INTERNATIONAL STANDARD

IEC 60228

Third edition
2004-11

Conductors of insulated cables

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

Reference number
IEC 60228:2004(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CONDUCTORS OF INSULATED CABLES

FOREWORD

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International Standard IEC 60228 has been prepared by IEC technical committee 20: Electric cables.

This third edition cancels and replaces the IEC 60228 (1978), its Amendment 1 (1993) and its first supplement, IEC 60228A (1982).

The principal changes with respect to the previous edition are as follows:

a) the consolidation of material from IEC 60228A;
b) addition of a definition for nominal cross-sectional area;
c) an increase in the range of conductor sizes in Tables 1 and 2;
d) addition of a note that solid aluminum alloy conductors, having the same dimensions as aluminum conductors, will have a higher resistance;
e) strengthening of the recommendations for dimensional limits of compacted stranded copper conductors.

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

FDIS	Report on voting
20/718/FDIS	20/737/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.

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- withdrawn,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.

Conductors described in IEC 60228 are specified in metric sizes. Canada at present uses conductor sizes and characteristics according to the American Wire Gauge (AWG) system and kcmil for larger sizes as shown below. The use of these sizes is currently prescribed uniformly across Canada for installations by sub-national regulations. IEC TC 20 cable product standards do not prescribe cables with AWG/kcmil conductors.

AWG				kcmil			
Conductor size	**Nominal cross-sectional area mm²**	**Conductor size**	**Nominal cross-sectional area mm²**	**Conductor size**	**Nominal cross-sectional area mm²**	**Conductor size**	**Nominal cross-sectional area mm²**
-	-	-	-	250	127	750	380
-	-	-	-	300	152	800	405
20	0,519	4	21,2	350	177	900	456
18	0,823	3	26,7	400	203	1000	507
16	1,31	2	33,6	450	228	1200	608
14	2,08	1	42,4	500	253	1250	633
12	3,31	1/0	53,5	550	279	1500	760
10	5,26	2/0	67,4	600	304	1750	887
8	8,37	3/0	85,0	650	329	2000	1010
6	13,3	4/0	107	700	355	-	-

INTRODUCTION

IEC 60228 is intended as a fundamental reference standard for IEC Technical Committees and National Committees in drafting standards for electric cables, and to the National Committees in drafting specifications for use in their own countries. These committees should select from the tables of this general standard the conductors appropriate to the particular applications with which they are concerned and either include the applicable details in their cable specifications or make appropriate references to this standard.

In preparing this edition the main objects have been to incorporate IEC 60228A into it and maintain a simplified yet informative standard so far as is compatible with technical and economic considerations.

CONDUCTORS OF INSULATED CABLES

1 Scope

This International Standard specifies the nominal cross-sectional areas, in the range 0,5 mm^2 to 2 500 mm^2, for conductors in electric power cables and cords of a wide range of types. Requirements for numbers and sizes of wires and resistance values are also included. These conductors include solid and stranded copper, aluminium and aluminium alloy conductors in cables for fixed installations and flexible copper conductors.

The standard does not apply to conductors for telecommunication purposes.

The applicability of this standard to a particular type of cable is as specified in the standard for the type of cable.

Unless indicated to the contrary in a particular clause, this standard relates to the conductors in the finished cable and not to the conductor as made or supplied for inclusion into a cable.

Informative annexes are included giving supplementary information covering temperature correction factors for resistance measurement (Annex B) and dimensional limits of circular conductors (Annex C).

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
metal-coated
coated with a thin layer of suitable metal, such as tin or tin alloy

2.2
nominal cross-sectional area
value that identifies a particular size of conductor but is not subject to direct measurement

NOTE Each particular size of conductor in this standard is required to meet a maximum resistance value.

3 Classification

The conductors have been divided into four classes, 1, 2, 5 and 6. Those in classes 1 and 2 are intended for use in cables for fixed installations. Classes 5 and 6 are intended for use in flexible cables and cords but may also be used for fixed installations.

- Class 1: solid conductors.
- Class 2: stranded conductors.
- Class 5: flexible conductors.
- Class 6: flexible conductors which are more flexible than class 5.

4 Materials

4.1 Introduction

The conductors shall consist of one of the following:

- plain or metal-coated annealed copper;
- aluminium or aluminium alloy.

4.2 Solid aluminium conductors

Circular and shaped solid aluminium conductors shall be made from aluminium such that the tensile strength of the completed conductor is within the following limits:

Nominal cross-sectional area mm^2	**Tensile strength** N/mm^2
10 and 16	110 to 165
25 and 35	60 to 130
50	60 to 110
70 and above	60 to 90

NOTE The values given above are not applicable to aluminium alloy conductors.

4.3 Circular and shaped stranded aluminium conductors

Stranded aluminium conductors shall be made from aluminium such that the tensile strength of the individual wires is within the following limits:

Nominal cross-sectional area mm^2	**Tensile strength** N/mm^2
10	up to 200
16 and above	125 to 205

NOTE 1 The values given above are not applicable to aluminium alloy conductors.

NOTE 2 This data can only be checked on wires taken before stranding and not on wires taken from a stranded conductor.

5 Solid conductors and stranded conductors

5.1 Solid conductors (class 1)

5.1.1 Construction

a) Solid conductors (class 1) shall consist of one of the materials specified in Clause 4.

b) Solid copper conductors shall be of circular cross-section.

NOTE Solid copper conductors having nominal cross-sectional areas of 25 mm^2 and above are for particular types of cable, e.g. mineral insulated, and not for general purposes.

c) Solid aluminium and solid aluminium alloy conductors of sizes 10 mm^2 to 35 mm^2 shall be of circular cross-section. Larger sizes shall be of circular cross-section for single-core cables and may be of either circular or shaped cross-section for multi-core cables.

5.1.2 Resistance

The resistance of each conductor at 20 °C, when determined in accordance with Clause 7, shall not exceed the appropriate maximum value given in Table 1.

NOTE For solid aluminium alloy conductors, having the same nominal cross-sectional area as an aluminium conductor the resistance value given in Table 1 should be multiplied by a factor of 1,162 unless otherwise agreed between the manufacturer and the purchaser.

5.2 Stranded circular non-compacted conductors (class 2)

5.2.1 Construction

a) Stranded circular non-compacted conductors (class 2) shall consist of one of the materials specified in Clause 4.

b) Stranded aluminium or aluminium alloy conductors shall have a cross-sectional area not less than 10 mm^2.

c) The wires in each conductor shall all have the same nominal diameter.

d) The number of wires in each conductor shall be not less than the appropriate minimum number given in Table 2.

5.2.2 Resistance

The resistance of each conductor at 20 °C, when determined in accordance with Clause 7, shall not exceed the appropriate maximum value given in Table 2.

5.3 Stranded compacted circular conductors and stranded shaped conductors (class 2)

5.3.1 Construction

a) Stranded compacted circular conductors and stranded shaped conductors (class 2) shall consist of one of the materials specified in Clause 4. Stranded compacted circular aluminium or aluminium alloy conductors shall have a nominal cross-sectional area not less than 10 mm^2. Stranded shaped copper, aluminium or aluminium alloy conductors shall have a nominal cross-sectional area of not less than 25 mm^2.

b) The ratio of the diameters of two different wires in the same conductor shall not exceed 2.

c) The number of wires in each conductor shall be not less than the appropriate minimum number given in Table 2.

NOTE This requirement applies to conductors made with wires of circular cross-section before compaction and not to conductors made with pre-shaped wires.

5.3.2 Resistance

The resistance of each conductor at 20 °C, when determined in accordance with Clause 7, shall not exceed the appropriate value given in Table 2.

6 Flexible conductors (classes 5 and 6)

6.1 Construction

a) Flexible conductors (classes 5 and 6) shall consist of plain or metal-coated annealed copper.

b) The wires in each conductor shall have the same nominal diameter.

c) The diameter of the wires in each conductor shall not exceed the appropriate maximum value given in Tables 3 or 4.