prospective current that a switching device, protected by a short-circuit protective device, can satisfactorily withstand for the operating time of that device under test conditions specified in the relevant product standard

3.12
selectivity of protection
ability of a protection to identify the faulty sections and/or phase(s) of a power system

Note 1 to entry: Whereas the terms “selectivity” and “discrimination” have a similar meaning according to the IEV definitions, this report prefers and uses the term “selectivity” to express the ability of one over-current device to operate in preference to another over-current device in series, over a given range of over-current. The effect of standing load current on selectivity in the overload zone is also considered.

[SOURCE: IEC 60050-448:1995, 448-11-06, modified (Note 1 to entry added)]

4 Fuse benefits

The current-limiting fuse provides complete protection against the effects of overcurrents by protecting both, electric circuits and their components. Fuses offer a combination of advantageous features, for example:

a) High breaking capacity (high current interrupting rating).

b) No need for complex short-circuit calculations.

c) Easy and inexpensive system expansion in case of increased fault currents.

d) High current limitation (low I^2t values).

e) Mandatory fault elimination before reenergizing.

Fuses cannot be reset, thus forcing the user to identify and correct the fault condition before re-energizing the circuit.

f) Reliability.

No moving parts to wear out or become contaminated by dust, oil or corrosion. Fuse replacement ensures protection is restored to its original level when the fuse is replaced.

g) Cost effective protection.

Compact size offers low cost overcurrent protection at high short-circuit levels.

h) No damage for starters and contactors (type 2 protection according to IEC 60947-4-1).

By limiting short-circuit energy and peak currents to extremely low levels, fuses are particularly suitable for type 2 protection without damage to components in motor circuits.

i) Safe, silent operation.

No emission of gas, flames, arcs or other materials when clearing the highest levels of short-circuit currents. In addition, the speed of operation at high short-circuit currents significantly limits the arc flash hazard at the fault location.

j) Easy coordination.

Standardized fuse characteristics and a high degree of current limitation ensure effective coordination between fuses and other devices.

k) Standardized performance.

Fuse-links designed and manufactured in accordance with IEC 60269 series ensure availability of replacements with standardized characteristics throughout the world.

l) Improved power quality.

Current-limiting fuses interrupt high fault currents in a few milliseconds, minimizing dips or sags in system supply voltage.

m) Tamperproof.

Once installed, fuses cannot be modified or adjusted thus preserving their level of performance and avoiding malfunction.

n) No maintenance.

Properly sized fuses require no maintenance, adjustments or recalibrations. They can remain in service providing originally designed overcurrent protection levels for many decades.

o) High level of energy efficiency.

The resistance and therefore the power dissipation of the fuse is very low compared with other protection devices. The magnitude of power loss compared to the power transmitted by rated current is much less than 0,1%.

p) Excellent personnel and equipment protection in case of arc flash.

Properly sized current limiting fuses operating in their current limiting range interrupt currents due to arcing fault in a few milliseconds, keeping arc energy well below hazardous and damaging levels.

5 Fuse construction and operation

5.1 Components

A fuse is a protective device comprising

- the fuse-link,
- the fuse-base,
- the fuse-carrier or replacement handle.

These components may be integrated in a fuse combination unit.

5.2 Fuse-construction

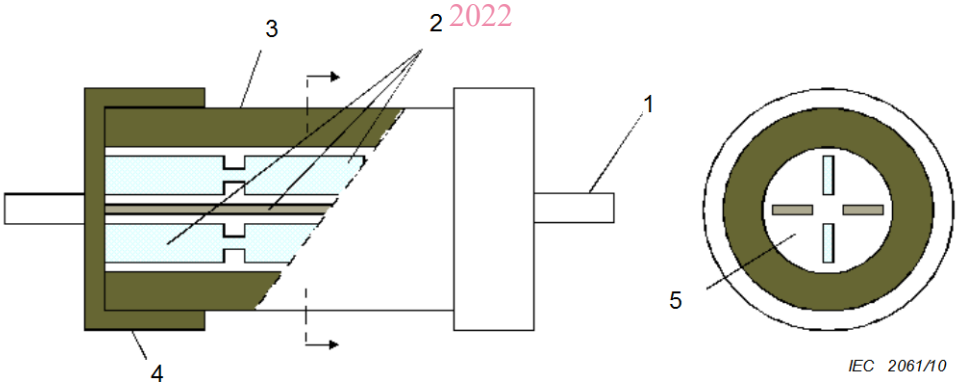
5.2.1 Fuse link

Figures 1 and 2 show the design of typical low-voltage fuse-links for industrial application. Such fuse-links are commonly called current-limiting or high breaking capacity fuse-links. Fuse-links according to IEC 60269-2 (fuses for industrial application) are available in current ratings up to 6 000 A.

Fuse-links according to IEC 60269-3 (fuses for household application) are available in current ratings up to 100 A.

The fuse-element is usually made of flat silver or copper with multiple restrictions in the cross-section, called notches. This restriction (or notch) pattern is an important feature of fuse design, normally achieved by precision stamping.

M-effect (see 5.3.3) material is added to the fuse-element to achieve controlled fuse operation in the overload range. The purity of the fuse-element materials and their precise physical dimensions are of vital importance for reliable fuse operation.



Key

1 Blade contact
2 Fuse-elements
3 Fuse body
4 End cap
5 Filler

Figure 1 – Typical fuse-link according to IEC 60269-2