IEC 60287-1-1

Edition 2.0 2006-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Electric cables – Calculation of the current rating – Part 1-1: Current rating equations (100 % load factor) and calculation of losses – General

Câbles électriques – Calcul du courant admissible – Partie 1-1: Equations de l'intensité du courant admissible (facteur de charge 100 %) et calcul des pertes – Généralités

IEC 60287-1-1:2006

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX V

ICS 29.060.20

ISBN 2-8318-8938-3

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRIC CABLES – CALCULATION OF THE CURRENT RATING –

Part 1-1: Current rating equations (100 % load factor) and calculation of losses – General

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FOREWORD

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International Standard IEC 60287-1-1 has been prepared by IEC technical committee 20: Electric cables.

This second edition cancels and replaces the first edition published in 1994, Amendment 1 (1995) and Amendment 2 (2001) The document 20/780/FDIS, circulated to the National Committees as Amendment 3, led to the publication of this new edition.

The text of this standard is based on the first edition, its Amendments 1 and 2, and the following documents:

FDIS	Report on voting
20/851/FDIS	20/867/RVD

Full information on the voting for the approval of this standard 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 60287 series, published under the general title: *Electric cables – Calculation of the current rating*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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- withdrawn,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.

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INTRODUCTION

This Part 1-1 contains formulae for the quantities R, W_d, λ_1 and λ_2.

It contains methods for calculating the permissible current rating of cables from details of the permissible temperature rise, conductor resistance, losses and thermal resistivities.

Formulae for the calculation of losses are also given.

The formulae in this standard contain quantities which vary with cable design and materials used. The values given in the tables are either internationally agreed, for example, electrical resistivities and resistance temperature coefficients, or are those which are generally accepted in practice, for example, thermal resistivities and permittivities of materials. In this latter category, some of the values given are not characteristic of the quality of new cables but are considered to apply to cables after a long period of use. In order that uniform and comparable results may be obtained, the current ratings should be calculated with the values given in this standard. However, where it is known with certainty that other values are more appropriate to the materials and design, then these may be used, and the corresponding current rating declared in addition, provided that the different values are quoted.

Quantities related to the operating conditions of cables are liable to vary considerably from one country to another. For instance, with respect to the ambient temperature and soil thermal resistivity, the values are governed in various countries by different considerations. Superficial comparisons between the values used in the various countries may lead to erroneous conclusions if they are not based on common criteria: for example, there may be different expectations for the life of the cables, and in some countries design is based on maximum values of soil thermal resistivity, whereas in others average values are used. Particularly, in the case of soil thermal resistivity, it is well known that this quantity is very sensitive to soil moisture content and may vary significantly with time, depending on the soil type, the topographical and meteorological conditions, and the cable loading.

The following procedure for choosing the values for the various parameters should, therefore, be adopted.

Numerical values should preferably be based on results of suitable measurements. Often such results are already included in national specifications as recommended values, so that the calculation may be based on these values generally used in the country in question; a survey of such values is given in Part 3-1.

A suggested list of the information required to select the appropriate type of cable is given in Part 3-1.

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ELECTRIC CABLES – CALCULATION OF THE CURRENT RATING –

Part 1-1: Current rating equations (100 % load factor) and calculation of losses – General

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1 General

1.1 Scope

This part of IEC 60287 is applicable to the conditions of steady-state operation of cables at all alternating voltages, and direct voltages up to 5 kV, buried directly in the ground, in ducts, troughs or in steel pipes, both with and without partial drying-out of the soil, as well as cables in air. The term "steady state" is intended to mean a continuous constant current (100 % load factor) just sufficient to produce asymptotically the maximum conductor temperature, the surrounding ambient conditions being assumed constant.

This part provides formulae for current ratings and losses.

The formulae given are essentially literal and designedly leave open the selection of certain important parameters. These may be divided into three groups:

– parameters related to construction of a cable (for example, thermal resistivity of insulating material) for which representative values have been selected based on published work;

– parameters related to the surrounding conditions, which may vary widely, the selection of which depends on the country in which the cables are used or are to be used;

– parameters which result from an agreement between manufacturer and user and which involve a margin for security of service (for example, maximum conductor temperature).

1.2 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 60027-3, *Letter symbols to be used in electrical technology – Part 3: Logarithmic and related quantities, and their units*

IEC 60028:1925, *International standard of resistance for copper*

IEC 60141 (all parts), *Tests on oil-filled and gas-pressure cables and their accessories*

IEC 60228, *Conductors of insulated cables*

IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 1: Cables for rated voltages of 1 kV (Um = 1,2 kV) and 3 kV (Um = 3,6 kV)*

IEC 60502-2, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)*

IEC 60889, *Hard-drawn aluminium wire for overhead line conductors*

1.3 Symbols

The symbols used in this standard and the quantities which they represent are given in the following list:

A	cross-sectional area of the armour	mm²
B_1, B_2	coefficients (see 2.4.2)	
C	capacitance per core	F/m
D_e^*	external diameter of cable	m
D_i	diameter over insulation	mm
D_s	external diameter of metal sheath	mm
D_{oc}	the diameter of the imaginary coaxial cylinder which just touches the crests of a corrugated sheath	mm
D_{it}	the diameter of the imaginary cylinder which just touches the inside surface of the troughs of a corrugated sheath	mm
F	coefficient defined in 2.3.5	
H	intensity of solar radiation	W/m²
H	magnetizing force (see 2.4.2)	ampere turns/m
H_s	inductance of sheath	H/m
H_1, H_2, H_3	components of inductance due to the steel wires (see 2.4.2)	H/m
I	current in one conductor (r.m.s. value)	A
M, N	coefficients defined in 2.3.5	
P, Q	coefficients defined in 2.3.3	Ω/m
R	alternating current resistance of conductor at its maximum operating temperature	Ω/m
R_A	a.c. resistance of armour at its maximum operating temperature	Ω/m
R_{Ao}	a.c. resistance of armour at 20 °C	Ω/m
R_e	equivalent a.c. resistance of sheath and armour in parallel	Ω/m
R_s	a.c. resistance of cable sheath or screen at their maximum operating temperature	Ω/m
R_{so}	a.c. resistance of cable sheath or screen at 20 °C	Ω/m
R'	d.c. resistance of conductor at maximum operating temperature	Ω/m
R_o	d.c. resistance of conductor at 20 °C	Ω/m
T_1	thermal resistance per core between conductor and sheath	K.m/W
T_2	thermal resistance between sheath and armour	K.m/W
T_3	thermal resistance of external serving	K.m/W
T_4	thermal resistance of surrounding medium (ratio of cable surface temperature rise above ambient to the losses per unit length)	K.m/W

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