

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Câbles d'énergie à isolant extrudé et leurs accessoires pour des tensions assignées de 1 kV ($U_m = 1,2$ kV) à 30 kV ($U_m = 36$ kV) – Partie 1: Câbles de tensions assignées de 1 kV ($U_m = 1,2$ kV) et 3 kV ($U_m = 3,6$ kV)



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INTERNATIONAL STANDARD

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**POWER CABLES WITH EXTRUDED INSULATION
AND THEIR ACCESSORIES FOR RATED VOLTAGES
FROM 1 kV ($U_m = 1,2$ kV) UP TO 30 kV ($U_m = 36$ kV) –**

**Part 1: Cables for rated voltages of 1 kV
($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV)**

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International Standard IEC 60502-1 has been prepared by IEC technical committee 20: Electric cables.

This consolidated version of IEC 60502-1 consists of the second edition (2004) [documents 20/683/FDIS and 20/691/RVD] and its amendment 1 (2009) [documents 20/1063/FDIS and 20/1069/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 2.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

The main changes with respect to the first edition relate to insulation and oversheath thickness requirements, and inclusion of constructions and requirements for halogen free cables with reduced flame propagation and low levels of smoke emission.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 60502 consists of the following parts, under the general title *Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV)*:

- Part 1: Cables for rated voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV);
- Part 2: Cables for rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV);
- Part 3: Reserved;
- Part 4: Test requirements on accessories for cables with rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV).

The committee has decided that the contents of the base publication and its amendments 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

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POWER CABLES WITH EXTRUDED INSULATION AND THEIR ACCESSORIES FOR RATED VOLTAGES FROM 1 kV ($U_m = 1,2$ kV) UP TO 30 kV ($U_m = 36$ kV) –

Part 1: Cables for rated voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV)

1 Scope

This part of IEC 60502 specifies the construction, dimensions and test requirements of power cables with extruded solid insulation for rated voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV) for fixed installations such as distribution networks or industrial installations.

This standard includes cables which exhibit properties of reduced flame spread, low levels of smoke emission and halogen-free gas emission when exposed to fire.

Cables for special installation and service conditions are not included, for example cables for overhead networks, the mining industry, nuclear power plants (in and around the containment area), submarine use or shipboard application.

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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 60038:1983, *IEC standard voltages*

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

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

IEC 60228:1978, *Conductors of insulated cables*

IEC 60230:1966, *Impulse tests on cables and their accessories*

IEC 60332-1:1993, *Tests on electric cables under fire conditions – Part 1: Test on a single vertical insulated wire or cable*

IEC 60332-3-24:2000, *Tests on electric cables under fire conditions – Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category C*

IEC 60502-2:1997, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV) – Part 2: Cables for rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV)*

IEC 60684-2:1987, *Flexible insulating sleeving – Part 2: Methods of test*

IEC 60724:2000, *Short-circuit temperature limits of electric cables with rated voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV)*

IEC 60754-1:1994, *Test on gases evolved during combustion of materials from cables – Part 1: Determination of the amount of halogen gas*

IEC 60754-2:1991, *Test on gases evolved during combustion of electric cables – Part 2: Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity*

IEC 60811-1-1:1993, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 1: Measurement of thickness and overall dimensions – Tests for determining the mechanical properties*

IEC 60811-1-2:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 2: Thermal ageing methods*

IEC 60811-1-3:1993, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 3: Methods for determining the density – Water absorption tests – Shrinkage test*

IEC 60811-1-4:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section 4: Tests at low temperature*

IEC 60811-2-1:1998, *Insulating and sheathing materials of electric and optical cables – Common test methods – Part 2-1: Methods specific to elastomeric compounds – Ozone resistance, hot set and mineral oil immersion tests*

IEC 60811-3-1:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 3: Methods specific to PVC compounds – Section 1: Pressure test at high temperature – Tests for resistance to cracking*

IEC 60811-3-2:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 3: Methods specific to PVC compounds – Section 2: Loss of mass test – Thermal stability test*

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IEC 60811-4-1:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 4: Methods specific to polyethylene and polypropylene compounds – Section 1: Resistance to environmental stress cracking – Wrapping test after thermal ageing in air – Measurement of the melt flow index – Carbon black and/or mineral content measurement in PE*

IEC 61034-2: 1997, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

ISO 48:1994, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

3 Terms and definitions

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

3.1 Definitions of dimensional values (thicknesses, cross-sections, etc.)

3.1.1

nominal value

value by which a quantity is designated and which is often used in tables

NOTE Usually, in this standard, nominal values give rise to values to be checked by measurements taking into account specified tolerances.

3.1.2

approximate value

value which is neither guaranteed nor checked; it is used, for example, for the calculation of other dimensional values

3.1.3**median value**

when several test results have been obtained and ordered in an increasing (or decreasing) succession, the median value is the middle value if the number of available values is odd, and the mean of the two middle values if the number is even

3.1.4**fictitious value**

value calculated according to the "fictitious method" described in Annex A

3.2 Definitions concerning the tests**3.2.1****routine tests**

tests made by the manufacturer on each manufactured length of cable to check that each length meets the specified requirements

3.2.2**sample tests**

tests made by the manufacturer on samples of completed cable or components taken from a completed cable, at a specified frequency, so as to verify that the finished product meets the specified requirements

3.2.3**type tests**

tests made before supplying, on a general commercial basis, a type of cable covered by this standard, in order to demonstrate satisfactory performance characteristics to meet the intended application

NOTE These tests are of such a nature that, after they have been made, they need not be repeated, unless changes are made in the cable materials or design or manufacturing process which might change the performance characteristics.

3.2.4**electrical tests after installation**

tests made to demonstrate the integrity of the cable and its accessories as installed

4 Voltage designations and materials**4.1 Rated voltages**

The rated voltages U_0/U (U_m) of the cables considered in this standard are 0,6/1 (1,2) kV and 1,8/3 (3,6) kV.

NOTE 1 The voltages given above are the correct designations although in some countries other designations are used, e.g. 1,7/3 kV or 1,9/3,3 kV instead of 1,8/3 kV.

In the voltage designation of cables U_0/U (U_m):

U_0 is the rated power frequency voltage between conductor and earth or metallic screen for which the cable is designed;

U is the rated power frequency voltage between conductors for which the cable is designed;

U_m is the maximum value of the "highest system voltage" for which the equipment may be used (see IEC 60038).

The rated voltage of the cable for a given application shall be suitable for the operating conditions in the system in which the cable is used. To facilitate the selection of the cable, systems are divided into three categories:

- Category A: this category comprises those systems in which any phase conductor that comes in contact with earth or an earth conductor is disconnected from the system within 1 min;
- Category B: this category comprises those systems which, under fault conditions, are operated for a short time with one phase earthed. This period, according to IEC 60183, should not exceed 1 h. For cables covered by this standard, a longer period, not exceeding 8 h on any occasion, can be tolerated. The total duration of earth faults in any year should not exceed 125 h;
- Category C: this category comprises all systems which do not fall into category A or B.

NOTE 2 It should be realized that in a system where an earth fault is not automatically and promptly isolated, the extra stresses on the insulation of cables during the earth fault reduce the life of the cables to a certain degree. If the system is expected to be operated fairly often with a permanent earth fault, it may be advisable to classify the system in Category C.

The values of U_0 recommended for cables to be used in three-phase systems are listed in Table 1.

Table 1 – Recommended rated voltages U_0

Highest system voltage (U_m) kV	Rated voltage (U_0) kV	
	Categories A and B	Category C
1,2	0,6	0,6
3,6	1,8	3,6*

* This category is covered by 3,6/6 (7,2) kV cables according to IEC 60502-2.

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4.2 Insulating compounds

The types of insulating compound covered by this standard are listed in Table 2, together with their abbreviated designations.

Table 2 – Insulating compounds

Insulating compound	Abbreviated designation
a) <i>Thermoplastic</i> Polyvinyl chloride intended for cables with rated voltages $U_0/U \leq 1,8/3$ kV	PVC/A*
b) <i>Cross-linked</i> : Ethylene propylene rubber or similar (EPM or EPDM)	EPR
High modulus or hard grade ethylene propylene rubber	HEPR
Cross-linked polyethylene	XLPE

* Insulating compound based on polyvinyl chloride intended for cables with rated voltages $U_0/U = 3,6/6$ kV is designated PVC/B in IEC 60502-2.

The maximum conductor temperatures for different types of insulating compound covered by this standard are given in Table 3.

Table 3 – Maximum conductor temperatures for different types of insulating compound

Insulating compound		Maximum conductor temperature °C	
		Normal operation	Short-circuit (5 s maximum duration)
Polyvinyl chloride	(PVC/A)		
	Conductor cross-section ≤300 mm ²	70	160
	Conductor cross-section >300 mm ²	70	140
Cross-linked polyethylene	(XLPE)	90	250
Ethylene propylene rubber	(EPR and HEPR)	90	250

The temperatures in Table 3 are based on the intrinsic properties of the insulating materials. It is important to take into account other factors when using these values for the calculation of current ratings.

For example, in normal operation, if a cable directly buried in the ground is operated under continuous load (100 % load factor) at the maximum conductor temperature shown in the table, the thermal resistivity of the soil surrounding the cable may, in the course of time, increase from its original value as a result of drying-out processes. As a consequence, the conductor temperature may greatly exceed the maximum value. If such operating conditions are foreseen, adequate provisions shall be made.

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For guidance on the short-circuit temperatures, reference should be made to IEC 60724.

4.3 Sheathing compounds

[IEC 60502-1:2004+AMD1:2009 CSV](https://standards.iteh.ai/catalog/standards/sist/2ebd7a44-7ee2-44bf-bf77-8853afb641d6/iec-60502-1-2004amd1-2009-csv)

[https://standards.iteh.ai/catalog/standards/sist/2ebd7a44-7ee2-44bf-bf77-](https://standards.iteh.ai/catalog/standards/sist/2ebd7a44-7ee2-44bf-bf77-8853afb641d6/iec-60502-1-2004amd1-2009-csv)

[8853afb641d6/iec-60502-1-2004amd1-2009-csv](https://standards.iteh.ai/catalog/standards/sist/2ebd7a44-7ee2-44bf-bf77-8853afb641d6/iec-60502-1-2004amd1-2009-csv)

The maximum conductor temperatures for the different types of sheathing compound covered by this standard are given in Table 4.

Table 4 – Maximum conductor temperatures for different types of sheathing compound

Sheathing compound	Abbreviated designation	Maximum conductor temperature in normal operation °C
a) <i>Thermoplastic:</i>		
Polyvinyl chloride (PVC)	ST ₁	80
	ST ₂	90
Polyethylene	ST ₃	80
	ST ₇	90
Halogen free	ST ₈	90
b) <i>Elastomeric:</i>		
Polychloroprene, chlorosulfonated polyethylene or similar polymers	SE ₁	85

5 Conductors

The conductors shall be either of Class 1 or Class 2 of plain or metal-coated annealed copper or of plain aluminium or aluminium alloy, or of Class 5 of plain or metal-coated copper in accordance with IEC 60228.

6 Insulation

6.1 Material

The insulation shall be extruded dielectric of one of the types listed in Table 2.

For halogen free cables, the insulation shall meet the requirements given in Table 23.

6.2 Insulation thickness

The nominal insulation thicknesses are specified in Tables 5 to 7.

The thickness of any separator shall not be included in the thickness of the insulation.

Table 5 – Nominal thickness of PVC/A insulation

Nominal cross-sectional area of conductor mm ²	Nominal thickness of insulation at rated voltage $U_0/U (U_m)$	
	0,6/1 (1,2) kV mm	1,8/3 (3,6) kV mm
1,5 and 2,5	0,8	–
4 and 6	1,0	–
10 and 16	1,0	2,2
25 and 35	1,2	2,2
50 and 70	1,4	2,2
95 and 120	1,6	2,2
150	1,8	2,2
185	2,0	2,2
240	2,2	2,2
300	2,4	2,4
400	2,6	2,6
500 to 800	2,8	2,8
1 000	3,0	3,0

NOTE Any conductor cross-section smaller than those given in this table is not recommended.