

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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**Electric cables – Calculation of the current rating –  
Part 2-1: Thermal resistance – Calculation of thermal resistance**

**Câbles électriques – Calcul du courant admissible –  
Partie 2-1: Résistance thermique – Calcul de la résistance thermique**



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Partie 2-1: Résistance thermique – Calcul de la résistance thermique**

INTERNATIONAL  
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ICS 29.060.20

ISBN 978-2-8322-2583-7

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## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references .....	7
3 Symbols.....	7
4 Calculation of thermal resistances.....	10
4.1 Thermal resistance of the constituent parts of a cable, $T_1$ , $T_2$ and $T_3$ .....	10
4.1.1 General .....	10
4.1.2 Thermal resistance between one conductor and sheath $T_1$ .....	10
4.1.3 Thermal resistance between sheath and armour $T_2$ .....	14
4.1.4 Thermal resistance of outer covering (serving) $T_3$ .....	14
4.1.5 Pipe-type cables .....	15
4.2 External thermal resistance $T_4$ .....	16
4.2.1 Cables laid in free air .....	16
4.2.2 Single isolated buried cable.....	17
4.2.3 Groups of buried cables (not touching) .....	18
4.2.4 Groups of buried cables (touching) equally loaded .....	20
4.2.5 Buried pipes .....	22
4.2.6 Cables in buried troughs .....	22
4.2.7 Cables in ducts or pipes .....	22
5 Digital calculation of quantities given graphically .....	24
5.1 General.....	24
5.2 Geometric factor $G$ for two-core belted cables with circular conductors.....	24
5.3 Geometric factor $G$ for three-core belted cables with circular conductors .....	25
5.4 Thermal resistance of three-core screened cables with circular conductors compared to that of a corresponding unscreened cable.....	26
5.5 Thermal resistance of three-core screened cables with sector-shaped conductors compared to that of a corresponding unscreened cable .....	26
5.6 Curve for $\bar{G}$ for obtaining the thermal resistance of the filling material between the sheaths and armour of SL and SA type cables.....	27
5.7 Calculation of $\Delta\theta_S$ by means of a diagram.....	27
Bibliography .....	42
Figure 1 – Diagram showing a group of $q$ cables and their reflection in the ground-air surface.....	32
Figure 2 – Geometric factor $G$ for two-core belted cables with circular conductors (see 4.1.2.2.2).....	33
Figure 3 – Geometric factor $G$ for three-core belted cables with circular conductors (see 4.1.2.2.4).....	34
Figure 4 – Thermal resistance of three-core screened cables with circular conductors compared to that of a corresponding unscreened cable (see 4.1.2.3.1) .....	35
Figure 5 – Thermal resistance of three-core screened cables with sector-shaped conductors compared with that of a corresponding unscreened cable (see 4.1.2.3.3) .....	36
Figure 6 – Geometric factor $\bar{G}$ for obtaining the thermal resistances of the filling material between the sheaths and armour of SL and SA type cables (see 4.1.3.2).....	37
Figure 7 – Heat dissipation coefficient for black surfaces of cables in free air, laying condition #1 to #4 .....	38

Figure 8 – Heat dissipation coefficient for black surfaces of cables in free air, laying condition #5 to #8 .....	39
Figure 9 – Heat dissipation coefficient for black surfaces of cables in free air, laying condition #9 to #10 .....	40
Figure 10 – Graph for the calculation of external thermal resistance of cables in air .....	41
Table 1 – Thermal resistivities of materials .....	29
Table 2 – Values for constants $Z$ , $E$ and $g$ for black surfaces of cables in free air .....	30
Table 3 – Absorption coefficient of solar radiation for cable surfaces .....	31
Table 4 – Values of constants $U$ , $V$ and $Y$ .....	31

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRIC CABLES –  
CALCULATION OF THE CURRENT RATING –****Part 2-1: Thermal resistance –  
Calculation of thermal resistance**

## FOREWORD

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International Standard IEC 60287-2-1 has been prepared by IEC technical committee 20: Electric cables.

This second edition of IEC 60287-2-1 cancels and replaces the first edition, published in 1994, Amendment 1:2001, Amendment 2:2006 and Corrigendum 1:2008. The document 20/1448/CDV, circulated to the National Committees as Amendment 3, led to the publication of this new edition. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) inclusion of a reference to the use of finite element methods where analytical methods are not available for the calculation of external thermal resistance;
- b) explanation about SL and SA type cables;

- c) calculation method for T3 for unarmoured three-core cables with extruded insulation and individual copper tape screens on each core;
- d) change of condition for X in 5.4;
- e) inclusion of constants or installation conditions for water filled ducts in Table 4.

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

FDIS	Report on voting
20/1561/FDIS	20/1588/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 in 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 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.

## INTRODUCTION

IEC 60287 has been divided into three parts so that revisions of, and additions to the document can be carried out more conveniently.

Each part is subdivided into subparts which are published as separate standards.

Part 1: Formulae of ratings and power losses

Part 2: Formulae for thermal resistance

Part 3: Operating conditions

This part of IEC 60287-2 contains methods for calculating the internal thermal resistance of cables and the external thermal resistance for cables laid in free air, ducts and buried.

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 IEC 60287-3-1.

A suggested list of the information required to select the appropriate type of cable is given in IEC 60287-3-1.

## ELECTRIC CABLES – CALCULATION OF THE CURRENT RATING –

### Part 2-1: Thermal resistance – Calculation of thermal resistance

#### 1 Scope

This part of IEC 60287 is solely 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, in 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 of IEC 60287 provides formulae for thermal resistance.

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).

Equations given in this part of IEC 60287 for calculating the external thermal resistance of a cable buried directly in the ground or in a buried duct are for a limited number of installation conditions. Where analytical methods are not available for calculation of external thermal resistance finite element methods may be used. Guidance on the use of finite element methods for calculating cable current ratings is given in IEC TR 62095.

#### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60287-1-1:2006, *Electric cables – Calculation of the current rating – Part 1-1: Current rating equations (100 % load factor) and calculation of losses – General*  
IEC 60287-1-1:2006/AMD1:2014

IEC 60853-2, *Calculation of the cyclic and emergency current rating of cables – Part 2: Cyclic rating of cables greater than 18/30 (36) kV and emergency ratings for cables of all voltages*

#### 3 Symbols

The symbols used in this part of IEC 60287 and the quantities which they represent are given in the following list: