

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

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

Conducteurs et câbles isolés au polychlorure de vinyle, de tension nominale au  
plus égale à 450/750 V –  
Partie 7: Câbles souples avec et sans écran, à deux âmes ou plus



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

**Partie 7: Câbles souples avec et sans écran, à deux âmes ou plus**

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ELECTROTECHNICAL  
COMMISSION

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ELECTROTECHNIQUE  
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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**

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International Standard IEC 60227-7 has been prepared by sub-committee 20B: Low-voltage cables, of IEC technical committee 20: Electric cables.

This consolidated version of IEC 60227-7 consists of the first edition (1995) [documents 20B/177/FDIS and 20B/199/RVD], its amendment 1 (2003) [documents 20/551/CDV and 20/597A/RVC] and its amendment 2 (2011) [documents 20/1264/FDIS and 20/1274/RVD].

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

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.

Annex A forms an integral part of this standard.

The committee has decided that the contents of the base publication and its amendments will remain unchanged until the stability 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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# 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

### 1 General

#### 1.1 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.

#### 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.

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 60502-1:2004, *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, *Metallic communication cable test methods – Part 4-3: Electromagnetic compatibility (EMC) – Surface transfer impedance – Triaxial method*

## **2 Oil resistant, polyvinyl chloride sheathed, screened and unscreened flexible cable**

### **2.1 Code designation**

60227 IEC 74 for screened cable

60227 IEC 75 for unscreened cable

### **2.2 Rated voltage**

300/500 V

### **2.3 Construction**

#### **2.3.1 Conductor**

Number 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

#### **2.3.2 Insulation**

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

The insulation thickness shall comply with the specified value given in column 2 of table 1 or 2. The insulation resistance shall be not less than the value given in table 1, column 8 or table 2, column 6.

### 2.3.3 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 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.

### 2.3.4 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, and where the fictitious diameter ( $d_f$ ) of 0,5 mm<sup>2</sup>, 0,75 mm<sup>2</sup> and 1,0 mm<sup>2</sup> conductors (not given in A.2.1) 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 column 3 of table 1.

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 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.

### 2.3.5 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 column 4 of table 1.

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.

### 2.3.6 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 an sheath around the laid-up cores of unscreened cables.

An optional tape may be applied between screen and oversheath.

For all cables the thickness or 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, annex A and 2.3.4 of this standard. The increase in diameter due to the braided screen is four times the diameter of the braiding wire specified in column 4 of table 1.

For cables with the preferred numbers of cores, the calculated values of the sheath and oversheath thickness are given in column 5 of table 1 and in column 3 of table 2 (see note in 2.3.4). Both for sheath and oversheath, the thickness requirements apply as specified in 5.5.3 of 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.

### 2.3.7 Core identification

Except the green and yellow core, if any, all cores shall be identified by numbers in accordance with 4.2 of IEC 60227-1.

### 2.3.8 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 columns 6 and 7 of table 1 or in columns 4 and 5 of table 2, (see note in 2.3.4).

## 2.4 Tests

Compliance with the requirements of 2.3 shall be checked by inspection and by the tests given in table 3.

## 2.5 Guide to 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 electromagnetic interference is encountered.

These cables are designed for use only inside buildings and where the ambient temperatures remain within the range of +5 °C to +40 °C.

Maximum rated conductor temperature in normal use: 70 °C.

Maximum sheath temperature: 60 °C.

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Table 1 – General data for type 60227 IEC 74

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