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)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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- withdrawn,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 $1 \times 10^8\ \Omega \cdot m$) 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).

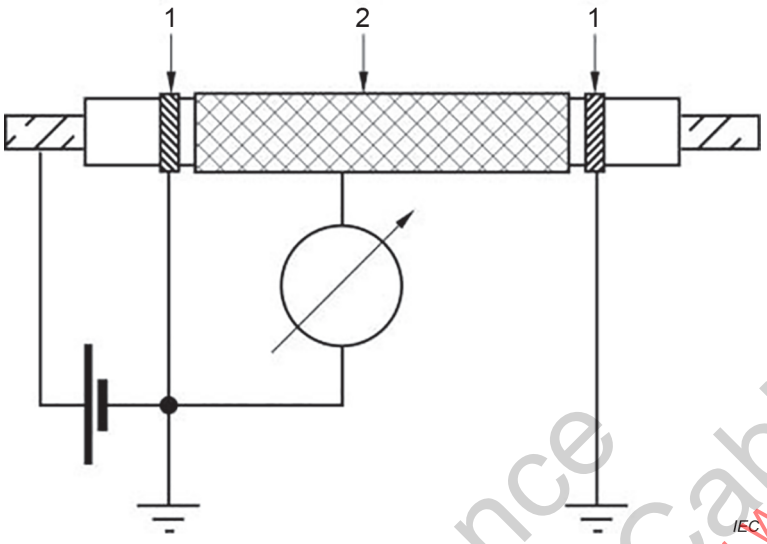
The sample shall then be wound to a ring with a diameter of approximately 15 D but at least 0,20 m (D is the nominal outer diameter of insulation).

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.

The measurement of the overall diameter of any circular cable and of the overall dimensions of flat cables with a major dimension not exceeding 15 mm shall be carried out in accordance with IEC 60811-203.

For the measurement of flat cables with a major dimension exceeding 15 mm, a micrometer, a profile projector or similar device shall be used.

The mean of the values obtained shall be taken as the mean overall dimension.

For checking the cable ovality of circular sheathed cables, the difference between any two values of the overall diameter of sheathed circular cables of the same cross-section (ovality) shall not exceed 15 % of the mean overall diameter.

6.5 Solderability test for non-tinned conductors

6.5.1 General

The test is intended to verify the effectiveness of the separator between the non-tinned conductor and the insulation.

6.5.2 Selection of samples and preparation of test pieces

One sample having a length suitable for the bending test defined in 6.8 is taken at three points in the cable, and the cores in each sample are carefully separated from all other components.

Each sample of core thus obtained is wound for three turns on a mandrel, the diameter of which is a maximum of three times that of the core.

The sample is then unwound and straightened out, whereupon it is wound again in such a way that the side which was compressed in the first case becomes the stretched fibre in the second.

This cycle of operations is repeated two more times, which represents three bending operations in one direction and three in the other.

From each sample of core which has been straightened out after the third cycle of bending operations, a test piece having a length of about 15 cm is taken from that part of the core which has actually been wound.

Each test piece is then subjected to accelerated ageing in an air oven for 240 h at a temperature of 70 °C ± 1 °C.

After this accelerated ageing, the test pieces are left at ambient temperature for at least 16 h.

Then each test piece is stripped at one end over a length of 60 mm and is subjected to the solderability test by the solder-bath method described in 6.5.4.

6.5.3 Description of the solder bath

The solder bath shall have a volume sufficient to ensure that the temperature of the solder remains uniform when the conductor is introduced. It shall be provided with a device which maintains the temperature of the solder at 270 °C ± 10 °C.

The depth of the solder bath shall be at least 75 mm.

The visible surface area of the bath shall be reduced as far as possible, by using a perforated plate of heat resistant material in order to protect the core against direct radiation from the bath.

The composition of the solder shall be tin (between 59,5 % and 61,5 %) and lead.

Impurities (as a percentage of the total mass) shall not exceed:

Antimony	0,50 %	Zinc	0,005 %
Bismuth	0,25 %	Aluminium	0,005 %
Copper	0,08 %	Others	0,080 %
Iron	0,02 %		

6.5.4 Test procedure

The surface of the solder bath shall be kept clean and shiny.

After immersion for 10 s at ambient temperature in a pickling bath consisting of a solution of zinc chloride in water ($ZnCl_2$ being 10 % of the total mass), the bare end of each test piece shall be immersed in the solder bath over a length of 50 mm in the direction of its longitudinal axis.

The speed of immersion is 25 mm/s ± 5 mm/s.

The duration of immersion, after 50 mm of the sample is fully immersed, is 5 s ± 0,5 s.

The speed of emergence is 25 mm/s ± 5 mm/s.

Each test piece shall be subjected to three immersion cycles with a period of 10 s between each cycle.

6.5.5 Requirements

The part of the conductor that has been immersed shall be adequately tinned. The result is that the tinning should completely cover that treated area and not reveal any part of the conductor beneath.

6.6 Flexing test

6.6.1 General

This test is applicable to flexible cables with cores of nominal cross-sectional area up to and including 4 mm^2.

This test is not applicable to cables having more than 18 cores laid up in more than two concentric layers.

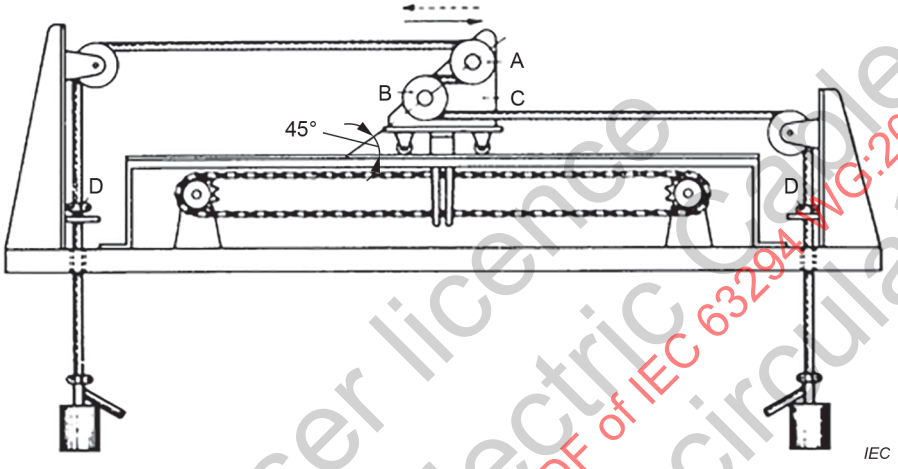
Test requirements are shown in the relevant cable standard.

6.6.2 Apparatus

This test shall be carried out by means of the apparatus shown in Figure 2. This apparatus consists of a carrier C, a driving system for the carrier and four pulleys for each sample of cable to be tested. The carrier C supports two pulleys A and B, which are of the same diameter. The two fixed pulleys, at either end of the apparatus, may be of a different diameter from pulleys A and B, but all four pulleys shall be so arranged that the sample is horizontal between them. The carrier makes cycles (forward and backward movements) over a distance of 1 m at an approximately constant speed of 0,33 m/s between each reversal of the direction of movement.

The pulleys shall be made of metal and have a semi-circular shaped groove for circular cables and a flat groove for flat cables. The restraining clamps D shall be fixed so that the pull is always applied by the weight from which the carrier is moving away. The distance from one restraining clamp to its support, while the other clamp is resting on its support, shall be of 5 cm maximum.

The driving system shall be such that the carrier turns smoothly and without jerks when it reverses from one direction to another.



Key

A pulley

B pulley

C carrier

D restraining clamps

Figure 2 – Flexing apparatus

6.6.3 Sample preparation

A sample of flexible cable about 5 m long shall be routed through the pulleys, as shown in Figure 2, each end being loaded with a weight.

The mass of this weight and the diameter of pulleys A and B are given in the relevant cable standard.

6.6.4 Current applied on cores

For the current application either a low voltage or a voltage of about 230/400 V may be used.

During the flexing test, the current specified in the relevant cable standard shall pass thorough the cable cores.

6.6.5 Voltage between cores

For two-core cables the voltage between the conductors shall be about 230 V AC. For all other cables having three or more cores, a three-phase AC voltage of about 400 V shall be applied to three conductors, any additional conductors being connected to the neutral. Three adjacent cores shall be tested. In case of a two-layer construction, the tested cores shall be from the outer layer. This also applies when a low voltage current loading system is used.

6.6.6 Fault detection (construction of the flexing apparatus)

The flexing apparatus shall be constructed so that it will detect and stop if the following occurs during the flexing test:

– interruption of the current;
– short circuit between the conductors;
– short circuit between the test sample and the pulleys (flexing apparatus).

6.7 Static flexibility test

Test requirements are shown in the relevant cable standard.

Before the test, the cable shall be conditioned at (20 ± 5) °C for 24 h in a vertical position.

A sample with a length of 3 m ± 0,05 m shall be tested in an apparatus similar to that shown in Figure 3. Two clamps, A and B, shall be located at a height of at least 1,5 m above ground level.

Clamp A shall be fixed and clamp B shall move horizontally at the level of clamp A.

The ends of the sample shall be clamped vertically (and remain vertical during the test), one end in clamp A, the other in the movable clamp B which shall be at a distance of 0,20 m from clamp A. The cable takes roughly the shape indicated in Figure 3 by the dotted lines.

The movable clamp B shall then be moved away from the fixed clamp A until the loop formed by the cable takes the shape, indicated in Figure 3 by the heavy outline, of the U enclosed wholly between two plumb lines through the clamps and set up tangentially to the outer parallel surfaces of the bent cable. The cable shall be turned in the clamp, through 180°, and the test repeated.

The mean of the two values of *l'* shall be measured between the two plumb lines.

If the results of the test are unfavourable, the sample shall be pre-conditioned by winding it four times on and off a reel with a diameter approximately 20 times the outer diameter of the cable; in this case, the sample shall be turned each time through 90°. After this pre-conditioning, the sample shall be subjected to the test described above and shall meet the specified requirements.

Dimensions in metres

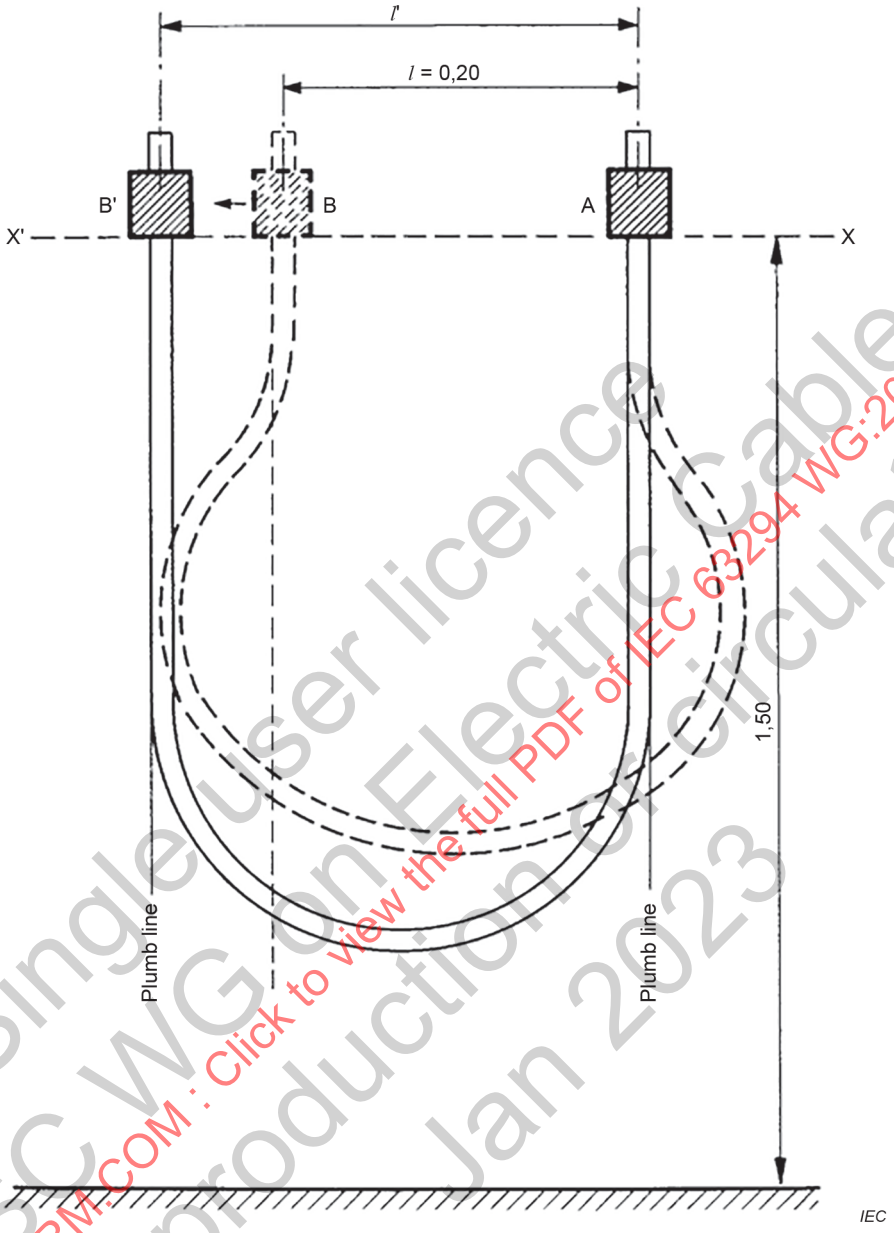


Figure 3 – Static flexibility test

6.8 Bending test

Test requirements are shown in the relevant cable standard.

A sample of cord of appropriate length shall be fixed in the apparatus as shown in Figure 4, and loaded with a weight having a mass of 0,5 kg. A current of a nominal value of 0,1 A shall be passed through the conductors.

The sample shall be bent backwards and forwards in a direction perpendicular to the plane of the axes of the conductors, the two extreme positions making an angle of 90° on both sides of the vertical.

A flexing is a movement through 180°. The rate of flexing is 60 cycles per minute.

If the sample does not comply with the requirements set by the relevant cable standard, the test shall be repeated with two additional samples, both of which shall then comply with the requirements.

Dimensions in millimetres

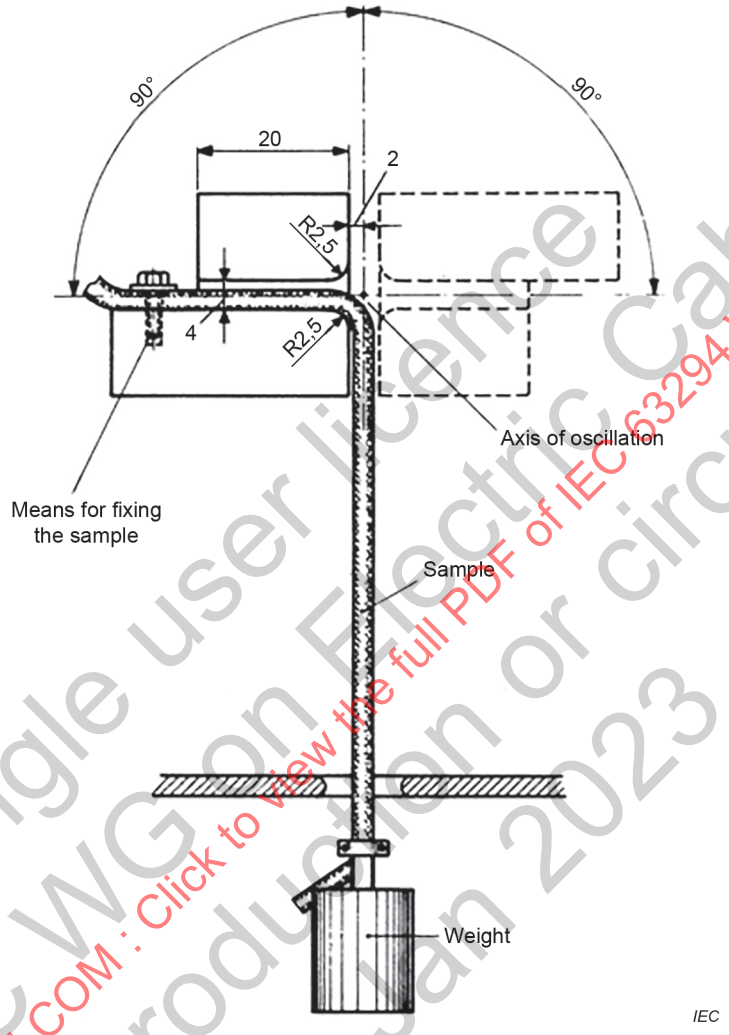


Figure 4 – Bending test apparatus

6.9 Wear resistance test

Test requirements are shown in the relevant cable standard.

This test shall be made on three pairs of samples of flexible cable, each sample having a length of about 1 m.

In each pair, one sample shall be wound so as to give nearly two turns on a fixed reel having a diameter of 40 mm at the bottom of the groove as shown in Figure 5, the distance between the flanges of the reel being such that the turns are in close contact with each other. The sample shall then be fixed to prevent any movement relative to the reel.

The other sample shall be placed in the groove formed by the turns and a weight having a mass of 500 g shall be attached to one end.

The other end shall be moved up and down over a distance of 0,10 m, at a rate of about 40 single strokes per minute.

Dimensions in millimetres

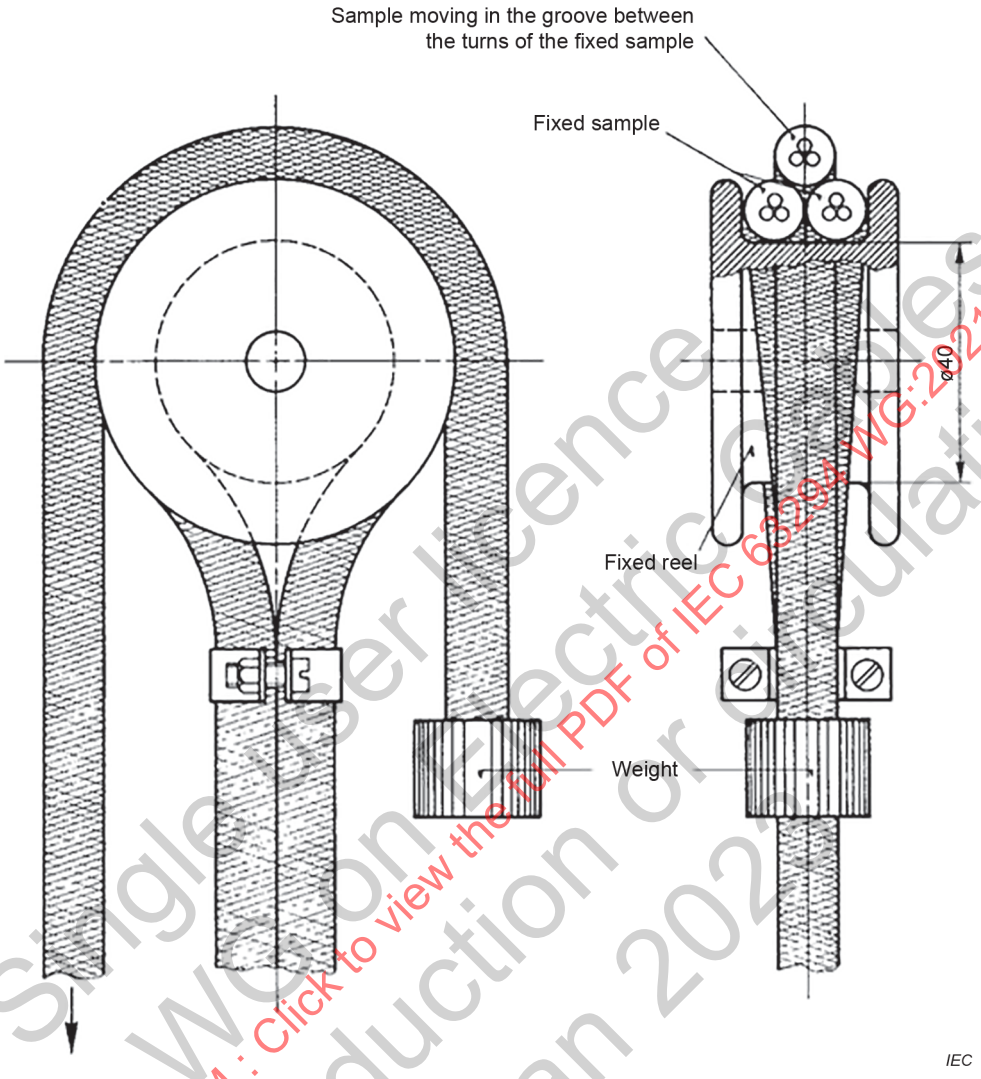


Figure 5 – Arrangement for wear-resistance test

6.10 Drop test

Test requirements are shown in the relevant cable standard.

A sample of cable of appropriate length shall be attached by one end to a rigid support, and a weight having a mass of 500 g shall be secured to the sample 0,5 m below the point of attachment. A current of about 0,1 A shall be passed through the conductors. The weight shall be raised to the point of attachment and then dropped, five times.

6.11 Void

6.12 Three-pulley flexing test

6.12.1 Test method

The test shall be carried out in accordance with 6.6 except for the following modifications to the apparatus described hereafter.

a) Carrier

The apparatus described in 6.6.2 shall have a modified carrier C, as shown in Figure 6.

b) Pulley wheels

The three pulley wheels of the modified carrier C shall be of equal diameter in accordance with what is stated in the relevant product standard.

c) Speed of carrier

The constant speed of the modified carrier C shall be approximately 0,1 m/s.

d) Weight

The weight applied to stress the conductor as described in 6.6 shall be calculated on the basis of 28 N/mm^2 of the conductor cross-section.

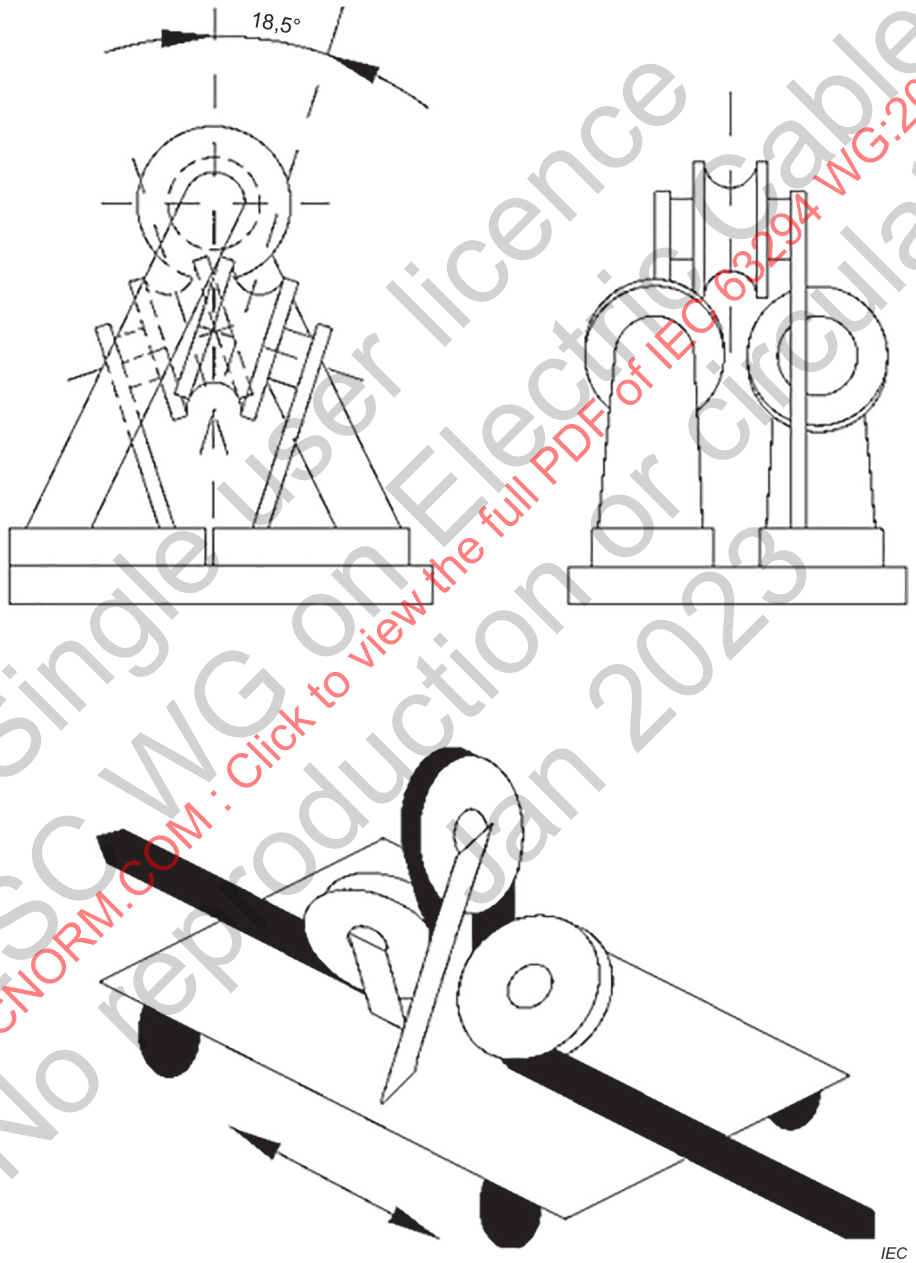


Figure 6 – Modified carrier C

6.12.2 Requirements

During the test consisting of 1 000 cycles, i.e. 2 000 single movements, neither interruption of the current, nor short-circuit between the conductors, nor short circuit between the cable and the pulleys (the flexing apparatus) shall occur.

After the required number of cycles the sheath of the cable shall be removed. The cores shall then withstand the voltage test carried out in accordance with 5.3, at a voltage specified in the relevant cable standard.

6.13 Kink test

6.13.1 Applicability

The test is applicable to two- and three-core sheathed cables, with a conductor cross-sectional area up to and including 1,5 mm^2.

6.13.2 Apparatus

The test shall be carried out by means of a tensile strength testing machine or equivalent apparatus.

There shall be two clamps for fixing the cable. The upper clamp shall be capable of upward and downward movement. The lower clamp shall allow free movement in the vertical direction, but shall be prevented from twisting about its vertical axis so that no change to the torsion in the cable is introduced during the test. The arrangement is shown in Figure 7.

6.13.3 Sample

The test cable sample shall have a length of approximately 1 m. The cable shall be twisted three times, as shown in position 1 (starting position only) of Figure 7, and then fixed in the upper and lower clamps so that the starting distance between the clamps is 200 mm. The total extended length of cable between the two clamps is approximately 800 mm, as shown in position 2 (extended position) of Figure 7.

Four samples shall be prepared for testing, two with the twists applied clockwise and two counter-clockwise.

6.13.4 Test procedure

The lower clamp shall be loaded with a weight sufficient to exert the tensile force given in the relevant product standard.

Each conductor of the cable shall be loaded with current, as specified in the relevant product standard. The current may be at a low voltage.

The moveable upper clamp shall make upward and downward movements at the rate of nine complete cycles per minute (one complete cycle equals one upward and downward movement). The distance of travel for each movement (up or down) shall be 650 mm.

When the upper clamp is fully raised, the weight attached to the bottom clamp shall have been raised by about 50 mm (see Figure 7, position 2).

A total of 3 000 cycles shall be made on each sample.

6.13.5 Requirements

During the test neither interruption of the current nor short circuit between conductors shall occur.

Also there shall be no damage (cracking or tearing) to the sheath or any outer covering (textile braid). Textile braids shall have no gap bigger than 2 mm.

At the conclusion of the test the sheath and any outer covering shall be removed, and the cores shall be subjected to the voltage test in accordance with 5.3.

Dimensions in millimetres

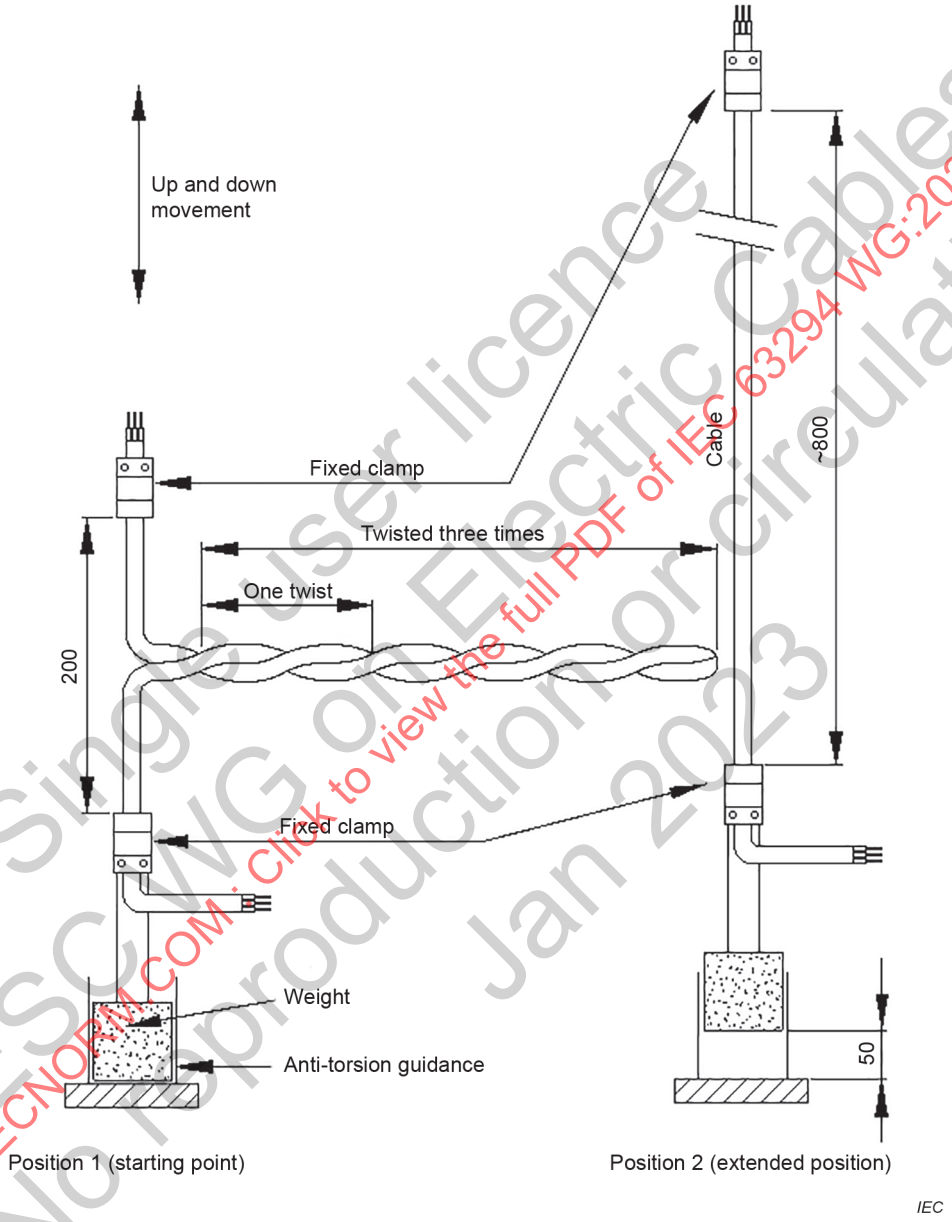


Figure 7 – Kink test apparatus

6.14 Tests for mechanical properties after air oven ageing of insulation consisting of rubber compound

6.14.1 General

The tests shall be carried out in accordance with IEC 60811-501 and IEC 60811-401 in conjunction with the modifications and additions given in 6.14.3 and 6.14.4.

Test conditions and test requirements are given in the relevant standard.