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CEI**

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2007-07

**Cables for portable earthing and
short-circuiting equipment**

**Câbles d'équipements portables de mise
à la terre et de court-circuit**



Reference number
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**CABLES FOR PORTABLE EARTHING AND
SHORT-CIRCUITING EQUIPMENT**

FOREWORD

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International Standard IEC 61138 has been prepared by IEC technical committee 20: Electric cables.

This third edition cancels and replaces the second edition published in 1994 and constitutes a technical revision.

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

- extension of the scope to cover silicone rubber as an insulation material;
- introduction of a new normative annex for clashing test.

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

FDIS	Report on voting
20/881/FDIS	20/898/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- withdrawn;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.

CABLES FOR PORTABLE EARTHING AND SHORT-CIRCUITING EQUIPMENT

1 Scope

This International Standard applies to flexible cables with insulation based on ethylene propylene rubber (EPR), polyvinyl chloride (PVC) or silicone rubber (SiR) for portable earthing and short-circuiting equipment.

For this type of cable no rated voltage is given as such cables are exclusively intended for earthing and short-circuiting equipment.

The particular types of cable and their code designations are specified in Clause 6 of this standard.

The test methods specified in this standard are given in IEC 60227-2, IEC 60245-2, IEC 60811 and IEC 62230.

NOTE In addition to the requirements given in this standard, mechanical requirements and requirements for the marking for the complete equipment should be taken into account. These requirements can be found in IEC 61230.

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 One or more references to the standard below are in respect of a specific subdivision of that standard, for instance a clause, a table, a class or a type. Cross-references to these standards are undated and, at all times, the latest version should be applied.

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

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

IEC 60228, *Conductors of insulated cables*

IEC 60245-2, *Rubber insulated cables of rated voltages up to and including 450/750 V – Part 2: Test methods*

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

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

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

IEC 60811-1-3, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 1-3: Methods for general application – Tests for determining the electrical properties*

optical cables – Part 1-3: Methods for general application – Methods for determining the density – Water absorption tests – Shrinkage test

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

IEC 60811-2-1, 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

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

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

IEC 61230, Live working – Portable equipment for earthing or earthing and short-circuiting

IEC 62230, Electrical cables – Spark-test method

3 Terms and definitions

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

3.1

type tests

symbol T

tests required to be made before supplying a type of cable covered by this standard on a general commercial basis 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, design or type of manufacturing process which might change the performance characteristics.

3.2

sample tests

symbol S

tests made on samples of completed cable, or components taken from a completed cable, adequate to verify that the finished product meets the design specifications

3.3

routine tests

symbol R

tests made on all production cable lengths to demonstrate their integrity

4 General requirements for the construction of cables

4.1 Conductors

4.1.1 Material

The conductor shall consist of annealed copper, aluminium or aluminium alloy in accordance with IEC 60228. The wires of copper conductors may be plain or tinned. Tinned wires shall be covered with an effective layer of tin.

4.1.2 Construction

The maximum diameter of the conductor wires is specified in Table 3 and Table 4.

4.1.3 Check of construction

Compliance with the requirements of 4.1.1 and 4.1.2 shall be checked by visual inspection and by measurement.

4.1.4 Electrical resistance

The d.c. resistance of copper conductors at 20 °C is specified in IEC 60228 Class 6.

The d.c. resistance of aluminium conductors at 20 °C is specified in Table 4 of this standard.

The test shall be carried out in accordance with IEC 60228, Annex A.

The current density shall not exceed 1 A/mm² to avoid any significant increase of temperature during the test.

4.2 Separator between conductor and insulation

A separating tape made of suitable material may be placed between the conductor and the insulation.

4.3 Insulation

4.3.1 Material

The insulation shall be one of the following types specified for each type of cable in Clause 6:

- an elastomeric insulation compound based on a cross-linked ethylene propylene rubber (EPR) or similar (EPM or EPDM);
- a general purpose thermoplastic insulation compound based on polyvinylchloride (PVC);
- a cold-resistant thermoplastic insulation compound based on polyvinylchloride (PVC);
- a cross-linked silicone rubber insulation compound (SiR).

For the requirements of these compounds, see 4.3.5.

The temperature limits for cables insulated by the above compounds are given in Clause 7.

4.3.2 Colour of insulation

There is no preferred colour for the insulation. The colour of the insulation shall be achieved by the use of coloured compounds or other suitable method.

The insulation, whether coloured or not, may be transparent.

4.3.3 Application to the conductor

The insulation shall be closely applied to the conductor or separator. It shall be possible to remove the insulation without damage to the insulation itself, to the conductor, or to the tin coating if any. Compliance shall be checked by inspection and by manual test.

4.3.4 Thickness

The mean value of the thickness of the insulation shall be not less than the specified value in Table 3 and Table 4.

However, the thickness at any place may be less than the specified value, provided that the difference does not exceed 0,1 mm + 15 % of the specified value. Compliance shall be checked by the test given in 1.9 of IEC 60227-2 or IEC 60245-2.

4.3.5 Mechanical properties before and after ageing

The insulation shall have adequate mechanical strength and elasticity within the temperature limits to which it may be exposed in normal use.

Compliance shall be checked by carrying out the tests specified for each type of insulation in:

- IEC 60502-1, Table 15 for EPR or similar; in addition, cables covered by this type of compound shall be subjected to a cold bending or elongation test at –50 °C;
- IEC 60227-1, Table 2 (PVC/ST 5) as a general purpose compound;
- Table 7 of this standard for PVC/ST 11 as a cold-resistant compound;
- Table 9 of this standard for cross-linked silicone rubber compound.

The applicable test methods and the results to be obtained for each type of insulation are also specified in the above-mentioned tables.

4.4 Marking

4.4.1 Indication of origin

Cables shall be provided with an indication of origin consisting of either

- the manufacturer's identification thread; or
- the continuous marking of the manufacturer's name or trade mark, by printing, or by indenting or embossing on the insulation.

4.4.2 Indication of code designation and cross-sectional area of the conductor

Cables shall be provided with an indication of the code designation according to 6.2 and the cross-sectional area of the conductor "..... mm²". (See Table 3 and Table 4).

This shall be made by printing or by indenting or embossing on the insulation.

4.4.3 Continuity of marks

The distance between the end of one complete set of marks and the beginning of the next shall not exceed 550 mm.

4.4.4 Durability

Printed markings shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of IEC 60227-2 or IEC 60245-2.

4.4.5 Legibility

All marking shall be legible.

The colours of the identification threads shall be easy to recognize or easily made recognizable if necessary, by cleaning with petrol or other solvent.

5 Tests on completed cables

5.1 Electrical properties

5.1.1 General

The cables shall have adequate dielectric strength.

Compliance shall be checked by carrying out the following tests.

5.1.2 Voltage test

A sample of cable shall be immersed in water and then the voltage specified below shall be applied between the conductor and the water, with the following test conditions:

- minimum length of sample: 10 m
- minimum period of immersion in water: 1 h
- temperature of water: $20\text{ °C} \pm 5\text{ °C}$
- voltage applied (a.c.): 1 000 V
- duration of application of voltage, minimum: 5 min
- result to be obtained: during test no breakdown shall occur

5.1.3 Spark test

The integrity of the insulation shall be verified by compliance with IEC 62230.

Table 1 – Requirement for test voltages

Tabulated radial thickness of layer under test mm		Test voltage kV			
from	up to	a.c.	d.c.	h.f.	pulse
1,01	1,25	9	13	10 ^a	13
1,26	1,50	10	15	11 ^a	15
1,51	1,75	12	17	13 ^a	17
1,76	2,00	13	20	14 ^a	20
2,01	2,25	14	22	15 ^a	-
2,26	2,50	16	24	17 ^a	-
2,51	2,75	17	26	18 ^a	-
2,76	3,00	19	28	20 ^a	-
^a h.f. Voltage testing for layer thickness greater than 1,0 mm should be limited to frequencies between 500 Hz and 4 kHz					

The insulation shall exhibit no fault when tested with the above mentioned test method.

5.2 Overall diameter

The mean overall diameter of the cables shall be within the limits specified in Table 3 and 4.

The difference between any two values of the overall diameter of the cables at the same cross-section (ovality) shall not exceed 15 % of the upper limit specified for the mean overall diameter.

Compliance shall be checked by the test given in 1.11 of IEC 60227-2 or IEC 60245-2.

5.3 Flexibility test

5.3.1 General

The cables shall be sufficiently flexible in normal use.

5.3.2 Test for cables with copper conductors

Compliance shall be checked by carrying out the test specified in 3.2 of IEC 60245-2.

Before the test, the samples shall be conditioned at 20 °C ± 5 °C for 24 h in a vertical position, after which the test shall be carried out within the same temperature limits.

The mean of the two values of I' (see Figure 2 in IEC 60245-2) shall not exceed the values specified in Table 2.

Table 2 – Requirements for the static flexibility test

Nominal cross-sectional area of conductor mm ²	Max distance l' EPR, PVC and SiR insulation m
16	0,45
25	0,45
35	0,50
50	0,50
70	0,55
95	0,60
120	0,65
150	0,65

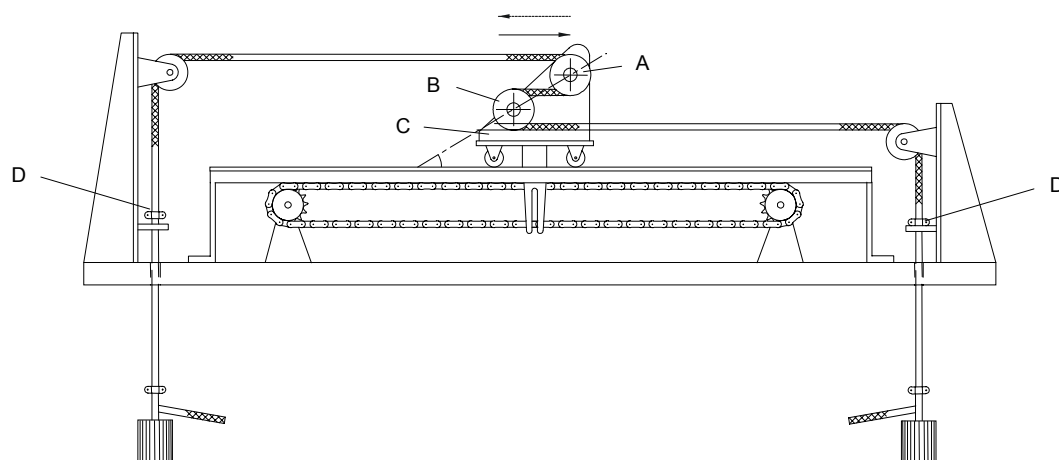
5.3.3 Test for cables with aluminium conductors

The test shall be carried out by means of an apparatus shown in Figure 1. This apparatus has a carrier C supporting two pulleys A and B arranged so that the cable is horizontal between the pulleys. The carriers make backward and forward movements over a distance of 1 m, at an approximately constant speed of 0,33 m/s (see also IEC 60227-2 or IEC 60245-2).

A sample of flexible cable about 5 m long shall be stretched over the pulleys, as shown in Figure 1, each end being loaded with a weight having a mass of 10 kg. The diameter of the pulleys A and B shall be 120 mm.

The pulleys have a semi-circular shaped groove, the diameter of which is 30 mm. An electrical current of 5 A shall be applied to the sample; the voltage shall be about 230 V, the frequency of which shall be between 48 Hz and 62 Hz.

A total of 2 000 movements (1 000 in each direction) shall be made.



IEC 1252/07

Figure 1 – Flexing apparatus

At the conclusion of the flexing movements no crack shall appear on the insulation. Furthermore, the value of the electrical resistance at the end of the test shall not vary by more than 10 % from the electrical resistance at the beginning of the test.

5.4 Optional clashing test

This test is optional and limited only on PVC insulated cables and carried out according to special national rules or customers requirement.

Cable satisfying the clashing test shall be identified by the manufacturer by printing of the words "Clashing test" on the insulation.

Test shall be carried as described in Annex A.

6 Particular specifications

6.1 General

Each cable shall comply with the appropriate requirements given in Clauses 4 and 5 and the particular requirements of this Clause 6.

6.2 Code designation

Type of insulation and of conductor	Code designation
EPR – Copper	61138 IEC 60110
EPR – Aluminium	61138 IEC 60210
PVC/ST 5 – Copper	61138 IEC 60150
PVC/ST 5 – Aluminium	61138 IEC 60250
PVC/ST 11 – Copper	61138 IEC 60155
PVC/ST 11 – Aluminium	61138 IEC 60255
SiR – Copper	61138 IEC 60165
SiR – Aluminium	61138 IEC 60265

6.3 Rated voltage

Not specified, see Clause 1.

6.4 Construction

6.4.1 Conductors

Number of conductors: 1.

The conductor shall comply with the requirements given in Table 3 and 4, column 2.

6.4.2 Insulation

Conductor and separator if any shall be protected by an insulation as specified in 4.3.

The thickness of insulation shall comply with the specified value given in Table 3 and 4, column 3.

6.4.3 Overall diameter

The mean overall diameter shall be within the limits given in Table 3 and 4, columns 4 and 5.

6.5 Tests

Compliance with the requirements of 6.4 shall be checked by inspection and by the tests given in Table 5 for EPR insulated cables, in Table 6 for PVC insulated cables, and in Table 8 for SiR insulated cables.

7 Guide to the use of the cables

These cables shall be exclusively used for portable earthing and short-circuiting equipment (see IEC 61230).

These cables are suitable for indoor and outdoor use within the following temperature limits:

EPR:	–40 °C to + 70 °C
PVC/ST 5:	–5 °C to + 70 °C
PVC/ST 11:	–25 °C to + 55 °C
SiR:	–40 °C to + 70 °C