IEC 63294

Edition 1.0 2021-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Test methods for electric cables with rated voltages up to and including 450/750 V

Méthodes d'essais pour les câbles électriques de tension assignée au plus égale à 450/750 V

IEC 63294:2021-11(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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TEST METHODS FOR ELECTRIC CABLES WITH RATED VOLTAGES UP TO AND INCLUDING 450/750 V

FOREWORD

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IEC 63294 has been prepared by IEC technical committee 20: Electric cables. It is an International Standard.

This first edition cancels and replaces IEC 60227-2:1997, IEC 60227-2:1997/AMD1:2003, IEC 60245-2:1994, IEC 60245-2:1994/AMD1:1997, IEC 60245-2:1994/AMD2:1997, IEC 62821-2:2015 and IEC 63010-2:2017. A table of cross-references for tests is given in Annex A.

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

Draft	Report on voting
20/1970/FDIS	20/1990/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/standardsdev/publications.

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- withdrawn,
- replaced by a revised edition, or
- amended.

TEST METHODS FOR ELECTRIC CABLES WITH RATED VOLTAGES UP TO AND INCLUDING 450/750 V

1 Scope

This document specifies the test methods for electric cables with rated voltages up to and including 450/750 V not included in the IEC 60811 series.

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 60811-201, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness*

IEC 60811-202, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath*

IEC 60811-203, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 203: General tests – Measurement of overall dimensions*

IEC 60811-401:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*

IEC 60811-501, *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 62230, *Electric cables – Spark-test method*

IEC 60502-1, *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)*

ISO 1302, *Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation*

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

4 General requirements

4.1 Sampling

If a marking is in relief in insulation or sheath, the samples used for the tests shall be taken so as to include such marking.

For multicore cables, except for the test specified in 5.6 and in 6.2, not more than three cores (of different colours, if applicable) shall be tested unless otherwise specified.

4.2 Pre-conditioning

All the tests shall be carried out not less than 16 h after the extrusion or vulcanization of the insulating or sheathing compounds.

4.3 Test temperature

Unless otherwise specified in the relevant cable standard, tests shall be made at an ambient temperature of (20 ± 15) °C.

4.4 Test voltage

Unless otherwise specified in the relevant cable standard, the test voltages shall be alternating current of approximately sinewave form and of frequency between 49 Hz and 61 Hz. The ratio of peak value to RMS value shall be equal to $\sqrt{2}$ with a tolerance of ±7 %.

The values quoted are RMS values.

4.5 Test values

Full test conditions (such as temperatures, durations) and full test requirements are not specified in this document. It is intended that they should be specified by the relevant cable standard.

Any test requirements which are given in this document may be modified by the relevant cable standard to suit the needs of a particular type of cable.

5 Electrical test methods

5.1 Electrical resistance of conductors

In order to check the electrical resistance of conductors, the resistance of each conductor shall be measured on a sample of cable of at least 1 m in length. The length of each sample shall be measured.

If necessary, a correction to 20 °C and to a length of 1 km shall be obtained by the formula:

$$R_{20} = R_t \times \frac{254{,}5}{234{,}5 + t} \times \frac{1\,000}{L}$$

where

R_{20} is the resistance at 20 °C, in ohms/kilometre;

R_t is the resistance of L metres of cable at t °C, in ohms;

t is the temperature of the sample at the moment of measurement, in degrees Celsius;

L is the length of the sample of cable, in metres (length of the complete sample and not of the individual cores or wires).

5.2 Voltage test carried out on completed cables

A sample of cable as delivered shall be immersed in water. The length of the sample, the temperature of the water and the duration of immersion and the test voltage shall be given in the relevant cable standard.

A voltage shall be applied in turn between each conductor and all the others together, connected to the metallic layer or metallic component, if any, or to the water; and then between all conductors together and the metallic layer or metallic component, if any, or to the water.

No breakdown of the insulation shall occur during the test.

5.3 Voltage test on cores in water

5.3.1 General

The test applies to sheathed cables, braided cables and flat non-sheathed cables.

5.3.2 Test sample

Prepare a sample of cable 5 m long, by carefully removing, without damaging the cores, the sheath or the overall braid and any other covering or fillers from a length of completed cable.

In the case of a flat non-sheathed cable, take a 5 m sample and make a cut in the insulation between the cores and separate the cores by hand over a length of 2 m, without damaging the cores.

5.3.3 Procedure

Immerse the sample in water at the temperature, and for the period specified in the relevant cable standard. Ensure that the ends of the cores protrude above the water by a distance sufficient to prevent excessive surface leakage when the test voltage is applied. Apply a voltage between the conductors and the water, of the magnitude and for the time specified in the relevant cable standard.

5.3.4 Requirements

No breakdown of the insulation shall occur during the test.

5.4 Insulation resistance

This test shall be made on the core samples, 5 m in length, previously submitted to the test described in 5.3 or, if this is not applicable, to the test described in 5.2.

The sample shall be immersed in water previously heated to the temperature indicated in the relevant cable standard. A length of about 0,25 m at each end of the sample shall be kept above the water.

The length of the samples, the temperature of the water and the duration of immersion shall be given by the relevant cable standard.

A DC voltage of between 80 V and 500 V shall then be applied between the conductor and the water.

The insulation resistance shall be measured 1 min after application of the voltage. The measured value shall be expressed in MΩ · km.

None of the resulting values shall be below the minimum insulation resistance value specified in the relevant cable standard.

NOTE The minimum values of the insulation resistance can be calculated (based on a volume resistivity of 1×10^8 Ω · m) from the formula:

$$R = 0{,}0367 \log_{10} \frac{D}{d}$$

where:

R is the insulation resistance, in MΩ · km;

D is the nominal outer diameter of the insulation, in mm;

d is the diameter of the circumscribed circle of the conductor or, for tinsel cables, the nominal inner diameter of the insulation, in mm.

5.5 Insulation resistance at temperatures above 90 °C

This test method applies to cables or cores with maximum rated conductor temperatures above 90 °C.

This test shall be made on the core samples previously submitted to the test described in 5.3 or, if this is not applicable, to the test described in 5.2.

A sample of 1,40 m in length shall be cut from the cable or core to be tested. Cover the central part of this test piece with a semi-conducting layer, and over this layer apply a metal braid or a metal tape in such a way as to obtain an active measuring length of 1,0 m.

At both ends of the active measuring length, leaving a gap 1 mm wide, a protective wire binding of approximately 5 mm wide shall be applied; any semi-conducting material covering the gap shall be removed (see Figure 1).

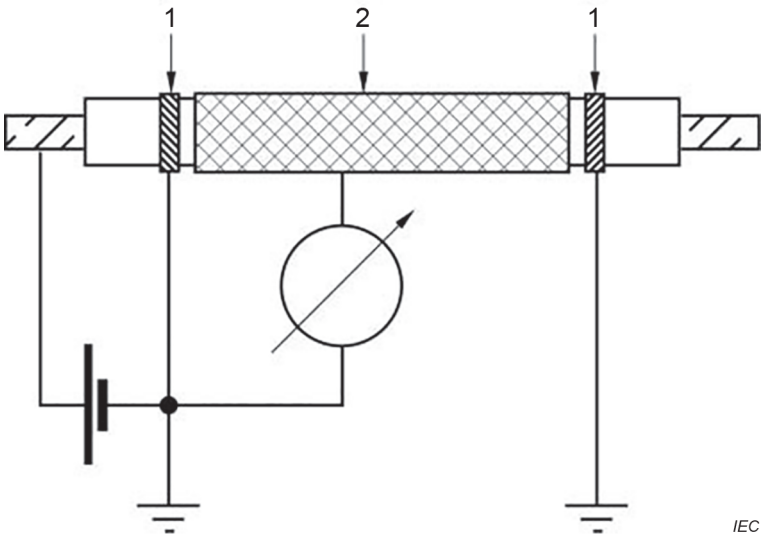
The sample shall then be wound to a ring with a diameter of approximately 15 D but at least 0,20 m (D is the nominal outer diameter of insulation).

The samples shall be maintained in an air oven for at least 2 h at the test temperature specified in the relevant cable standard. The clearance between the sample and the walls of the air oven shall be at least 50 mm.

After the conditioning period a DC voltage between 80 V and 500 V shall be applied between the conductor and the screen (semi-conducting layer and metal braid or metal tape including the protective wire binding being earthed), the sample still being kept in the air oven.

The insulation resistance shall be measured 1 min after application of the voltage and this value shall be used to calculate the insulation resistance of a 1 km length of cable. The measured value shall be expressed in MΩ · km. See note under 5.4.

None of the resulting values shall be below the minimum insulation resistance value specified in the relevant cable standard.



Key

1 guard electrode (protective wire binding)

2 screen electrode

Figure 1 – Positioning of electrodes

5.6 Long-term resistance of insulation to direct current

5.6.1 Test sample

Carry out the test on a sample of cable of 5 m in length from which all coverings have been removed. The cores of flat non-sheathed cables shall not be separated. Ensure any damage to the core(s) is avoided during removal of the coverings.

For cables having up to five cores, each core shall be tested. For multicore cables having more than five cores, one core of each colour in the cable shall be tested, and where the number of colours is less than five, duplicated coloured cores shall be tested as necessary to bring the number of cores tested up to a minimum of five.

5.6.2 Procedure

Immerse the sample, for the period and at the temperature given in the relevant cable standard, in an aqueous solution of sodium chloride having a concentration of 10 g/l, with a length of about 250 mm at each end of the sample projecting above the solution. Connect the negative pole of a 220 V DC supply to the conductor(s) of the sample and the positive pole to a copper electrode immersed in the solution for the time given in the relevant cable standard.

5.6.3 Requirements

No breakdown of the insulation shall occur during the test and, after the test, the exterior of the insulation shall show no sign of damage.

Discoloration of the insulation should be ignored.

5.7 Absence of faults in insulation

5.7.1 General

Test all the cable that is in the final stage of manufacture, whether it is in delivery lengths or in manufacturing lengths prior to being cut into delivery lengths.

Test single core cables, whether sheathed or non-sheathed, by the spark test in accordance with 5.7.2. Test all other cables, including sheathed flat cables, with the voltage test in accordance with 5.7.3.

The requirements of 4.2 do not apply when the check for absence of faults is carried out as a routine (R) test.

5.7.2 Spark test

5.7.2.1 Procedure

Carry out the test in accordance with IEC 62230, except that the option to use a pulsed waveform high-voltage source is not permitted.

5.7.2.2 Requirements

No faults shall be detected during the test.

5.7.3 Voltage test

5.7.3.1 Procedure

With the cable in the dry state and at ambient temperature, apply a voltage of the magnitude given in the relevant cable standard, supplied either from an AC source or from a DC source, between each conductor and all the other conductors and the metallic layer if any, connected to earth.

Increase the voltage gradually and maintain it at the full value for the duration given in the relevant cable standard.

5.7.3.2 Requirements

No breakdown of the insulation shall occur during the test.

5.8 Surface resistance of sheath

5.8.1 Test samples

Carry out the test on three samples of completed cable, each about 250 mm in length.

5.8.2 Procedure

Clean the sheath of each of the samples with industrial methylated spirit, and apply two electrodes consisting of wire helices of copper wire of between 0,2 mm and 0,6 mm diameter, at a distance of (100 ± 2) mm from each other to each sample. After the wire has been applied, clean the surface of the sheath again thoroughly between the electrodes.

Condition the samples with electrodes attached in a conditioning chamber at a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) % for 24 h.

Immediately after removal from the conditioning chamber, apply a DC voltage of between 100 V and 500 V between the electrodes, and measure the resistance after 1 min.

Multiply the measured resistance of each sample, in ohms, by $a/100$, where a is the circumference of the sheath of the sample, in millimetres. Record the median of the three values so obtained as the surface resistance of the sheath.

5.8.3 Requirements

The median of the three values so obtained shall be not lower than the value in the cable standard.

6 Non-electrical test methods

6.1 Checking of the durability of colours and markings

Compliance with this requirement shall be checked by trying to remove the marking of the manufacturer's name or trade mark and the colours of cores or numerals by rubbing lightly ten times with a piece of cotton wool or cotton cloth soaked in water.

6.2 Measurement of thickness of insulation

6.2.1 Procedure

The thickness of insulation shall be measured in accordance with IEC 60811-201.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

The preparation of the test pieces shall be done in accordance with IEC 60811-501.

Compliance shall be checked on each core of cables having up to five cores, and on any five cores of cables with more than five cores.

6.2.2 Evaluation of results

The mean of the 18 values (expressed in millimetres) obtained from the three pieces of insulation from each core shall be calculated to two decimal places and rounded as specified in IEC 60502-1, and this shall be taken as the mean value of the thickness of insulation.

The lowest of all values obtained shall be taken as the minimum thickness of insulation at any point.

6.3 Measurement of thickness of sheath

6.3.1 Procedure

The thickness of sheath shall be measured in accordance with IEC 60811-202.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

6.3.2 Evaluation of results

The mean of all the values (expressed in millimetres) obtained from the three pieces of sheath shall be calculated to two decimal places and rounded as specified in IEC 60502-1, and this shall be taken as the mean value of the thickness of sheath.

The lowest of all values obtained shall be taken as the minimum thickness of sheath at any place.

6.4 Measurement of overall dimensions and ovality

The three samples taken in accordance with 6.2 or 6.3 shall be used.