IEC TR 60269-5

Edition 2.0 2020-12

TECHNICAL REPORT

AMENDMENT 1

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

IEC TR 60269-5:2014-03/AMD1:2020-12(en)

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

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FOREWORD

This amendment has been prepared by subcommittee 32B: Low voltage fuses, of IEC technical committee 32: Fuses.

This amendment corrects and adds to IEC TR 60269-5 published in 2014. This edition constitutes a technical revision.

This amendment includes the following significant technical changes with respect to the original document:

a) addition of battery fuses;
b) new clause on inverter protection;
c) numerous details improved.

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

Draft TR	Report on voting
32B/694/DTR	32B/697A/RVDTR

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

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC website 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- withdrawn,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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2 Normative References

Replace the existing reference to IEC 60269-1:2006 by the following new reference:

IEC 60269-1:2006, *Low-voltage fuses - Part 1: General requirements*
IEC 60269-1:2006/AMD1:2009
IEC 60269-1:2006/AMD2:2014

Replace the existing reference to IEC 60269-4:2009 by the following new reference:

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

Replace the existing reference to IEC 60947-3:2008 by the following new reference:

IEC 60947-3:2015, *Low-voltage switchgear and controlgear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

4 Fuse benefits

Replace the existing text of bullet point h) by the following new text:

h) Compact size offers economical overcurrent protections at high short-circuit levels

Add the following new bullet point after point p):

q) Fuse-links will operate independent of the operation position of the fuse. The operation position is usually vertical. Other positions of use are permissible. The deratings of the manufacturers of the fuse must be observed.

5 Fuse construction and operation

5.2.1 Fuse-link

Replace the existing third paragraph of 5.2.1 by the following new text:

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

Replace the existing first sentence of the fourth paragraph of 5.2.1 by the following new text:

M-effect (see 5.3.3) is sometimes added to the fuse-element to achieve controlled fuse operation in the overload range.

5.3.2 Fuse operation in case of short-circuit

Replace the existing bullet points by the following new text:

- the arcing stage (t_a): the arcs begin at restrictions and are then extinguished by the filler.
- M-effect (see 5.3.3) is sometimes added to the fuse-element to achieve controlled fuse operation in the overload range;

5.3.3 Fuse operation in case of overload

Replace the existing third bullet point by the following new text:

- Both stages make up the fuse operating time ($t_m + t_a$). The energy generated in the circuit by the overload current during pre-arcing (melting) time and operating time can still be represented by the pre-arcing I^2t and operating I^2t values, respectively; however under overload conditions the pre-arcing I^2t value is so high it provides little useful application data and the prearcing time is the preferred measure for times longer than a few cycles or few time constants. In this case, arcing time is negligible compared to the prearcing time.

5.3.5 Fuse operation in altitudes exceeding 2 000 m

Replace the second sentence of the first paragraph of 5.3.5 by the following new text:

This is as stated in IEC 60269-1:2014, Subclause 3.2.

Replace the existing second and third paragraphs of 5.3.5 by the following new text:

For the current carrying capacity of a fuse and the cable to be influenced by the cooling effect of the surrounding air, the current carrying capacity is derated with lower air pressure. This can be described by the following approximation:

Above 2 000 m a de-rating factor of 0,5 % for every 100 m above 2 000 m will be required, due to reduced convection of heat and lower air pressure.

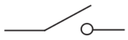
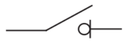
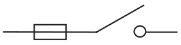
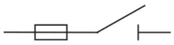
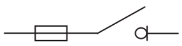
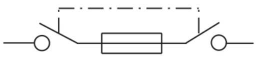
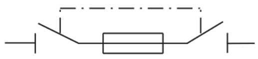
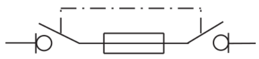
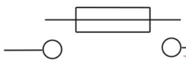
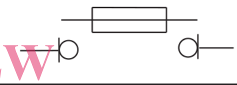
6 Fuse-combination units

Replace the second sentence of the first paragraph of Clause 6 by the following new text:

Fuse-combination units are shown in Table 2 (equivalent to Table 1 of IEC 60947-3:2008).

Table 2 – Definitions and symbols of switches and fuse-combination units

Replace existing Table 2 by the following new table:

Functions		
Making and breaking current	**Isolating**	**Making, breaking and isolating**
Switch 	Disconnector 	Switch-disconnector 
Fuse-combination units		
Switch-fuse single opening[a] 	Disconnector-fuse single opening[a] 	Switch-disconnector-fuse single opening[a] 
Switch-fuse double opening[b] 	Disconnector-fuse double opening 	Switch-disconnector-fuse double opening[b] 
Fuse-switch single opening[a] 	Fuse-disconnector single opening[a] 	Fuse-switch-disconnector single opening[a] 
Fuse-switch double opening[b] 	Fuse-disconnector double opening 	Fuse-switch-disconnector double opening[b] 
NOTE 1 Equipment shown as single opening may comprise multiple openings in series NOTE 2 The symbols do not govern the design of switches, disconnectors and fuse-combination units (Fuse-switches, fuse-disconnectors)		
[a] The fuse may be on either side of the contacts of the equipment. [b] Depending on the design, breaking may take place on one or both sides of the fuse-link.		

Replace the existing last paragraph of Clause 6 by the following new text:

The fuse(s) fitted to a fuse-combination unit or fuse-combination switch also protect the unit or the switch itself against the effects of overcurrent.

7 Fuse selection and markings

Renumber the existing note after the second paragraph of Clause 7 as Note 1.

Table 3

Add the following new row to the end of Table 3:

gBat, aBat	Protection of batteries	Full and partial range

Replace the text of the final bullet point of the eighth paragraph of Clause 7 by the following new text:

- Size*) or reference

Add the following new note after the final bullet point of the eighth paragraph of Clause 7:

NOTE 2 The definition of fuse sizes, especially the dimensions are given by IEC 60269-2. In general fuse- links and fuse-bases and fuse-combination units shall have the same size. Some manufacturers offer to use a smaller fuse-link size in a bigger fuse-base or fuse-combination unit.

Example: size 1 fuse-link used in size 2 fuse-switch disconnector. Those combinations shall be tested and confirmed by the manufacturer.

8 Conductor protection

Figure 6 – Currents for fuse-link selection

$$I_B \leq I_n \leq I_z \quad (B.1)$$
$$I_2 \leq 1,45 \times I_z \quad (B.2)$$

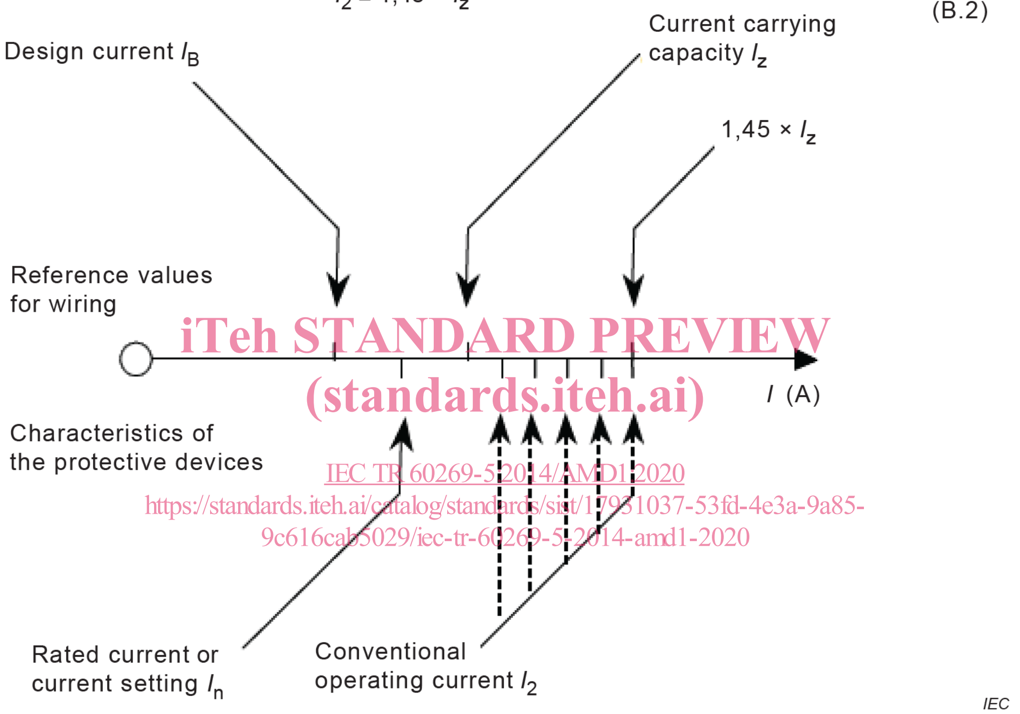


Figure 1 – Currents for fuse-link selection

8.6 Utilization category gK

Replace, in the first sentence of 8.6, "limitating" *by* "limiting".

8.7 Utilization category gPV

Replace, in the first sentence of 8.7, "(see Clause 19.)." *by* "(see Clause 19).".

Add the following new Subclause 8.8 and renumber existing Subclause 8.8 as 8.9:

8.8 Utilization category gBat

Selection of a fuse for battery systems. These fuse-links are for overload and short circuit protection.

8.9 Protection against short-circuit current only

Replace, in the first sentence of Subclause 8.9 (formerly 8.8), the phrase "let through I^2t" *by* "operating I^2t".

9 Selectivity of protective devices

9.2.1 General

In the second sentence of the NOTE replace the phrase "let through I^2t" *by* "operating I^2t".

9.3 Selectivity of circuit upstream breakers of fuses

Replace the existing title of Subclause 9.3 by the following new title:

Selectivity between circuit-breakers upstream and fuses

9.4 Selectivity of upstream fuses of circuit breakers

Replace the existing title of Subclause 9.4 by the following new title:

Selectivity between fuses upstream and circuit-breakers

9.4.3 Verification of selectivity for operating times < 0,1s

Replace, in the first sentence of 9.4.3, the word "prearcing" *by* "pre-arcing".

Figure 11 – Verification of selectivity between fuse F_2 and circuit-breaker C_3 for operating time t < 0,1 s

Replace, in the note to Figure 11, "I_c" *by* "I_S".

12 Transformer Protection

12.1 Distribution transformers with a high-voltage primary

Replace the second sentence of the first paragraph of 12.1 by the following new text:

Short-circuit protection of these transformers are generally provided by high voltage fuse-links on the primary, and such fuse-links are selected to withstand the transformer magnetising (inrush) current during energization.

15 Protection of semiconductor devices in a.c. and d.c. rated voltage circuits

Add, at the beginning of Clause 15, the following new Subclause heading:

15.1 General recommendations

Replace the existing text of the second sentence of the third paragraph of Clause 15 by the following new text:

(In this connection, experience has shown that semiconductors fail as a short-circuit protection and a large current results.)

Add, at the end of Clause 15, the following new subclauses:

15.2 Fuse application with inverters

15.2.1 Inverters

Figures 17 to 19 show examples of inverters of voltage source type.

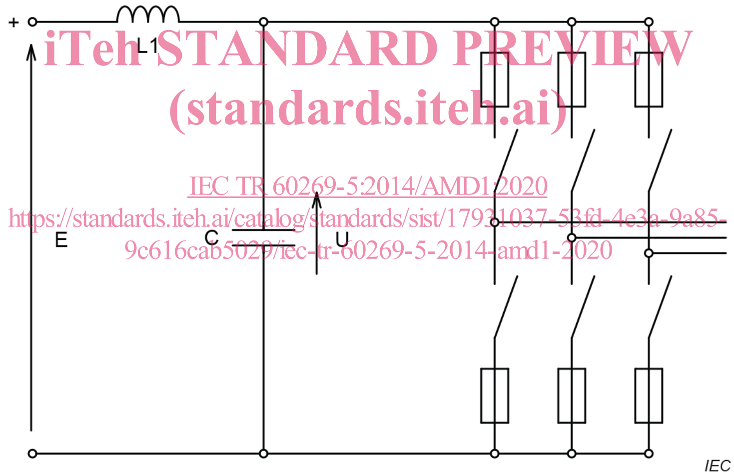


Figure 17 – Inverter double-way connection with arm fuses for regenerative or non-regenerative load

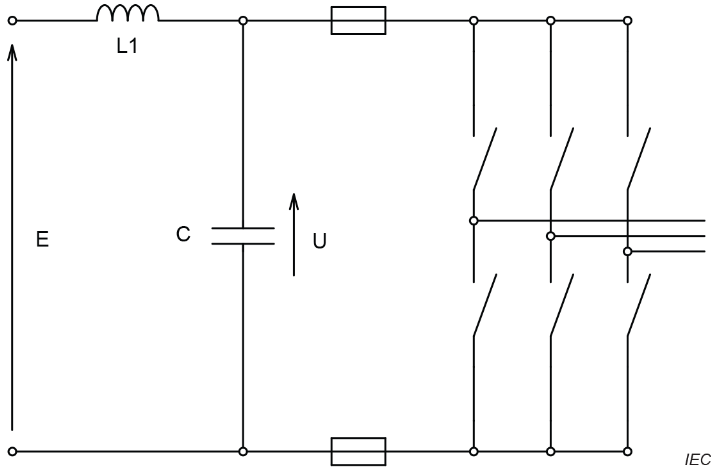


Figure 18 – Inverter double-way connection with d.c. loop fuses for regenerative or non-regenerative load

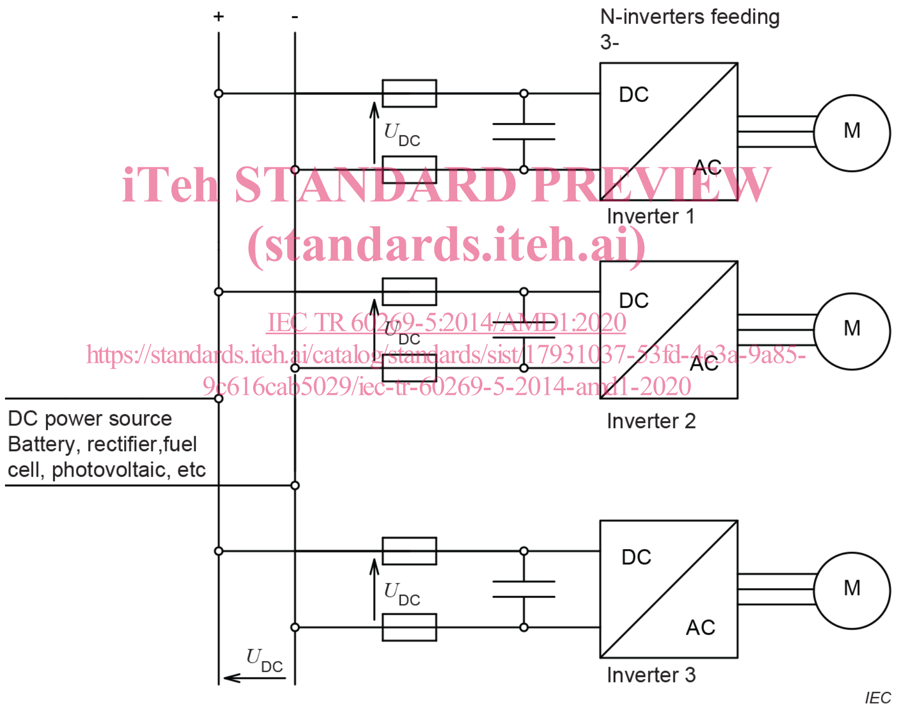


Figure 19 – Multi inverters systems double-way connection with d.c. loop fuses for regenerative or non-regenerative load

Fast fuses can protect the junction of a GTO thyristor against the effect of a large current. As for transistors, IGBT junctions cannot be protected by fuses because of their extremely low I^2t value. Nevertheless, as for other semiconductors, a high fault current will cause the explosion of the IGBT case because of the energy built up inside the component. A lot of power tests demonstrate that the explosion I^2t of the IGBT can be defined and show that fast fuses can prevent an IGBT from exploding.

Moreover tests have been made to measure the fuse contribution to the inductance of the circuit and the effect of high frequencies on the current carrying capability of the fuse. The fuse technology and the circuit design play a great part in the total inductance of the circuit.

The publication of appropriate curves and data is absolutely necessary to allow the selection of a fuse for the protection of power inverters.