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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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRIC CABLES –
CALCULATION OF THE CURRENT RATING –
Part 1-1: Current rating equations (100 % load factor)
and calculation of losses – General

FOREWORD

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International Standard IEC 60287-1-1 has been prepared by subcommittee 20A: High-voltage cables, of IEC technical committee 20: Electric cables.

This first edition of IEC 60287-1-1 cancels and replaces sections one and two of the second edition of IEC 60287 published in 1982 and the appropriate part of amendment 3, without technical changes.

IEC 60287-2-1 replaces section three and annexes C and D of the second edition of IEC 60287; IEC 60287-3-1 replaces annexes A and B of the second edition of IEC 60287.

This consolidated version of IEC 60287-1-1 is based on the first edition (1994) [documents 20A(CO)75 and 20A(CO)81], its amendment 1 (1995) [documents 20A/262/FDIS and 20A/280/RVD] and its amendment 2 (2001) [documents 20A/477/FDIS and 20A/483/RVD].

It bears the edition number 1.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.
The committee has decided that the contents of the base publication and its amendments will remain unchanged until 2006. 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- withdrawn;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 and sections so that revisions of, and additions to, the document can be carried out more conveniently.

Each part is divided into sections which are published as separate standards.

Part 1: Formulae for ratings (100 % load factor) and power losses
Part 2: Formulae for thermal resistance
Part 3: Sections on operating conditions

Part 1 – Section 1: General, contains formulae for the quantities \( R \), \( W_d \), \( \lambda_1 \) and \( \lambda_2 \).

This section 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 in this section.

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, section 1.

A suggested list of the information required to select the appropriate type of cable is given in part 3, section 1.
1 General

1.1 Scope

This section 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 section 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, Letter symbols to be used in electrical technology

IEC 60028:1925, International standard of resistance for copper

IEC 60141, Tests on oil-filled and gas-pressure cables and their accessories

IEC 60183:1984, Guide to the selection of high-voltage cables

IEC 60228:1978, Conductors of insulated cables
Amendment 1 (1993)

IEC 60228A:1982, First supplement – Guide to the dimensional limits of circular conductors

IEC 60502:1983, Extruded solid dielectric insulated power cables for rated voltages from 1 kV up to 30 kV

IEC 60889:1987, Hard-drawn aluminium wire for overhead line conductors