BS EN 60644:2009

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Specification for high-voltage fuse-links for motor circuit application

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This British Standard is the UK implementation of EN 60644:2009. It is identical to IEC 60644:2009. It supersedes BS EN 60644:1993 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/32, Fuses.

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

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English version

Specification for high-voltage fuse-links for motor circuit application
(IEC 60644:2009)

Spécification relative aux éléments de remplacement à haute tension destinés à des circuits comprenant des moteurs (CEI 60644:2009)

Anforderungen für Hochspannungs-Sicherungseinsätze für Motorstromkreise (IEC 60644:2009)

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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.

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Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 32A/267/CDV, future edition 2 of IEC 60644, prepared by SC 32A, High-voltage fuses, of IEC TC 32, Fuses, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60644 on 2009-10-01.

This European Standard supersedes EN 60644:1993.

The main changes with regard to EN 60644:1993 concern the following:

– update of the normative references;

– renewal of the figures.

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)	2010-07-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2012-10-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60644:2009 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60470 NOTE Harmonized as EN 60470:2000 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

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 60282-1	2005	High-voltage fuses - Part 1: Current-limiting fuses	EN 60282-1	2006

CONTENTS

SPECIFICATION FOR HIGH-VOLTAGE FUSE-LINKS FOR MOTOR CIRCUIT APPLICATIONS

1 Scope

This standard applies primarily to fuse-links used with motors started direct-on-line on alternating current systems of 50 Hz and 60 Hz.

NOTE When motors are used with assisted starting this specification can also be applied but particular attention should be paid to the selection of the rated current of the fuse-link (see 8.1) and the manufacturer of the fuse-link should preferably be consulted.

Fuse-links according to this specification are intended to withstand normal service conditions and motor starting pulses. They should comply with the requirements of IEC 60282-1.

The purpose of this standard is to standardize time-current characteristics, to formulate pulse withstand requirements regarding testing and to give guidance regarding the selection of fuse-links intended to be used with motors.

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 60282-1:2005, *High-voltage fuses – Part 1: Current-limiting fuses*

3 Fuse-link time-current characteristics

Compared to fuses typically used for distribution system protection, fuses for motor circuit protection should have:

- relatively high melting current (slow operation) in the 10 s region of the pre-arcing time-current characteristic to give maximum withstand against motor starting current;
- relatively low melting current (fast operation) in the region below 0,1 s to give maximum short-circuit protection to associated switching devices, cables and motors and their terminal boxes.

Therefore pre-arcing time-current characteristics of fuse-links for motor circuit applications shall be within the following limits:

$$I_{f10} / I_n \geq 3 \quad \text{for} \quad I_n \leq 100$$

$$I_{f10} / I_n \geq 4 \quad \text{for} \quad I_n > 100$$

$$I_{f0,1} / I_n \leq 20 \left(I_n / 100\right)^{0,25} \quad \text{for all current ratings}$$

where

I_n is the numerical value of the current rating, expressed in amperes, of the fuse-link;

I_{f10} and $I_{f0,1}$ are the numerical values of the pre-arcing currents, expressed in amperes, corresponding to 10 s and 0,1 s respectively, as mean values with the tolerances specified in 4.11 of IEC 60282-1.

The term $(I_n/100)^{0,25}$ is introduced to take account of the fact that the pre-arcing time-current characteristics for a range of fuse-links diverge as they approach the short-time region.

4 *K* factor

Factor which defines an overload characteristic to which the fuse-link may be repeatedly subjected under specified motor starting conditions, and other specified motor-operating overloads, without deterioration.

For the purpose of this specification, the value of K is chosen at 10 s. Unless otherwise stated by the fuse-link manufacturer, it is valid from 5 s to 60 s, for a frequency of starts up to six per hour and for not more than two consecutive starts. For conditions different from those specified above, for example where service conditions involve inching, plugging or more frequent starts, the manufacturer should be consulted.

The overload characteristic is obtained by multiplying the current on the pre-arcing characteristic by K (less than unity).

5 Withstand requirements

The performance of a fuse-link for motor circuit applications is in general determined by the following criteria:

– to withstand without deterioration starting pulses in rapid succession due for example to abnormal conditions, such as those occurring during commissioning of the equipment;

– to withstand without deterioration a large number of motor starts in normal service conditions.

This standard therefore specifies two sequences of tests representative of these conditions: 100 cycles corresponding to abnormal service conditions; 2 000 cycles corresponding to normal service conditions. It is expected that a fuse-link which passes these tests will have a good behaviour during a satisfactory life duration.

6 Withstand tests

6.1 General

The withstand tests are type tests. Both test sequences shall be carried out on the same fuse-link.

The fuse-link shall be tested under the same test conditions as in 6.5.1.2 of IEC 60282-1.

The values of test currents shall be $K\,I_{f10}$ for pulses simulating the motor starting pulses and $K\,I_{f10}/6$ for periods simulating the normal motor running, I_{f10} being the pre-arcing current at 10 s. The tolerance on both values shall be $^{+10}_{\ 0}$ %.

The duration of individual pulses shall be 10 s. The tolerance on the 10 s periods, both pulses and off periods, shall be ±0,5 s.

Tests shall be made at any convenient voltage and at a frequency from 48 Hz to 62 Hz.

6.2 Test sequence No. 1

This test sequence shall comprise 100 cycles of 1 h as follows:

- a current $K I_{f10}$ for 10 s;
- an off period of 10 s;
- a current $K I_{f10}$ for 10 s;
- a current $K I_{f10}/6$ for 3 560 s;
- an off period of 10 s.

6.3 Test sequence No. 2

This test sequence shall comprise 2 000 cycles of 10 min as follows:

- a current $K I_{f10}$ for 10 s;
- a current $K I_{f10}/6$ for 290 s;
- an off period of 300 s.

Test sequences No.1 and No.2 are illustrated in Figure 1.

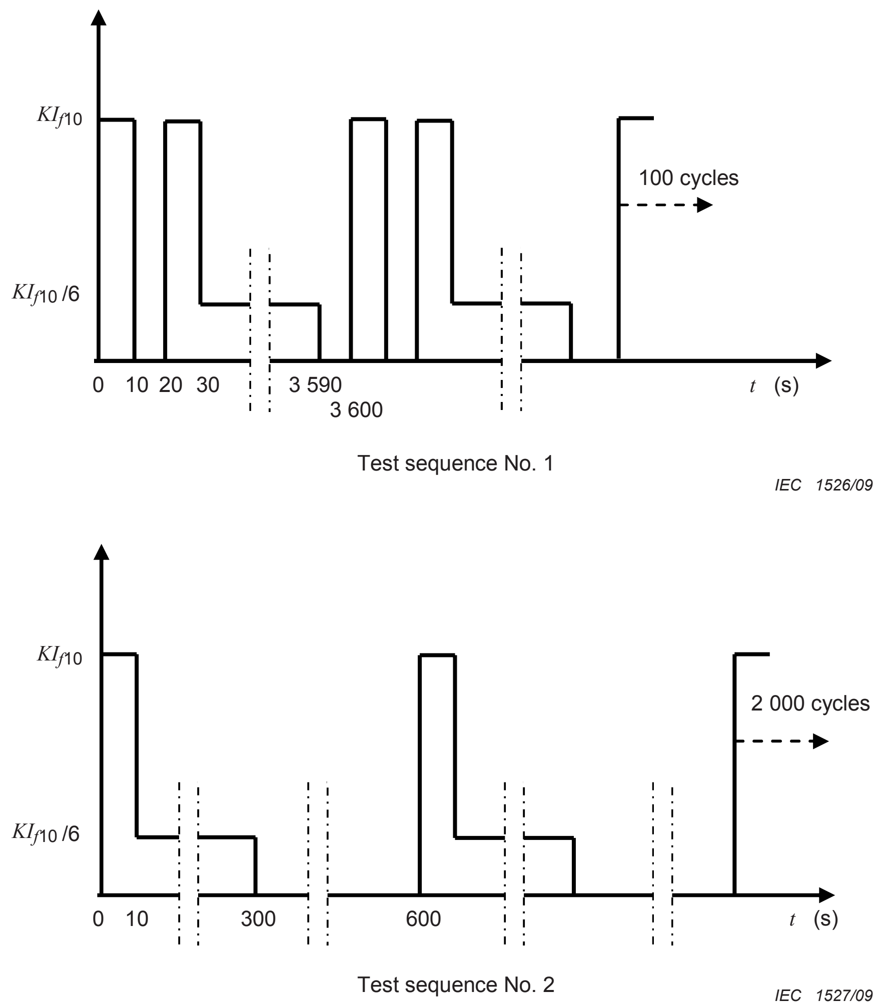


Figure 1 – Diagrams of the test sequences

6.4 Interpretation of the test results

After each test sequence is completed, the fuse-link shall be allowed to cool. After cooling, there shall have been no significant change in its characteristics. A check need not be made until after completion of both test sequences. Measurements to show that there is no significant difference in the values of resistance of the fuse-links before and after test give an indication of conformity with this requirement. In case of doubt, a further method is to subject the fuse-link after cooling after test to the current $K\,I_{f10}$ sustained for a sufficient time to cause the fuse-element to melt. The pre-arcing time shall lie within the tolerances of the pre-arcing time-current characteristic given by the manufacturer.

If fuse-links form part of a homogeneous series as defined in items d), e) and f) of 6.6.4.1 of IEC 60282-1, the maximum and minimum current ratings only need be tested.

If the same value of K is assigned to both maximum and minimum current ratings, then that value may also be deemed to apply to all intermediate current ratings within the homogeneous series. If different values of K are assigned to the maximum and minimum current ratings, then the K factors for intermediate ratings may be determined by linear interpolation; see Figure 2.

If a manufacturer assigns a higher value of K for an intermediate rating than that resulting from interpolation, this assigned value shall be proved by tests to the requirements of Clause 6.

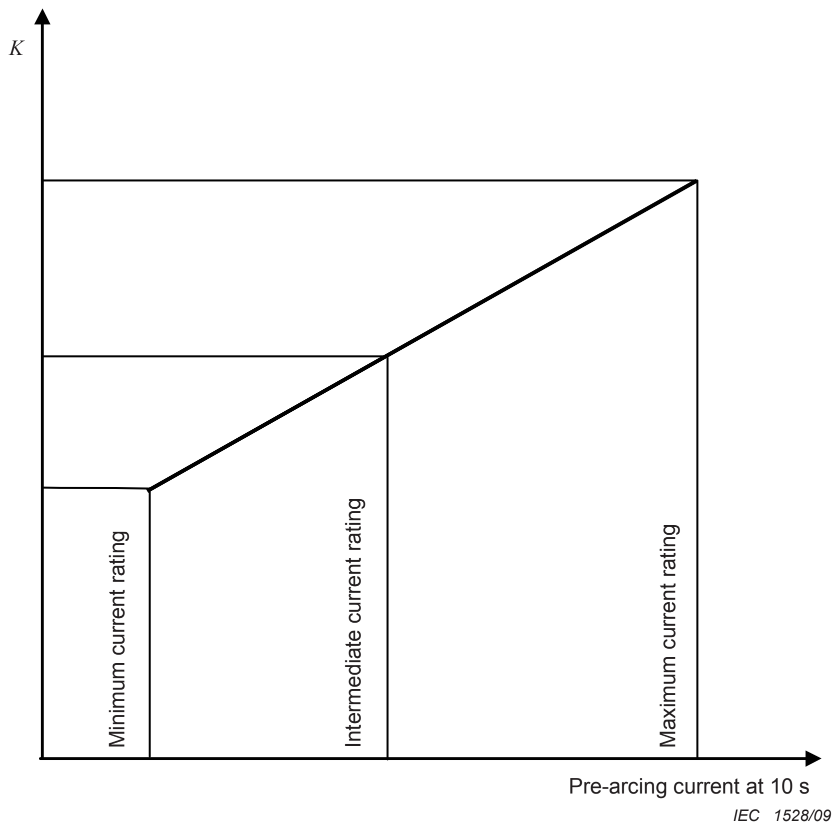


Figure 2 – Determination of *K* factor for fuse-links of intermediate rating of a homogeneous series

7 Information to be given to the user

Although in principle any high-voltage fuse-link can be used to protect motor circuits, there are advantages in selecting a fuse-link specifically designed for this application.

For fuse-links intended to be used for motor circuit protection, the manufacturer shall state the K factor which will indicate to the user the degree to which the fuse-link is capable of withstanding cyclic overloads without deterioration. It shall be stated if the K factor is related to the minimum or the mean pre-arcing time-current characteristic.

The pre-arcing time-current characteristic of the fuse-link with current values multiplied by factor K thus defines the boundary of the overload curve for a given number of motor starts per hour.

8 Selection of fuse-links for motor circuit applications and correlation of fuse-link characteristics with those of other components of the circuit

8.1 Selection of fuse-links

The fuse-link is inserted into the motor circuit that the fuse-link is intended to protect. Some ratings of the fuse-links (e.g. rated voltage and rated breaking current) are therefore dependent on the system and others (e.g. rated current) are dependent on the motor.

The ability to withstand repetitive starting conditions is an important factor. When selecting a fuse-link for a given motor circuit application, due regard should be paid to the K factor, which should be applied to the pre-arcing time-current characteristic of the fuse-link to take account of these starting conditions.

The usual concept of rated current, based upon the ability of a fuse-link to carry a given current continuously without exceeding a specified temperature rise, is usually of secondary importance where the motor is started direct-on-line. The fuse-link for such applications is normally chosen by reference to the paragraphs above.

However, when the fuse-links are enclosed in motor circuit equipment, it should be verified that their rated current exceeds the running current of the motor by an amount sufficient to take account of the effects of the temperature of the air surrounding them (see Annex F of IEC 60282-1).

Where assisted starting is used and thereby starting currents are reduced, the above method of selection is generally applicable, but allowance may have to be made for the high transient currents which, with some methods of starting, flow during transition from one connection to the succeeding connection. Further, since assisted starting in general allows the use of fuse-links of lower current rating, the temperature rise under running conditions is likely to be of primary importance.

8.2 Co-ordination with other circuit components

Figure 3 illustrates a typical motor circuit application involving a motor, relay or relays (providing one or more of the following: inverse overcurrent protection, instantaneous overcurrent protection, instantaneous earth fault protection), contactor or other mechanical switching device, the cable and the fuse-link itself.

The motor will be chosen for its particular duty, thus fixing the values of the full load current and the starting current. The duration and frequency of the starts will also be fixed. The characteristic of the associated inverse time overcurrent relay will then be chosen to give adequate thermal protection to the motor. The switching device is selected in conjunction with fuse-link to co-ordinate with the already selected motor.

In particular, referring to Figure 3:

a) the pre-arcing time-current characteristic of the fuse-link, when multiplied by the appropriate K factor, should lie to the right of the motor starting current at point A;

b) the switching device should be capable of withstanding the conditions defined by the operating characteristic curves shown in Figure 3 and defined by the points D, B, C and E;

c) the rated current of the fuse-link should be chosen such that when the fuse-link is mounted in its service position it is capable of carrying continuously the running current of the motor without overheating. This is of particular importance where assisted starting is used;

d) the current corresponding to the point of intersection B of the curves of the fuse-link and the overcurrent relay should be less than the rated maximum breaking current of the switching device;

e) the rated minimum breaking current of the fuse-link should not exceed the minimum take-over current (where the switching device takes over breaking duty from the fuse, point B);

f) in the event of instantaneous protection being provided, the take-over point will move from B to C. Due regard should be paid to the possibility that the switching device might open at a current greater than its rated maximum breaking current;

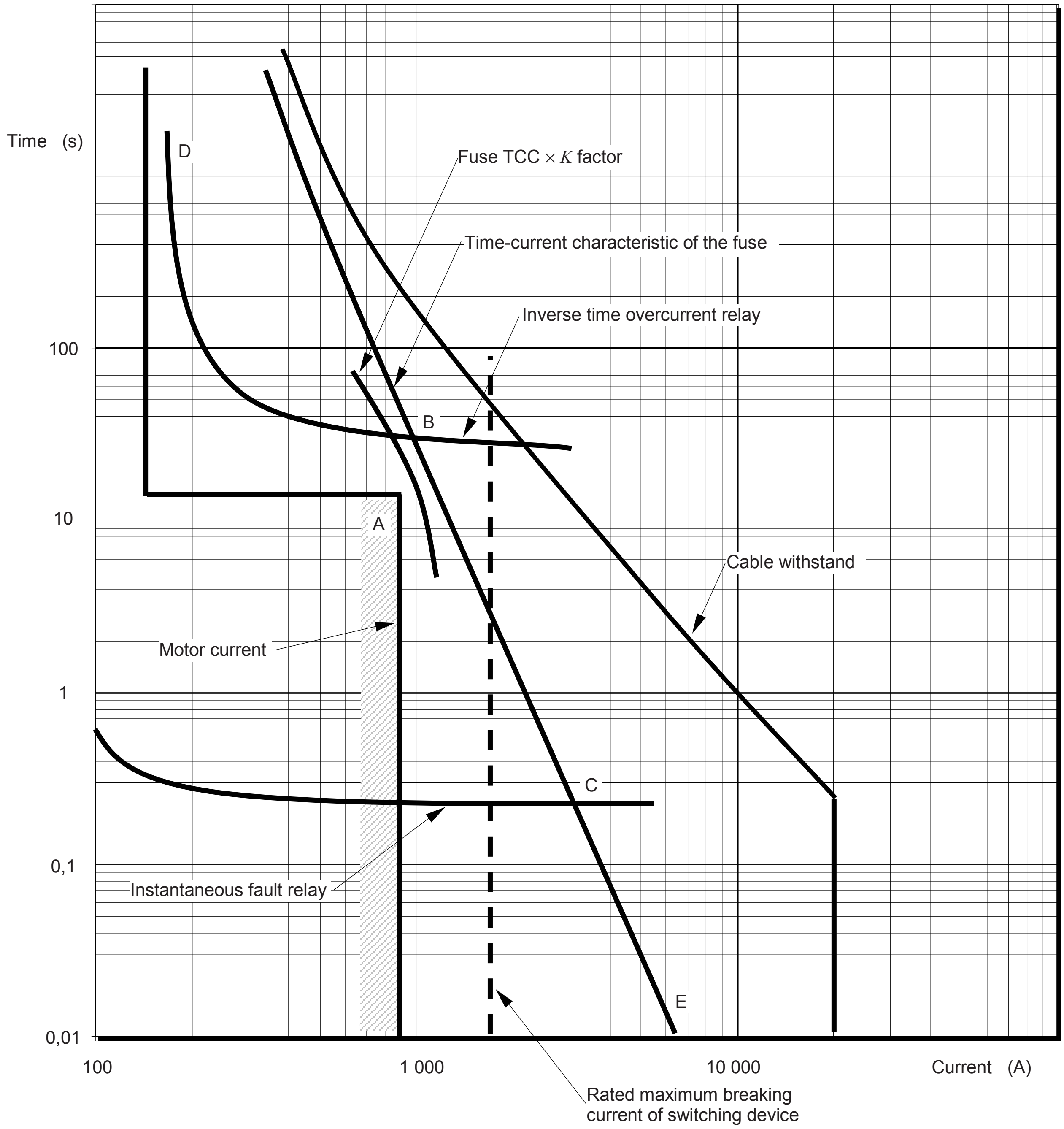
g) the cut-off current of the fuse-link at the maximum fault current of the system should not exceed the rated peak short-circuit withstand current (I_p) of the switching device;

h) it is desirable that the rated minimum breaking current of the fuse-link should be as low as possible and preferably should be at least as low as the starting current of the motor (see also 9.3.3.5 of IEC 60282-1);

i) as shown in Figure 3, the whole of the withstand curve of the cable should lie to the right of the operating characteristic DBCE. Where high ratings of fuse-link are necessary due to the nature of the motor starting duty (for example, long starting times and frequent starts), the section B, C and E moves to the right and may necessitate an appropriate increase of cable size.

NOTE In cases where the switching device can be tripped by operation of the fuse striker, reference should be made to IEC 60470[1][1].

1 Figures in square brackets refer to the bibliography.



TCC Time-current characteristic

IEC 1529/09

NOTE For simplicity, only mean characteristics are shown. In practice, manufacturing tolerances and the variations between the "cold" and "hot" characteristics of the various components of the circuit should be taken into account.

Figure 3 – Characteristics relating to the protection of a motor circuit

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[1] IEC 60470, *High-voltage alternating current contactors and contactor-based motor-starters*

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