

Method for

Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects

ICS 29.020

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National foreword

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The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to IEC text carry the number of the amendment. For example, text altered by IEC amendment 1 is indicated in the text by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee GEL/20, to subcommittee GEL/20/16 Medium/high voltage cables.

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

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This British Standard, having been prepared under the direction of the Cables and Insulation Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 30 April 1991

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Introduction

The method of calculating the short-circuit rating of any current carrying component of a cable has generally been based on the assumption that the heat is retained inside the current carrying component for the duration of the short-circuit (i.e. adiabatic heating). However, there is some heat transfer into the adjacent materials during the short-circuit and advantage can be taken of this. This standard gives a simple method for incorporating this non-adiabatic heating effect when calculating short-circuit ratings so that the same short-circuit ratings are obtained by different designers. It is recognized that more sophisticated computer methods are available but these do not significantly affect the accuracy and are considered too complex to be standardized.

The formulae contain quantities which vary with the materials used in the cables. Values are given in the tables; these values are either internationally standardized, for example electric resistivities and resistance temperature coefficients, or those which are generally accepted in practice, for example specific heats.

In order that uniform and comparable results may be obtained, the short-circuit ratings shall be calculated using the method and the values given in this standard. However, where it is known with certainty that other values of material constants are more appropriate then these may be used, and the corresponding short-circuit rating declared in addition, provided that the different values are quoted.

In this standard the worst case conditions have been assumed and the short-circuit ratings will be pessimistic.

The non-adiabatic method is valid for all short-circuit durations. When compared to the adiabatic method it will provide significant increases of the permissible short-circuit currents in the case of screens, sheaths, and possibly small conductors of $< 10 \text{ mm}^2$ (especially when used as screen wires). For the usual range of power cable conductors 5 % is the minimum increase in short-circuit current that would be useful in practice, so that for ratios of short-circuit duration to conductor cross-sectional area of $< 0.1 \text{ s/mm}^2$ the improvement in current is negligible and the adiabatic method may be used. This covers the majority of practical situations.

The approach set out in this standard is to:

- calculate the adiabatic short-circuit current,
- calculate a modifying factor that takes account of the non-adiabatic heating effect,
- multiply a) and b) to obtain the permissible short-circuit current.

1 List of symbols

		<i>Units</i>
A	} constants based on thermal properties of the surrounding or adjacent materials	$(\text{mm}^2/\text{s})^{\frac{1}{2}}$
B		mm^2/s
C_1	} constants used in the non-adiabatic formula for conductors and spaced wire screens	mm/m
C_2		$\text{K.m.mm}^2/\text{J}$
D_{it}	diameter of the imaginary co-axial cylinder which just touches the inside surface of the troughs of a corrugated sheath	mm
D_{oc}	diameter of the imaginary co-axial cylinder which just touches the outside surface of the crests of a corrugated sheath	mm
F	factor to account for imperfect thermal contact	—
I	permissible short-circuit current (r.m.s. over duration)	A
I_{AD}	short-circuit current calculated on an adiabatic basis (r.m.s. over duration)	A
I_{SC}	known maximum short-circuit current (r.m.s. over duration)	A
K	constant depending on the material of the current carrying component	$\text{As}^{\frac{1}{2}}/\text{mm}^2$
M	thermal contact factor	$\text{s}^{-\frac{1}{2}}$
S	geometrical cross-sectional area of the current carrying component	mm^2
X	} constants for use in the simplified formula for conductors and spaced wire screens	$(\text{mm}^2/\text{s})^{\frac{1}{2}}$
Y		mm^2/s
d	mean diameter of sheath, screen or armour	mm
n	number of tapes or wires	—
t	duration of short-circuit	s
w	width of tape	mm