

INTERNATIONAL STANDARD



Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V –

Part 7: Flexible cables screened and unscreened with two or more conductors and of rated voltages up to and including 300/500 V





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450/750 V –**

**Part 7: Flexible cables screened and unscreened with two or more conductors
and of rated voltages up to and including 300/500 V**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**POLYVINYL CHLORIDE INSULATED CABLES
OF RATED VOLTAGES UP TO AND INCLUDING 450/750 V –****Part 7: Flexible cables screened and unscreened with two or more
conductors and of rated voltages up to and including 300/500 V****FOREWORD**

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IEC 60227-7 has been prepared by IEC technical committee 20: Electric cables. It is an International Standard.

This second edition cancels and replaces the first edition published in 1995, Amendment 1:2003 and Amendment 2:2011. This edition constitutes a technical revision.

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

- a) the reference to tests according to IEC 60227-2 has been withdrawn and replaced with a reference to IEC 63294;
- b) normative references have been updated.

The text of this International Standard is based on the following documents:

Draft	Report on voting
20/2144/FDIS	20/2157/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60227 series, published under the general title *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V* can be found on the IEC website.

This document is to be used in conjunction with IEC 60227-1.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

The IEC 60227 series, published under the general title *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*, consists of the following parts:

- IEC 60227-1: General requirements;
- IEC 60227-2: Test methods (withdrawn and replaced by IEC 63294);
- IEC 60227-3: Non-sheathed cables for fixed wiring;
- IEC 60227-4: Sheathed cables for fixed wiring;
- IEC 60227-5: Flexible cables (cords);
- IEC 60227-6: Lift cables and cables for flexible connections;
- IEC 60227-7: Flexible cables screened and unscreened with two or more conductors and of rated voltages up to and including 300/500 V.

This part of IEC 60227, when used in conjunction with IEC 60227-1, forms the complete standard for flexible cables screened and unscreened with two or more conductors and of rated voltages up to and including 300/500 V only.

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POLYVINYL CHLORIDE INSULATED CABLES OF RATED VOLTAGES UP TO AND INCLUDING 450/750 V –

Part 7: Flexible cables screened and unscreened with two or more conductors and of rated voltages up to and including 300/500 V

1 General

1 Scope

This part of IEC 60227 details the particular specifications for polyvinyl chloride insulated, screened and unscreened control cables of rated voltages up to and including 300/500 V.

~~All cables comply with the appropriate requirements given in IEC 60227-1 and each individual type of cable complies with the particular requirements of this part.~~

This document provides the particular requirements for screened and unscreened control cables of rated voltages up to and including 300/500 V, which apply in addition to the appropriate requirements specified in IEC 60227-1, which apply to all cables. The tests for cables specified in the IEC 60227 series are described in IEC 63294.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

~~NOTE The IEC 60811 series is currently undergoing a revision, which will lead to a restructuring of its parts. A description of this, as well as a cross-reference table between the current and planned parts is given in IEC 60811-100.~~

IEC 60227-1:2007, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 1: General requirements*

~~IEC 60227-2:1997, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 2: Test methods*
Amendment 1 (2003)~~

IEC 60228, *Conductors of insulated cables*

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60811-401, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*

IEC 60811-404, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths*

IEC 60811-409, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 409: Miscellaneous tests – Loss of mass test for thermoplastic insulations and sheaths*

IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC 60811-504, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 504: Mechanical tests – Bending tests at low temperature for insulation and sheaths*

IEC 60811-505, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: Mechanical tests – Elongation at low temperature for insulations and sheaths*

IEC 60811-506, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 506: Mechanical tests – Impact test at low temperature for insulations and sheaths*

IEC 60811-508, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths*

IEC 60811-509, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)*

IEC 60502-1:~~2004~~2021, *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)*

Amendment 1 (2009)

IEC 60719:~~1992~~, *Calculation of the lower and upper limits for the average outer dimensions of cables with circular copper conductors and of rated voltages up to and including 450/750 V*

~~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~~

Amendment 1 (2001)

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

Amendment 1 (1989)

Amendment 2 (2000)

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

Amendment 1 (1993)

Amendment 2 (2001)

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

Amendment 1 (2001)

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

Amendment 1 (1994)

Amendment 2 (2001)

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

~~Amendment 1 (1993)~~

~~Amendment 2 (2003)~~

IEC 62153-4-3:2006/2013, *Metallic communication cable test methods – Part 4-3: Electromagnetic compatibility (EMC) – Surface transfer impedance – Triaxial method*

IEC 63294:2021, *Test methods for electric cables with rated voltages up to and including 450/750 V*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60227-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

type test

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

Note 1 to entry: Type tests are of such a nature that, after they have been made, it is not necessary for them to be repeated, unless changes are made in the cable materials or design which can change the performance characteristics.

Note 2 to entry: The symbol T is used to refer to type tests.

3.2

sample test

test made on samples of completed cable or components taken from a completed cable to verify that the finished product meets the design standards

Note 1 to entry: The symbol S is used to refer to sample tests.

4 Oil resistant, polyvinyl chloride sheathed, screened and unscreened flexible cable

4.1 Code designation

60227 IEC 74 for screened cables;

60227 IEC 75 for unscreened cables.

4.2 Rated voltage

300/500 V.

4.3 Construction

4.3.1 Conductors

Number of conductors: 2 to 60.

Preferred number of conductors: 2, 3, 4, 5, 6, 7, 12, 18, 27, 36, 48 and 60.

The conductors shall comply with the requirements given in IEC 60228 for class 5 conductors.

4.3.2 Insulation

The insulation shall be polyvinyl chloride compound of type PVC/D (see IEC 60227-1) applied around each conductor.

The specified value of the insulation thickness ~~shall comply with the specified value~~ is given in Table 2, column 2 and Table 3, column 2. The insulation resistance shall be not less than the value given in Table 2, column 8 or Table 3, column 6.

4.3.3 Assembly of cores and fillers, if any

The cores shall be twisted together, where appropriate in several concentric layers.

A centre core is not permitted but a centre filler of suitable material shall be applied for cables with five or more cores in the first layer. Assemblies with three or more cores shall have one core which is coloured green-and-yellow.

Around each layer a tape may be applied which ~~may~~ can cover the cores fully or partially. The tape shall not adhere to the cores.

For two-core cables, the space between the cores shall be filled either by separate fillers or by the sheath filling the interstices.

4.3.4 Inner sheath for screened cables

The inner sheath shall be a polyvinyl chloride compound of type PVC/ST5 (see IEC 60227-1) applied around the core assembly. For all cables, the thickness of the inner sheath shall be determined by the formula:

$$t_{is} = 0,02 D_f + 0,6 \text{ mm},$$

where D_f is the fictitious diameter over the laid-up core, calculated in accordance with ~~A.2.1, A.2.2 and A.2.3 of IEC 60502, annex A~~ IEC 60502-1:2021, A.3.1, A.3.2 and A.3.3, and where the fictitious diameter (d_f) of 0,5 mm², 0,75 mm² and 1,0 mm² conductors (not given in ~~A.2.1~~ IEC 60502-1:2021, A.3.1) shall be taken to be 0,8 mm, 1,0 mm and 1,1 mm, respectively.

For cables with the preferred number of cores, the calculated values of the inner sheath thickness are given in Table 2, column 3.

NOTE In the case of cables comprising 10 or more cores, the values specified apply to a core assembly in two or more layers.

The mean value of the thickness of the sheath shall be not less than the calculated value. However, the thickness at any ~~place~~ point may be less than the calculated value provided that the difference does not exceed 0,1 mm + 15 % of the calculated value.

The inner sheath may fill the interstices of the laid-up core assembly, but it shall not adhere to the cores.

4.3.5 Screen

For screened cables, the screen shall be applied over the inner sheath, in the form of a braid of plain or tinned copper wires.

For cables with the preferred number of cores, the diameter of the copper wires shall comply with the values given in Table 2, column 4.

For the other cables, the following maximum values apply:

- 0,16 mm for $d \leq 10,0$ mm
- 0,21 mm for $10,0 \text{ mm} < d \leq 20,0$ mm
- 0,26 mm for $20,0 \text{ mm} < d \leq 30,0$ mm
- 0,31 mm for $d > 30,0$ mm

where d is the fictitious diameter under the braid which is calculated by adding to the fictitious diameter over laid-up cores, twice the specified thickness of inner sheath.

The screening efficiency shall be determined by measuring the transfer impedance. The value obtained shall not exceed $250 \Omega/\text{km}$ at 30 MHz.

4.3.6 Sheath or oversheath

The sheath or oversheath shall be polyvinyl chloride compound of type PVC/ST9 (see IEC 60227-1) applied either:

- as an oversheath around the screen of screened cables, or
- as a sheath around the laid-up cores of unscreened cables.

An optional tape may be applied between the screen and oversheath.

For all cables the thickness of the sheath or oversheath shall be determined by the formula:

$$t_s = 0,08 d_L + 0,4 \text{ mm}$$

with a maximum value of 2,4 mm, where d_L is the fictitious diameter over the screen of the screened cables or over the laid-up core assembly of unscreened cables.

The fictitious diameter shall be calculated in accordance with IEC 60502-1:2021, Annex A and 4.3.4 of this document. The increase in diameter due to the braided screen is four times the diameter of the braiding wire specified in Table 2, column 4.

For cables with the preferred number of cores, the ~~calculated~~ specified values of the sheath and over-sheath thickness are given in Table 2, column 5 and in Table 3, column 3 (see note in 4.3.4). Both for sheath and oversheath, the thickness requirements apply as specified in IEC 60227-1.

In unscreened cables, the sheath may fill the interstices of the laid-up core assembly, but it shall not adhere to the cores. In screened cables, the oversheath shall fit closely but not adhere to the screen.

All cables shall have practically a circular cross-section.

4.3.7 Core identification

Except for the green-and-yellow core, if any, all cores shall be identified by numbers in accordance with IEC 60227-1.

4.3.8 Overall diameter

The mean overall diameter of the cables shall be within the limits to be determined in accordance with IEC 60719. For cables with the preferred number of cores, the limits, according to IEC 60719 are given in Table 2, columns 6 and 7 or in Table 3, columns 4 and 5, (see note in 4.3.4).

4.4 Tests

4.4.1 General

Compliance with the requirements of 4.3 shall be checked by inspection and by the sample tests and type tests given in Table 4.

4.4.2 Flexing test

4.4.2.1 General

The requirements are given in IEC 60227-1.

4.4.2.2 Sample preparation

The mass of the weight and the diameter of pulleys A and B are given in Table 1.

Table 1 – Mass of weight and diameter of pulleys

Number of cores ^b	Nominal cross-sectional area mm ²	Mass of weight kg	Diameter of pulleys ^a mm
2	0,5	0,5	60
	0,75	1,0	80
	1	1,0	80
	1,5	1,0	80
	2,5	1,5	120
3	0,5	0,5	80
	0,75	1,0	80
	1	1,0	80
	1,5	1,0	80
	2,5	1,5	120
4	0,5	0,5	80
	0,75	1,0	80
	1	1,0	80
	1,5	1,5	120
	2,5	1,5	120
5	0,5	1,0	80
	0,75	1,0	80
	1	1,0	120
	1,5	1,5	120
	2,5	2,0	120
6	0,5	1,0	120
	0,75	1,5	120
	1	1,5	120
	1,5	2,0	120
	2,5	3,5	160
7	0,5	1,0	120
	0,75	1,5	120
	1	1,5	120
	1,5	2,0	160
	2,5	3,5	160
12	0,5	1,5	120
	0,75	2,0	160
	1	3,0	160
	1,5	4,0	160
	2,5	7,0	200
18	0,5	2,0	160
	0,75	3,0	160
	1	4,0	160
	1,5	6,0	200
	2,5	7,5	200

Number of cores ^b	Nominal cross-sectional area mm ²	Mass of weight kg	Diameter of pulleys ^a mm
^a Diameter measured at the lowest point of the groove.			
^b Cables with a number of cores between 7 and 18, but not specified in this table, are non-preferred cable types. They may be tested using the mass of weight and the pulley diameter for the same conductor size at the next higher specified number of cores.			

4.4.2.3 Current loading of cores

During the flexing test, the cable sample shall be loaded as follows:

- Two- and three-core cables: all cores to be loaded with 1 A/mm^2 $^{+10\%}_0$
- Four- and five-core cables: three cores to be loaded with 1 A/mm^2 $^{+10\%}_0$ or all cores to be loaded with $\sqrt{3/n} \text{ A/mm}^2$ $^{+10\%}_0$, where n is the number of cores.

Cables having more than five cores shall not be loaded. On all cores, a signal current shall be applied.

4.5 Guidance on use

The main purpose of these cables is for the interconnection of parts of machines used for manufacturing purposes, including machine tools and mechanical handling equipment. The cables are permitted for the direct connection to the mains. Continual flexing is not recommended for the screened cables. If any of these cables is not required to move during use, installation in conduits, trunking, etc. is advised.

Screened cables are recommended in environments where a moderate level of electro-magnetic interference is encountered.

These cables are designed for use only inside buildings and where the ambient temperatures remain within the range of $+5 \text{ }^{\circ}\text{C}$ to $+40 \text{ }^{\circ}\text{C}$.

The maximum rated conductor temperature in normal use is: $70 \text{ }^{\circ}\text{C}$.

The maximum sheath temperature is: $60 \text{ }^{\circ}\text{C}$.

Table 2 – General data for type 60227 IEC 74

1 Number and nominal cross- sectional area of conductors mm ²	2 Insulation thickness specified value mm	3 Inner sheath thickness specified value mm	4 Maximum diameter of the wires of the screen mm	5 Oversheath thickness specified value mm	Mean overall diameter		8 Minimum insulation resistance at 70 °C MΩ · km
					6 Lower limit mm	7 Upper limit mm	
2 × 0,5	0,6	0,7	0,16	0,9	7,7	9,6	0,013
2 × 0,75	0,6	0,7	0,16	0,9	8,0	10,0	0,011
2 × 1	0,6	0,7	0,16	0,9	8,2	10,3	0,010
2 × 1,5	0,7	0,7	0,16	1,0	9,3	11,6	0,010
2 × 2,5	0,8	0,7	0,16	1,1	10,7	13,3	0,009
3 × 0,5	0,6	0,7	0,16	0,9	8,0	10,0	0,013
3 × 0,75	0,6	0,7	0,16	0,9	8,3	10,4	0,011
3 × 1	0,6	0,7	0,16	1,0	8,8	11,0	0,010
3 × 1,5	0,7	0,7	0,16	1,0	9,7	12,1	0,010
3 × 2,5	0,8	0,7	0,16	1,1	11,3	14,0	0,009
4 × 0,5	0,6	0,7	0,16	0,9	8,5	10,7	0,013
4 × 0,75	0,6	0,7	0,16	1,0	9,1	11,3	0,011
4 × 1	0,6	0,7	0,16	1,0	9,4	11,7	0,010
4 × 1,5	0,7	0,7	0,16	1,1	10,7	13,2	0,010
4 × 2,5	0,8	0,8	0,16	1,2	12,6	15,5	0,009
5 × 0,5	0,6	0,7	0,16	1,0	9,3	11,6	0,013
5 × 0,75	0,6	0,7	0,16	1,0	9,7	12,1	0,011
5 × 1	0,6	0,7	0,16	1,1	10,3	12,8	0,010
5 × 1,5	0,7	0,8	0,16	1,2	11,8	14,7	0,010
5 × 2,5	0,8	0,8	0,21	1,3	13,9	17,2	0,009
6 × 0,5	0,6	0,7	0,16	1,0	9,9	12,4	0,013
6 × 0,75	0,6	0,7	0,16	1,1	10,5	13,1	0,011
6 × 1	0,6	0,7	0,16	1,1	11,0	13,6	0,010
6 × 1,5	0,7	0,8	0,16	1,2	12,7	15,7	0,010
6 × 2,5	0,8	0,8	0,21	1,4	15,2	18,7	0,009
7 × 0,5	0,6	0,7	0,16	1,1	10,8	13,5	0,013
7 × 0,75	0,6	0,7	0,16	1,2	11,5	14,3	0,011
7 × 1	0,6	0,8	0,16	1,2	12,2	15,1	0,010
7 × 1,5	0,7	0,8	0,21	1,3	14,1	17,4	0,010
7 × 2,5	0,8	0,8	0,21	1,5	16,5	20,3	0,009
12 × 0,5	0,6	0,8	0,21	1,3	13,3	16,5	0,013
12 × 0,75	0,6	0,8	0,21	1,3	13,9	17,2	0,011
12 × 1	0,6	0,8	0,21	1,4	14,7	18,1	0,010
12 × 1,5	0,7	0,8	0,21	1,5	16,7	20,5	0,010
12 × 2,5	0,8	0,9	0,21	1,7	19,9	24,4	0,009
18 × 0,5	0,6	0,8	0,21	1,3	15,1	18,6	0,013
18 × 0,75	0,6	0,8	0,21	1,5	16,2	19,9	0,011
18 × 1	0,6	0,8	0,21	1,5	16,9	20,8	0,010
18 × 1,5	0,7	0,9	0,21	1,7	19,6	24,1	0,010
18 × 2,5	0,8	0,9	0,21	2,0	23,3	28,5	0,009
27 × 0,5	0,6	0,8	0,21	1,6	18,0	22,1	0,013
27 × 0,75	0,6	0,9	0,21	1,7	19,3	23,7	0,011
27 × 1	0,6	0,9	0,21	1,7	20,2	24,7	0,010
27 × 1,5	0,7	0,9	0,21	2,0	23,4	28,6	0,010
27 × 2,5	0,8	1,0	0,26	2,3	28,2	34,5	0,009
36 × 0,5	0,6	0,9	0,21	1,7	20,1	24,7	0,013
36 × 0,75	0,6	0,9	0,21	1,8	21,3	26,2	0,011
36 × 1	0,6	0,9	0,21	1,9	22,5	27,6	0,010
36 × 1,5	0,7	1,0	0,26	2,2	26,6	32,5	0,010
36 × 2,5	0,8	1,1	0,26	2,4	31,5	38,5	0,009
48 × 0,5	0,6	0,9	0,26	1,9	23,1	28,3	0,013
48 × 0,75	0,6	1,0	0,26	2,1	24,9	30,4	0,011
48 × 1	0,6	1,0	0,26	2,1	26,1	31,9	0,010
48 × 1,5	0,7	1,1	0,26	2,4	30,4	37,0	0,010
48 × 2,5	0,8	1,2	0,31	2,4	35,9	43,7	0,009
60 × 0,5	0,6	1,0	0,26	2,1	25,5	31,1	0,013
60 × 0,75	0,6	1,0	0,26	2,2	27,0	32,9	0,011
60 × 1	0,6	1,0	0,26	2,3	28,5	34,7	0,010
60 × 1,5	0,7	1,1	0,26	2,4	32,7	39,9	0,010
60 × 2,5	0,8	1,2	0,31	2,4	38,8	47,2	0,009

Table 3 – General data for type 60227 IEC 75

1	2	3	4	5	6
Number and nominal cross-sectional area of conductors mm ²	Insulation thickness specified value mm	Sheath thickness specified value mm	Mean overall diameter		Minimum insulation resistance at 70 °C MΩ · km
			Lower limit mm	Upper limit mm	
2 × 0,5	0,6	0,7	5,2	6,6	0,013
2 × 0,75	0,6	0,8	5,7	7,2	0,011
2 × 1	0,6	0,8	5,9	7,5	0,010
2 × 1,5	0,7	0,8	6,8	8,6	0,010
2 × 2,5	0,8	0,9	8,2	10,3	0,009
3 × 0,5	0,6	0,7	5,5	7,0	0,013
3 × 0,75	0,6	0,8	6,0	7,6	0,011
3 × 1	0,6	0,8	6,3	8,0	0,010
3 × 1,5	0,7	0,9	7,4	9,4	0,010
3 × 2,5	0,8	1,0	9,0	11,2	0,009
4 × 0,5	0,6	0,8	6,2	7,9	0,013
4 × 0,75	0,6	0,8	6,6	8,3	0,011
4 × 1	0,6	0,8	6,9	8,7	0,010
4 × 1,5	0,7	0,9	8,2	10,2	0,010
4 × 2,5	0,8	1,1	10,1	12,5	0,009
5 × 0,5	0,6	0,8	6,8	8,6	0,013
5 × 0,75	0,6	0,9	7,4	9,3	0,011
5 × 1	0,6	0,9	7,8	9,8	0,010
5 × 1,5	0,7	1,0	9,1	11,4	0,010
5 × 2,5	0,8	1,1	11,0	13,7	0,009
6 × 0,5	0,6	0,9	7,6	9,6	0,013
6 × 0,75	0,6	0,9	8,1	10,1	0,011
6 × 1	0,6	1,0	8,7	10,8	0,010
6 × 1,5	0,7	1,1	10,2	12,6	0,010
6 × 2,5	0,8	1,2	12,2	15,1	0,009
7 × 0,5	0,6	0,9	8,3	10,4	0,013
7 × 0,75	0,6	1,0	9,0	11,3	0,011
7 × 1	0,6	1,0	9,5	11,8	0,010
7 × 1,5	0,7	1,2	11,3	14,1	0,010
7 × 2,5	0,8	1,3	13,6	16,8	0,009
12 × 0,5	0,6	1,1	10,4	12,9	0,013
12 × 0,75	0,6	1,1	11,0	13,7	0,011
12 × 1	0,6	1,2	11,8	14,6	0,010
12 × 1,5	0,7	1,3	13,8	17,0	0,010
12 × 2,5	0,8	1,5	16,8	20,6	0,009
18 × 0,5	0,6	1,2	12,3	15,3	0,013
18 × 0,75	0,6	1,3	13,2	16,4	0,011
18 × 1	0,6	1,3	14,0	17,2	0,010
18 × 1,5	0,7	1,5	16,5	20,3	0,010
18 × 2,5	0,8	1,8	20,2	24,8	0,009
27 × 0,5	0,6	1,4	15,1	18,6	0,013
27 × 0,75	0,6	1,5	16,2	19,9	0,011
27 × 1	0,6	1,5	17,0	21,0	0,010
27 × 1,5	0,7	1,8	20,3	24,9	0,010
27 × 2,5	0,8	2,1	24,7	30,2	0,009
36 × 0,5	0,6	1,5	17,0	20,9	0,013
36 × 0,75	0,6	1,6	18,2	22,4	0,011
36 × 1	0,6	1,7	19,4	23,8	0,010
36 × 1,5	0,7	2,0	23,0	28,2	0,010
36 × 2,5	0,8	2,3	28,0	34,2	0,009
48 × 0,5	0,6	1,7	19,8	24,3	0,013
48 × 0,75	0,6	1,8	21,2	25,9	0,011
48 × 1	0,6	1,9	22,5	27,6	0,010
48 × 1,5	0,7	2,2	26,2	32,5	0,010
48 × 2,5	0,8	2,4	32,1	39,1	0,009
60 × 0,5	0,6	1,8	21,7	26,6	0,013
60 × 0,75	0,6	2,0	23,4	28,7	0,011
60 × 1	0,6	2,1	24,9	30,5	0,010
60 × 1,5	0,7	2,4	29,5	35,8	0,010
60 × 2,5	0,8	2,4	35,0	42,6	0,009

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Table 4 – Tests for types 60227 IEC 74 and 60227 IEC 75

1	2	3	4
Ref. no.	Tests	Category of test	Test method described in
1	Electrical test		
1.1	Resistance of conductors	T, S	60227-2 IEC 63294:2021, 5.1
1.2	Voltage test on cores according to specified insulation thickness		
1.2.1	At $1\ 500\ V \leq 0,6\ mm$	T	60227-2 IEC 63294:2021, 5.3
1.2.2	At $2\ 000\ V > 0,6\ mm$	T	60227-2 IEC 63294:2021, 5.3
1.3	Voltage test on completed cable at 2 000 V	T, S	60227-2 IEC 63294:2021, 5.2
1.4	Insulation resistance at $70\ ^\circ C$	T	60227-2 IEC 63294:2021, 5.4 IEC 60227-1
1.5	Transfer impedance for screened cables	T	IEC 62153-4-3:2013, 5.2 and Clause 6
2	Provisions covering constructional and dimensional characteristics		60227-1 and 60227-2
2.1	Checking of compliance with constructional provisions	T, S	IEC 60227-1 Inspection and manual test
2.2	Measurements of insulation thickness	T, S	60227-2 IEC 63294:2021, 6.2
2.3	Measurements of thickness of sheath or inner sheath or oversheath	T, S	60227-2 IEC 63294:2021, 6.3
2.4	Measurement of overall diameter		
2.4.1	– mean value	T, S	60227-2 IEC 63294:2021, 6.4
2.4.2	– ovality	T, S	60227-2 IEC 63294:2021, 6.4
3	Mechanical properties of insulation		
3.1	Tensile test before ageing	T	60811-1-1 IEC 60811-501
3.2	Tensile test after ageing	T	60811-1-2 IEC 60811-401
3.3	Loss of mass test	T	60811-3-2 IEC 60811-409
4	Mechanical properties of inner sheath		
4.1	Tensile test before ageing	T	60811-1-1 IEC 60811-501
4.2	Tensile test after ageing	T	60811-1-2 IEC 60811-401
5	Mechanical properties of sheath or oversheath		
5.1	Tensile test before ageing	T	60811-1-1 IEC 60811-501
5.2	Tensile test after ageing	T	60811-1-2 IEC 60811-401
5.3	Loss of mass test	T	60811-3-2 IEC 60811-409
6	Compatibility test ^a	T	60811-1-2 IEC 60811-401
7	Pressure test at high temperature		
7.1	Insulation	T	60811-3-1 IEC 60811-508
7.2	Sheath or oversheath	T	60811-3-1 IEC 60811-508
8	Test at low temperature		
8.1	Bending test for insulation	T	60811-1-4 IEC 60811-504
8.2	Bending test for sheath or oversheath ^b	T	60811-1-4 IEC 60811-504
8.3	Elongation test for sheath or oversheath ^c	T	60811-1-4 IEC 60811-505
8.4	Impact test ^d	T	60811-1-4 IEC 60811-506
9	Heat shock test		
9.1	Insulation	T	60811-3-1 IEC 60811-509
9.2	Sheath or oversheath	T	60811-3-1 IEC 60811-509
10	Mechanical strength of completed cable		
10.1	Flexing test for unscreened cable ^e	T	60227-2 IEC 63294:2021, 6.6 see also 4.4.2 of this document
11	Test of flame retardance	T	IEC 60332-1-2
12	Mineral oil resistance of sheath or oversheath	T	60811-2-1 IEC 60811-404

^a If applicable, see IEC 60227-1.^b Only applicable to cables having mean overall diameters up to and including 12,5 mm.^c Only applicable if the mean overall diameter of the cable exceeds 12,5 mm.^d The inner sheath of screened cables shall also be checked.^e Not applicable to cables with more than 18 cores.

Annex A (normative)

Code designation

~~Cables of the types covered by this standard are designated by two numerals, preceded by the reference number of this standard.~~

~~The first numeral indicates the basic class of cable; the second numeral indicates the particular type within the basic class.~~

~~The classes and types are as follows:~~

~~0. Non-sheathed cables for fixed wiring.~~

- ~~01. Single-core non-sheathed cable with rigid conductor for general purposes (60227 IEC 01).~~
- ~~02. Single-core non-sheathed cable with flexible conductor for general purposes (60227 IEC 02).~~
- ~~05. Single-core non-sheathed cable with solid conductor for internal wiring for a conductor temperature of 70 °C (60227 IEC 05).~~
- ~~06. Single-core non-sheathed cable with flexible conductor for internal wiring for a conductor temperature of 70 °C (60227 IEC 06).~~
- ~~07. Single-core non-sheathed cable with solid conductor for internal wiring for a conductor temperature of 90 °C (60227 IEC 07).~~
- ~~08. Single-core non-sheathed cable with flexible conductor for internal wiring for a conductor temperature of 90 °C (60227 IEC 08).~~

~~1. Sheathed cables for fixed wiring.~~

- ~~10. Light polyvinyl chloride sheathed cable (60227 IEC 10).~~

~~4. Non-sheathed flexible cables for light duty.~~

- ~~41. Flat tinsel cord (60227 IEC 41).~~
- ~~42. Flat non-sheathed cord (60227 IEC 42).~~
- ~~43. Cord for decorative chains (60227 IEC 43).~~

~~5. Sheathed flexible cables for normal duty.~~

- ~~52. Light polyvinyl chloride sheathed cord (60227 IEC 52).~~
- ~~53. Ordinary polyvinyl chloride sheathed cord (60227 IEC 53).~~
- ~~56. Heat-resistant light PVC sheathed cord for a maximum conductor temperature of 90 °C (60227 IEC 56).~~
- ~~57. Heat-resistant ordinary PVC sheathed cord for a maximum conductor temperature of 90 °C (60227 IEC 57).~~

~~7. Sheathed flexible cables for special duty.~~

- ~~71f. Flat polyvinyl chloride sheathed lift cables and cables for flexible connections (60227 IEC 71f).~~
- ~~74. Oil-resistant polyvinyl chloride sheathed, screened flexible cable (60227 IEC 74).~~

Bibliography

IEC 60227-2, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 2: Test methods*¹

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¹ Withdrawn.

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INTERNATIONAL STANDARD

**Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V –
Part 7: Flexible cables screened and unscreened with two or more conductors and of rated voltages up to and including 300/500 V**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**POLYVINYL CHLORIDE INSULATED CABLES
OF RATED VOLTAGES UP TO AND INCLUDING 450/750 V –****Part 7: Flexible cables screened and unscreened with two or more
conductors and of rated voltages up to and including 300/500 V****FOREWORD**

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IEC 60227-7 has been prepared by IEC technical committee 20: Electric cables. It is an International Standard.

This second edition cancels and replaces the first edition published in 1995, Amendment 1:2003 and Amendment 2:2011. This edition constitutes a technical revision.

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

- a) the reference to tests according to IEC 60227-2 has been withdrawn and replaced with a reference to IEC 63294;
- b) normative references have been updated.

The text of this International Standard is based on the following documents:

Draft	Report on voting
20/2144/FDIS	20/2157/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60227 series, published under the general title *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V* can be found on the IEC website.

This document is to be used in conjunction with IEC 60227-1.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

The IEC 60227 series, published under the general title *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*, consists of the following parts:

- IEC 60227-1: General requirements;
- IEC 60227-2: Test methods (withdrawn and replaced by IEC 63294);
- IEC 60227-3: Non-sheathed cables for fixed wiring;
- IEC 60227-4: Sheathed cables for fixed wiring;
- IEC 60227-5: Flexible cables (cords);
- IEC 60227-6: Lift cables and cables for flexible connections;
- IEC 60227-7: Flexible cables screened and unscreened with two or more conductors and of rated voltages up to and including 300/500 V.

This part of IEC 60227, when used in conjunction with IEC 60227-1, forms the complete standard for flexible cables screened and unscreened with two or more conductors and of rated voltages up to and including 300/500 V only.

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POLYVINYL CHLORIDE INSULATED CABLES OF RATED VOLTAGES UP TO AND INCLUDING 450/750 V –

Part 7: Flexible cables screened and unscreened with two or more conductors and of rated voltages up to and including 300/500 V

1 Scope

This part of IEC 60227 details the particular specifications for polyvinyl chloride insulated, screened and unscreened control cables of rated voltages up to and including 300/500 V.

This document provides the particular requirements for screened and unscreened control cables of rated voltages up to and including 300/500 V, which apply in addition to the appropriate requirements specified in IEC 60227-1, which apply to all cables. The tests for cables specified in the IEC 60227 series are described in IEC 63294.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60227-1, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 1: General requirements*

IEC 60228, *Conductors of insulated cables*

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60811-401, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*

IEC 60811-404, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths*

IEC 60811-409, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 409: Miscellaneous tests – Loss of mass test for thermoplastic insulations and sheaths*

IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC 60811-504, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 504: Mechanical tests – Bending tests at low temperature for insulation and sheaths*

IEC 60811-505, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: Mechanical tests – Elongation at low temperature for insulations and sheaths*

IEC 60811-506, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 506: Mechanical tests – Impact test at low temperature for insulations and sheaths*

IEC 60811-508, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths*

IEC 60811-509, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)*

IEC 60502-1:2021, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2 \text{ kV}$) up to 30 kV ($U_m = 36 \text{ kV}$) – Part 1: Cables for rated voltages of 1 kV ($U_m = 1,2 \text{ kV}$) and 3 kV ($U_m = 3,6 \text{ kV}$)*

IEC 60719, *Calculation of the lower and upper limits for the average outer dimensions of cables with circular copper conductors and of rated voltages up to and including 450/750 V*

IEC 62153-4-3:2013, *Metallic communication cable test methods – Part 4-3: Electromagnetic compatibility (EMC) – Surface transfer impedance – Triaxial method*

IEC 63294:2021, *Test methods for electric cables with rated voltages up to and including 450/750 V*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60227-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

type test

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

Note 1 to entry: Type tests are of such a nature that, after they have been made, it is not necessary for them to be repeated, unless changes are made in the cable materials or design which can change the performance characteristics.

Note 2 to entry: The symbol T is used to refer to type tests.

3.2

sample test

test made on samples of completed cable or components taken from a completed cable to verify that the finished product meets the design standards

Note 1 to entry: The symbol S is used to refer to sample tests.

4 Oil resistant, polyvinyl chloride sheathed, screened and unscreened flexible cable

4.1 Code designation

60227 IEC 74 for screened cables;

60227 IEC 75 for unscreened cables.

4.2 Rated voltage

300/500 V.

4.3 Construction

4.3.1 Conductors

Number of conductors: 2 to 60.

Preferred number of conductors: 2, 3, 4, 5, 6, 7, 12, 18, 27, 36, 48 and 60.

The conductors shall comply with the requirements given in IEC 60228 for class 5 conductors.

4.3.2 Insulation

The insulation shall be polyvinyl chloride compound of type PVC/D (see IEC 60227-1) applied around each conductor.

The specified value of the insulation thickness is given in Table 2, column 2 and Table 3, column 2. The insulation resistance shall be not less than the value given in Table 2, column 8 or Table 3, column 6.

4.3.3 Assembly of cores and fillers, if any

The cores shall be twisted together, where appropriate in several concentric layers.

A centre core is not permitted but a centre filler of suitable material shall be applied for cables with five or more cores in the first layer. Assemblies with three or more cores shall have one core which is coloured green-and-yellow.

Around each layer a tape may be applied which can cover the cores fully or partially. The tape shall not adhere to the cores.

For two-core cables, the space between the cores shall be filled either by separate fillers or by the sheath filling the interstices.

4.3.4 Inner sheath for screened cables

The inner sheath shall be a polyvinyl chloride compound of type PVC/ST5 (see IEC 60227-1) applied around the core assembly. For all cables, the thickness of the inner sheath shall be determined by the formula:

$$t_{is} = 0,02 D_f + 0,6 \text{ mm},$$

where D_f is the fictitious diameter over the laid-up core, calculated in accordance with IEC 60502-1:2021, A.3.1, A.3.2 and A.3.3, and where the fictitious diameter (d_f) of 0,5 mm², 0,75 mm² and 1,0 mm² conductors (not given in IEC 60502-1:2021, A.3.1) shall be taken to be 0,8 mm, 1,0 mm and 1,1 mm, respectively.

For cables with the preferred number of cores, the calculated values of the inner sheath thickness are given in Table 2, column 3.

NOTE In the case of cables comprising 10 or more cores, the values specified apply to a core assembly in two or more layers.

The mean value of the thickness of the sheath shall be not less than the calculated value. However, the thickness at any point may be less than the calculated value provided that the difference does not exceed 0,1 mm + 15 % of the calculated value.

The inner sheath may fill the interstices of the laid-up core assembly, but it shall not adhere to the cores.

4.3.5 Screen

For screened cables, the screen shall be applied over the inner sheath, in the form of a braid of plain or tinned copper wires.

For cables with the preferred number of cores, the diameter of the copper wires shall comply with the values given in Table 2, column 4.

For the other cables, the following maximum values apply:

- 0,16 mm for $d \leq 10,0$ mm
- 0,21 mm for $10,0 \text{ mm} < d \leq 20,0$ mm
- 0,26 mm for $20,0 \text{ mm} < d \leq 30,0$ mm
- 0,31 mm for $d > 30,0$ mm

where d is the fictitious diameter under the braid which is calculated by adding to the fictitious diameter over laid-up cores, twice the specified thickness of inner sheath.

The screening efficiency shall be determined by measuring the transfer impedance. The value obtained shall not exceed 250 Ω/km at 30 MHz.

4.3.6 Sheath or oversheath

The sheath or oversheath shall be polyvinyl chloride compound of type PVC/ST9 (see IEC 60227-1) applied either:

- as an oversheath around the screen of screened cables, or
- as a sheath around the laid-up cores of unscreened cables.

An optional tape may be applied between the screen and oversheath.

For all cables the thickness of the sheath or oversheath shall be determined by the formula:

$$t_s = 0,08 d_L + 0,4 \text{ mm}$$

with a maximum value of 2,4 mm, where d_L is the fictitious diameter over the screen of the screened cables or over the laid-up core assembly of unscreened cables.

The fictitious diameter shall be calculated in accordance with IEC 60502-1:2021, Annex A and 4.3.4 of this document. The increase in diameter due to the braided screen is four times the diameter of the braiding wire specified in Table 2, column 4.

For cables with the preferred number of cores, the specified values of the sheath and oversheath thickness are given in Table 2, column 5 and in Table 3, column 3 (see note in 4.3.4). Both for sheath and oversheath, the thickness requirements apply as specified in IEC 60227-1.

In unscreened cables, the sheath may fill the interstices of the laid-up core assembly, but it shall not adhere to the cores. In screened cables, the oversheath shall fit closely but not adhere to the screen.

All cables shall have practically a circular cross-section.

4.3.7 Core identification

Except for the green-and-yellow core, if any, all cores shall be identified by numbers in accordance with IEC 60227-1.

4.3.8 Overall diameter

The mean overall diameter of the cables shall be within the limits to be determined in accordance with IEC 60719. For cables with the preferred number of cores, the limits, according to IEC 60719 are given in Table 2, columns 6 and 7 or in Table 3, columns 4 and 5, (see note in 4.3.4).

4.4 Tests

4.4.1 General

Compliance with the requirements of 4.3 shall be checked by inspection and by the sample tests and type tests given in Table 4.

4.4.2 Flexing test

4.4.2.1 General

The requirements are given in IEC 60227-1.

4.4.2.2 Sample preparation

The mass of the weight and the diameter of pulleys A and B are given in Table 1.

Table 1 – Mass of weight and diameter of pulleys

Number of cores ^b	Nominal cross-sectional area mm ²	Mass of weight kg	Diameter of pulleys ^a mm
2	0,5	0,5	60
	0,75	1,0	80
	1	1,0	80
	1,5	1,0	80
	2,5	1,5	120
3	0,5	0,5	80
	0,75	1,0	80
	1	1,0	80
	1,5	1,0	80
	2,5	1,5	120
4	0,5	0,5	80
	0,75	1,0	80
	1	1,0	80
	1,5	1,5	120
	2,5	1,5	120
5	0,5	1,0	80
	0,75	1,0	80
	1	1,0	120
	1,5	1,5	120
	2,5	2,0	120