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Rubber insulated cables of rated voltages up to and including 450/750 V - Part 2: Test methods (IEC 60245-2:1994, related)

ICS 29.060.20

Referenčna številka
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HARMONIZATION DOCUMENT
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HD 22.2 S3

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Supersedes HD 22.2 S2:1992 and its amendments

Descriptors: Conductor, cable, flexible cable, rigid cable, single core cable, multicore cable, conductor material, flat cable, compound, polychloroprene, rubber, elastomer, insulation compound, type test, sample test, routine test, rated voltage, mark, common marking, identification, colour scheme, construction, insulation, separator, filler, sheath, braid, inner layer, outer layer, thickness, mean value, specified value, electrical resistance, test, tensile strength, elongation at break, ageing, air oven, oxygen bomb, hot set, complete cable, overall dimensions, bending, flexing, voltage test, absence of short circuits, spark (test), insulation resistance, wear resistance, test (under) fire (conditions), guide to use, solderability test

English version

Rubber insulated cables of rated voltages up to and including 450/750 V Part 2: Test methods

Conducteurs et câbles isolés au caoutchouc, de tension assignée au plus égale à 450/750 V Partie 2: Méthodes d'essais

Gummi-isolierte Starkstromleitungen mit Nennspannungen bis 450/750 V Teil 2: Prüfverfahren

This Harmonization Document was approved by CENELEC on 1997-07-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for implementation of this Harmonization Document on a national level.

Up-to-date lists and bibliographical references concerning such national implementation may be obtained on application to the Central Secretariat or to any CENELEC member.

This Harmonization Document exists in three official versions (English, French, German).

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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FOREWORD

This edition 3 of HD 22.2 has been prepared by Technical Committee CLC/TC20, Electric cables.

HD 22 was originally adopted by CENELEC on 9th July 1975.

Edition 2 of HD 22 was implemented on 1st January 1984, and at that time contained four parts.

Since 1984, new parts have been published and original parts amended. This new edition provides a full updating, and amalgamation of amendments since 1984.

HD 22.2 S3 is related to IEC 60245-2 (1994), but is not directly equivalent.

HD 22 now has the following parts:

HD 22.1 S3	-	General requirements
HD 22.2 S3	-	Test methods
HD 22.3 S3	-	Heat resistant silicone rubber insulated cables
HD 22.4 S3	-	Cords and flexible cables
HD 22.5	-	(Spare)
HD 22.6 S2	-	Arc welding cables
HD 22.7 S2	-	Cables with increased heat resistance for internal wiring for a conductor temperature of 110 °C
HD 22.8 S2	-	Polychloroprene or equivalent synthetic elastomer sheathed cable for decorative chains
HD 22.9 S2	-	Single core non-sheathed cables for fixed wiring having low emission of smoke and corrosive gases
HD 22.10 S1	-	EPR insulated and polyurethane sheathed flexible cables
HD 22.11 S1	-	EVA cords and flexible cables
HD 22.12 S1	-	Heat resistant EPR cords and flexible cables
HD 22.13 S1	-	Single and multicore flexible cables, insulated and sheathed with crosslinked polymer and having low emission of smoke and corrosive gases
HD 22.14 S1	-	Cords for applications requiring high flexibility

In order that this revision of Part 2 of HD 22 does not introduce unnecessary changes to long-established clause numbers, the Normative References (which would otherwise be inserted as clause 2) are given in Annex A.

The draft Harmonisation Document was submitted to the Unique Acceptance Procedure and approved by CENELEC as HD 22.2 S3 on 1997-07-01.

The following dates were fixed:

- latest date by which the existence of the HD has to be announced at national level	(doa)	1997-12-01
- latest date by which the HD has to be implemented at national level by publication of a harmonized national standard or by endorsement	(dop)	1998-06-01
- latest date by which the national standards conflicting with the HD have to withdrawn	(dow)	1998-06-01

For products which have complied with HD 22.2 S2:1992 and its amendments A5:1992, A6:1992, A7:1992, A8:1993, A9:1993, A10:1995 and A11:1995 before 1998-06-01, as shown by the manufacturer or by a certification body, this previous standard may continue to apply for production until 1999-06-01.

CONTENTS

RUBBER INSULATED CABLES OF RATED VOLTAGES UP TO AND INCLUDING 450/750V

Part 2 : Test Methods

1. General

1.1 Scope

HD 22 applies to rigid and flexible cables with insulation and sheath, if any, based on vulcanised rubber, of rated voltages U_o/U up to and including 450/750V used in power installations of nominal voltage not exceeding 450/750V a.c.

This Part 2 specifies the methods of carrying out the tests specified in HD 22 in conjunction with HD 405 and EN 60811. General Requirements are specified in HD 22.1.

Particular types of cable are specified in HD 22 Part 3 onwards, and are hereafter referred to as "the particular specifications".

1.2 Applicable tests

The tests applicable to the types of cables are given in the particular specifications.

1.3 Classification of tests according to the frequency with which they are carried out

The tests specified are type tests (Symbol T) and/or sample tests (Symbol S) and/or routine tests (Symbol R) as defined in Part 1, Sub-clause 2.2. The Symbols T, S and R are used in the relevant tables of the particular specifications.

1.4 Sampling

If a marking is indented in the 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 Part 2, sub-clause 1.9, not more than three cores (of different colours, if available) shall be tested unless otherwise specified.

1.5 Pre-conditioning

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

1.6 Test temperature

Unless otherwise specified, tests shall be made at ambient temperature.

1.7 Test voltage

Unless otherwise specified, the test voltages shall be a.c. 49Hz to 61Hz of approximately sine-wave form, the ratio peak value/r.m.s. value being equal to $\sqrt{2}$ with a tolerance of ±7%

The values quoted are r.m.s. values.

1.8 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 trademark and the colours of cores or numerals by rubbing lightly 10 times with a piece of cotton wool or cloth soaked in water.

1.9 Measurement of insulation thickness

1.9.1 Procedure

The thickness of insulation shall be measured in accordance with sub-clause 8.1 of EN 60811-1-1. Three samples shall be taken from the cable; each sample shall be separated from the next by a distance of at least 1m.

Compliance shall be checked on each core of cable.

If withdrawal of the conductor is difficult, it shall be stretched in a tensile machine or the piece of core shall be loosened by stretching or some other suitable means that does not damage the insulation.

1.9.2 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 off as given below, and this shall be taken as the mean value of the thickness of insulation.

If in the calculation the second decimal figure is 5 or more, the first decimal figure shall be raised to the next number; thus for example, 1,74 shall be rounded to 1,7 and 1,75 to 1,8.

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

1.10 Measurement of sheath thickness

1.10.1 Procedure

The thickness of the sheath for circular cables shall be measured in accordance with sub-clause 8.2 of EN 60811-1-1.

For flat cords the measurements shall be carried out in accordance with Annex C of this Part 2.

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

1.10.2 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 off as given below, and this shall be taken as the mean value of the thickness of sheath.

If in the calculation the second decimal figure is 5 or more, the first decimal figure shall be raised to the next number; thus for example, 1,74 shall be rounded to 1,7 and 1,75 to 1,8.

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

1.11 Measurement of overall dimensions and ovality

The three samples taken in accordance with Part 2, sub-clause 1.9 or 1.10 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 15mm shall be carried out in accordance with sub-clause 8.3 of EN 60811-1-1.

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

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

For checking the ovality of circular sheathed cables, two measurements shall be made at the same cross-section of the cable, covering the maximum and minimum values.

1.12 Solderability test for untinned conductors

1.12.1 Aim of the test

The test is intended to assess possible interaction between insulation and bare copper conductor.

1.12.2 Pre-selection of samples

The test shall not be carried out until the normal ageing test in the air oven has been completed.

When the normal ageing test in the air oven has been completed, the conductors of the test samples shall be examined. If there is no blackening of the conductors no further action is required.

If the conductors are blackened, the normal ageing test in the air oven shall be repeated on new samples, except that the ageing conditions shall be seven days at (70 ± 2) °C. At the end of this ageing period the conductors shall be examined, and if there is no blackening no further action is required.

If the conductors are blackened, carry out the test described in 1.12.3 to 1.12.6 below.

1.12.3 Selection of samples and preparation of test pieces

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

1.12.3.2 Each sample of core thus obtained shall be wound, in three turns, on a mandrel, the diameter of which is three times that of the core.

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

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

1.12.3.3 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 150mm shall be taken from that part of the core which has actually been wound.

Each test piece shall then be subjected to accelerated ageing in a hot-air oven for 168 h at a temperature of (70 ± 2)°C.

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

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

1.12.4 Description of the solder bath

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

The height 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 resisting 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		

1.12.5 Test procedure

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

After immersion for 10 seconds at ambient temperature in a pickling bath constituted by a solution of zinc chloride in water (ZnCl being 10% of the total mass), the bared 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 shall be (25 ± 5) mm/s.

The duration of immersion shall be (5 ± 0,5) s.

The speed of emergence shall be (25 ± 5) mm/s.

The number of immersions shall be three and the interval between each immersion shall be as short as possible, and in any case not more than 5s.

1.12.6 Requirement

The part of the conductor that has been immersed shall be adequately tinned.

2. Electrical tests

2.1 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 1m in length, and the length of this sample shall be measured.

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

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

where :

t	=	Temperature of the sample at the moment of measurement, in degrees Celsius
R_{20}	=	Resistance at 20°C, in ohm/kilometre
R_t	=	Resistance of L metres of cable at t°C in ohms
L	=	Length of the sample of cable, in metres (length of the complete sample and not of the individual cores or wires)

2.2 Voltage test on completed cable

If the cable has no metallic layer, a sample of the cable as delivered shall be immersed in water. The length of the sample, the temperatrue of the water and the duration of immersion are given in Part 1, Table 3.

A voltage shall be applied in turn between each conductor and all the others connected together and to the water.

If the cable has a metallic layer, a sample of the cable shall be taken of the length defined in Part 1, Table 3.

A voltage shall be applied in turn between each conductor and all the others connected together and to the metallic layer.

If the cable has a metallic strain-bearing member, this shall be connected to the water or the metallic layer, as appropriate.

The voltage and the duration of its application are given for each case in Part 1, Table 3.

2.3 Voltage test on cores

The test applies to sheathed or braided cables.

The test shall be made on a sample of cable of 5m length. The sheath or the overall braid and any other covering or filling shall be removed without damaging the cores.

The cores shall be immersed in water as specified in Part 1, Table 3 and a voltage shall be applied between the conductors and the water.

The voltage and the duration of its application are given for each case in Part 1, Table 3.

2.4 Insulation resistance

NOTE: An explanation of the calculation of minimum insulation resistance is given in Annex D.

2.4.1 Insulation resistance for cables with maximum conductor temperatures not exceeding 90°C

This test shall be made on the core samples, 5m long, previously submitted to the test described in sub-clause 2.3 of this Part of HD 22 or, if this is not applicable, to the test described in sub-clause 2.2 of this Part of HD 22.

The sample shall be immersed in water previously heated to the specified temperature, a length about 0,25m at each end of the sample being kept above the water.

The length of the samples, the temperature of the water and the duration of immersion are given in Part 1, Table 3.

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

The insulation resistance shall be measured one minute after application of the voltage and this value shall be related to 1km.

NOTE: This test applies only when required by the particular specification in Part 3 onwards of this HD.

2.4.2 Insulation resistance for cables with maximum conductor temperatures exceeding 90°C

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

The test shall be made on the same sample used for the voltage test.

A sample of 1,40 m length shall be cut from the cable or core to be tested, and shall be provided with outer electrodes consisting of a screen and a semi-conducting layer (see Figure 1). In the central part the sample shall be covered with a semi-conducting layer over the length of the screen - electrode and over the width of the guard electrodes to be applied to these layers.

The screen may be a metal braid or a metal tape and shall be applied 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 of 1 mm wide, a protective wire binding (guard electrode) of approximately 5 mm length shall be applied on its own semi-conducting layer; any semi-conducting material covering the gap shall be removed.

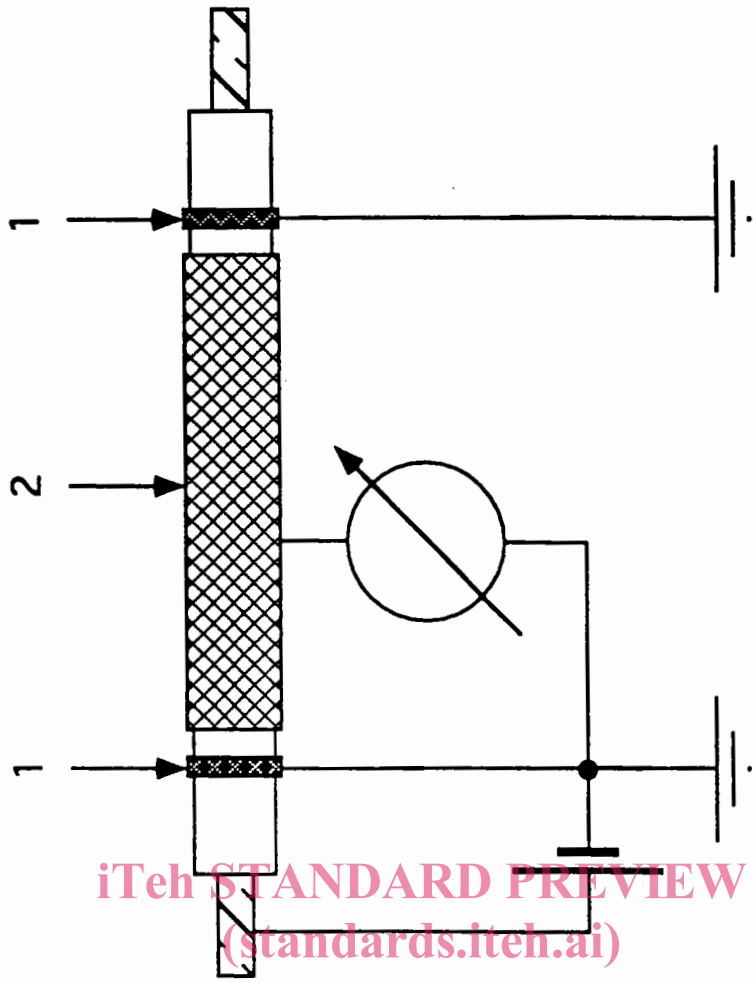
The sample shall then be wound to a ring with a diameter of approximately 15 D but at least 0,20 m (D = nominal outer diameter of insulation).

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

The insulation resistance shall be measured one minute after a d.c. voltage between 80V and 500V is applied between the conductor and the screen; the guard electrodes being earthed. This value shall be related to 1 km.

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

NOTE: Further basic information on this measurement may be obtained from IEC 93 clause 6 "Test pieces for the volume resistivity measurement".



1 = Guard Electrode (Protective Wire Binding)
2 = Screen Electrode

Figure 1 - Positioning of electrodes

2.5 Long term resistance of insulation to direct current

This test shall be made on samples of core 5m long, after removal of any covering. The samples shall be immersed in an aqueous solution of sodium chloride at about 10 g/litre, brought to the specified temperature. A length of about 0,25m at each end of the sample shall be kept above the solution. A voltage of 220V d.c. shall be applied between the conductor(s) of each sample, connected to the negative pole, and copper electrode immersed in the solution, connected to the positive pole. The temperature of the solution and the duration of the applied voltage shall be as specified in Part 1, Table 3.

After the test, the exterior of the insulation shall show no damage.

NOTE: Discolouration of the insulation should be ignored.

2.6 Test to check the absence of faults on insulation

This test shall be carried out as a routine test in the final stage of manufacture either on delivery lengths or on manufacturing lengths before cutting them into delivery lengths.

The test shall be either, (i) for unsheathed or sheathed single core cables, a spark test in accordance with Part 2 sub-clause 2.6.1, or, (ii) for multicore cables, a voltage test in accordance with Part 2 sub-clause 2.6.2.

2.6.1 Spark test

Test requirements : The cable shall withstand the test voltage specified below without failure of the insulation. The spark test equipment shall detect a puncture in the insulation having a diameter equal to or greater than half of the specified insulation thickness. The recovery time of the spark tester shall be not greater than one second.

Test voltage : The voltage applied by the spark tester may be power frequency a.c., d.c., high frequency or of other form.

The magnitude and the presence of the voltage shall be such that with the electrode system employed and at the speed employed for the passage of the cable through the spark tester the test requirements are effectively met.

The reference method to be used to establish the efficacy of the spark testing equipment is given in Part 2, Annex B.

When sheathed single core cables are tested in accordance with this sub-clause, the efficacy of the spark testing equipment shall be determined by reference to the thickness of insulation only.

For the purposes of testing sheathed single core cables, all references in Part 2 Annex B to 'insulation', except where it refers to the determination of the diameter of the calibration hole (second sentence of sub-clause 2.2(d)), shall be interpreted as meaning the combination of insulation and sheathing.

2.6.2 Voltage test

Test requirements : The cable in the dry state and at ambient temperature shall withstand the test voltage applied as specified below without failure of the insulation.

Test voltage : The voltage shall be either derived from an a.c. source complying with Part 2, clause 1.7, or from a d.c. source.

The magnitude of the applied voltages shall be as follows:

Rated voltage U_o/U of the cable, V	Test Voltage, V	
	a.c. (r.m.s.)	d.c. Not less than
300/300	2 000	5 000
300/500	2 000	5 000
450/750	2 500	5 000

The voltage shall be applied between conductor and groups of conductors in such a way that the insulation on each core is tested against all adjacent cores and screen if any. The voltage shall be increased gradually and thereafter be maintained at the full value for 5 min.

2.7 Surface resistance of sheath

When specified in the particular part of HD 22 this test shall be carried out on cables with sheaths. It shall be carried out on three samples of complete cable, each about 250 mm in length.

The sheath of each of the samples shall be cleaned with spirit, and two electrodes consisting of wire helices applied at a distance of (100 ± 2) mm from each other. For the helices, copper wire of between 0,2 and 0,6 mm diameter shall be used. After the wire has been applied, the surface of the sheath shall again be thoroughly cleaned between the electrodes.

The samples shall then be conditioned at a temperature of (20 ± 2)°C, and a relative humidity of (65 ± 5)%, for 24 hours.

Immediately after removal from the conditioning chamber, a d.c. voltage of between 100 and 500 V shall be applied between the wire electrodes, and the resistance measured one minute after application of the voltage.

The measured resistance for each sample in ohms shall be multiplied by a/100, where a is the circumference of the sheath of the sample in mm. The median of the three values so obtained is recorded as the surface resistance of the sheath, and shall not be lower than 10^9 ohms.

3. Tests of mechanical strength of completed flexible cables

3.1 Flexing test

3.1.1 General

The requirements are given in Part 1, sub-clause 5.6.3.1.

This test is not applicable to flexible cables with cores of nominal cross sectional area greater than 4mm² and also not to cables having more than 18 cores laid up in more than two concentric layers.