SLOVENSKI STANDARD
SIST IEC/TR 61459:1998

01-april-1998

Low-voltage fuses - Coordination between fuses and contactors/motor-starters - Application guide

Low-voltage fuses - Coordination between fuses and contactors/motor-starters - Application guide

Coordination entre fusibles et contacteurs/démarreurs - Guide d'application

Ta slovenski standard je istoveten z: IEC/TR 61459

ICS:

29.120.50	Varovalke in druga medtokovna zaščita	Fuses and other overcurrent protection devices

SIST IEC/TR 61459:1998 en

RAPPORT TECHNIQUE – TYPE 3

TECHNICAL REPORT – TYPE 3

CEI
IEC
1459

Première édition
First edition
1996-08

Fusibles basse tension – Coordination entre fusibles et contacteurs/démarreurs – Guide d'application

Low-voltage fuses – Coordination between fuses and contactors/motor-starters – Application guide

Bureau central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève Suisse

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

CODE PRIX
PRICE CODE P

Pour prix, voir catalogue en vigueur
For price, see current catalogue

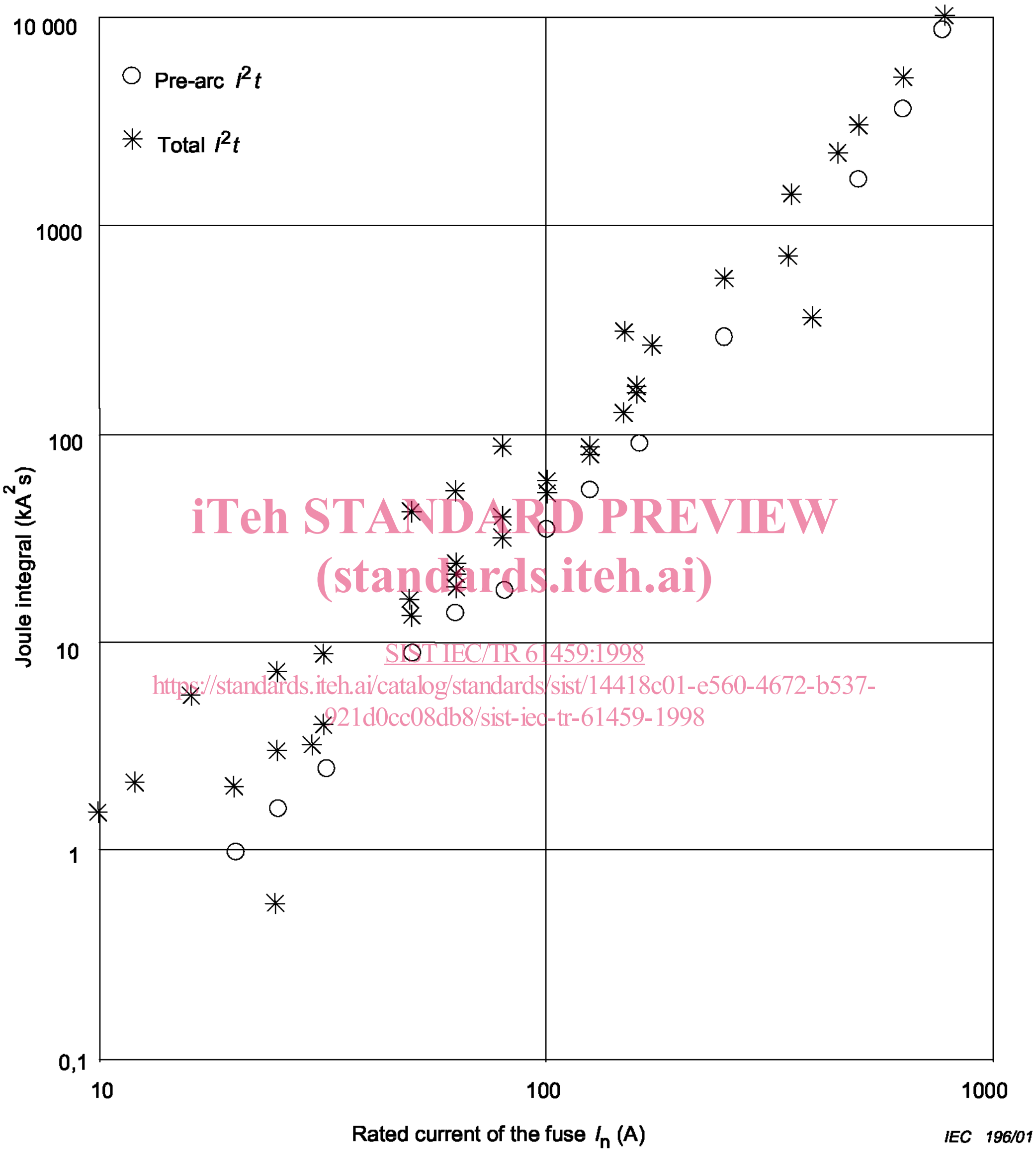
CONTENTS

Page 31

Figure B.3

Replace the existing figure by the following new figure:

Fuses used in successful coordination - International results



INTERNATIONAL ELECTROTECHNICAL COMMISSION

COORDINATION BETWEEN FUSES AND CONTACTORS/MOTOR-STARTERS – APPLICATION GUIDE

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters, express as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but no immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

IEC 1459, which is a technical report of type 3, has been prepared by sub-committee 32B: Low-voltage fuses, of IEC technical committee 32: Fuses.

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

Committee draft	Report on voting
32B/250/CDV	32B/265/RVC

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

Annexes A and B are for information only.

COORDINATION BETWEEN FUSES AND CONTACTORS/MOTOR-STARTERS – APPLICATION GUIDE

1 Scope

The information given in this technical report provides guidance to assist in selecting a fuse-link to ensure coordination with contactors or motor-starters (contactors with overload relay).

The coordination between motor-starters and the fuses which protect them is covered in IEC standards by test requirements such as those in IEC 947, in particular parts 1 and 4.

Overcurrent protection of other equipment, such as motors, conductors, etc., is not covered by this standard.

Tests are specified at three levels of prospective current, according to IEC 947-4-1:

a) in the region of the current I_c (see clause 5). Tests are made at 0,75 I_c when the starter shall disconnect the current without damage and the fuse does not operate, and at 1,25 I_c when the fuse shall operate before the starter (see annex A, figure A.1);

b) at the appropriate value of prospective current "r" shown in IEC 947-4-1, table XI (see table A.1 in annex A);

c) at the rated conditional short-circuit current I_q, if higher than the test current "r".

The fuse selected is capable of absorbing the surge of current on starting the motor and is normally selected from the recommendations of the manufacturer or by compliance with national installation codes and wiring rules.

Studies carried out by IEC committee "Fuses" in collaboration with motor-starter manufacturers worldwide have revealed that there is no major difficulty in achieving satisfactory coordination at the most exacting of the levels of type of coordination using selected fuses according to IEC 269-2 in coordination with modern contactors. A survey is presented in annex B of the rated currents, I^2t values and cut-off currents of fuses correctly chosen according to the ratings of the starters they protect, based on the results of successful type testing throughout the world.

Examples of suitable fuse-links used for motor protection are also given in annex B.

2 Reference documents

IEC 50(441): 1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

IEC 269-2: 1986, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)*

IEC 269-2-1: 1987, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Section 1: Examples of types of standardized fuses for use by authorized persons*

IEC 947: *Low-voltage switchgear and controlgear*

IEC 947-1: 1988, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 947-4-1: 1990, *Low-voltage switchgear and controlgear – Part 4: Contactors and motor-starters – Section 1: Electromechanical contactors and motor-starters*

3 Definitions

For the purpose of this technical report the definitions in IEC 269-1 apply together with the following additional definitions:

3.1 **switching device (SD)**: A device designed to make or break the current in one or more electric circuits. [IEV 441-14-01]

NOTE – A switching device may perform one or both of these operations.

3.2 **short-circuit protective device (SCPD)**: A device intended to protect a circuit or parts of a circuit against short circuits by interrupting them.

4 Criteria for coordination at the rated conditional short-circuit current I_q

4.1 *Maximum total operating I^2t and cut-off current*

When a fuse is the SCPD being used, I_q can be any value up to 50 kA or more. Under these conditions, the most important parameters are the total let-through I^2t of the fuse-link (under the conditions of the three-phase coordination test with the starter in series with the fuse) and the maximum cut-off current of the fuse.

Values can be provided for all voltage systems and maximum I^2t let-through values corresponding to a test voltage equivalent to the three-phase coordination test (for example: 400 V/$\sqrt{3}$ for a 400 V-three-phase starter) are to be introduced in IEC 269-2-1.

This will also limit the peak cut-off current, because the values are related. However, until values are introduced in the standard, it can be reported on the basis of international coordination tests at prospective currents from 50 kA to 200 kA, that at a prospective current of I_p (A), the cut-off current I_0 (A) of a fuse-link of rated current I_n (A) is equal to or less than the value given by the formula:

$$I_0 = 20\sqrt[3]{I_n^2 I_p}$$

4.2 *Guidance for choosing the maximum rated current of an alternative fuse type*

From the successful results of coordination type tests at I_q, the starter manufacturer can plot the curves of the maximum total I^2t withstand of the contactor and the overload relay and the maximum peak let-through current as a function of the rated operational current of the motor-starter (I_e). Such a curve is shown in figure 1a.

A fuse-link of a different type cannot be used without further testing unless its I^2t and I_0 values are equal to or less than the maximum values observed in the tests used to plot the curves. However, it may be possible to get from the fuse manufacturer data for total I^2t values and cut-off currents measured under comparable conditions, (i.e. at an equivalent test voltage and at a prospective current equal to I_q). These will be plotted as a function of rated current I_n of the fuse. Typical curves derived from such data are shown for alternative fuses of type A in figure 1b and for fuses of type B in figure 1c. These have to be plotted on the same scales as in figure 1a.

We have just seen that without further testing we cannot use a fuse with a bigger I^2t or a bigger cut-off current. Therefore for a starter rated at I_e = X (amperes) the maximum permissible rated current of fuses of type A is seen to be Y (amperes), see figure 1, the I^2t of rated current Y((amperes) is acceptable, but the cut-off current would be too high. In the case of replacement fuses of type B, however, the limiting factor is the I^2t, and Z′(amperes) is therefore the highest permissible rated current to achieve predictable coordination with the starter at I_q (see figure 1).

Fuse-link types A and B could be any of the types used for motor circuit protection listed in annex B.

This procedure may, however, lead to the choice of fuses of excessively low nominal current, because it does not take into account the additional impedance of the starter (e.g. in case of association for which the rated operational current of the starter is lower than 10 A, the overload relay impedance may have a noticeable influence). In such cases, if the additional impedance is not taken into account to estimate more precisely the prospective short-circuit current and the suitability of the fuses to protect the starter, direct tests will be needed to verify coordination with fuses of higher ratings than determined by the procedure outlined in this standard.

4.3 *Further guidance*

In addition to the above, the following points should be noted:

High values of clearing time increase the risk of welding of the contacts of the contactor. In evaluating the "clearing time" for this purpose we consider that the current is "cleared" when it becomes a small percentage (ca. 5 %) of its limiting peak value. This value may be difficult to obtain, and an acceptable alternative method is to assume that the limiting curve is a sinusoidal waveform and from the total I^2t (value = $[I^2t]$ in A²s) and the peak let-through current (value = $\hat{I}$ in A) calculate an "equivalent clearing time" t_{eq} given by:

$$t_{eq} = \frac{2 \times [I^2t]}{\hat{I}^2}$$

A satisfactory value for this equivalent clearing time has been found to be: $t_{eq} \leq 5$ ms.

NOTE – Risk of contact welding increases when, after being thrown apart, contacts close again while relatively high arcing currents remain established between the contacts. Considering the inertia of moving contacts, the probability of reclosing with such currents increases, if these currents still persist 5 ms after the beginning of the short circuit.

The conditions for determining the total operating I^2t of the fuse for the condition of a three-phase circuit with unearthed phase can be taken as equivalent to a maximum applied voltage of $\sqrt{3/2}$ times the phase-to-phase voltage.

NOTE – This technique gives the maximum rating for coordination at prospective current I_q. A smaller rating may be necessary to provide adequate coordination for test currents I_c and/or "r". The type of coordination is determined in IEC 947-4-1 by the results of tests at all these current levels. Guidance in securing proper coordination at these levels is provided in clauses 5 and 6.

5 Criteria for coordination at the take-over current I_c

I_c is the current corresponding to the intersection of the mean time/current characteristics of the fuse and the overload relay of the starter (see annex 1, figure A.1). Tests are prescribed for ensuring proper coordination at I_c in IEC 947-4-1, annex B, clause B.4.