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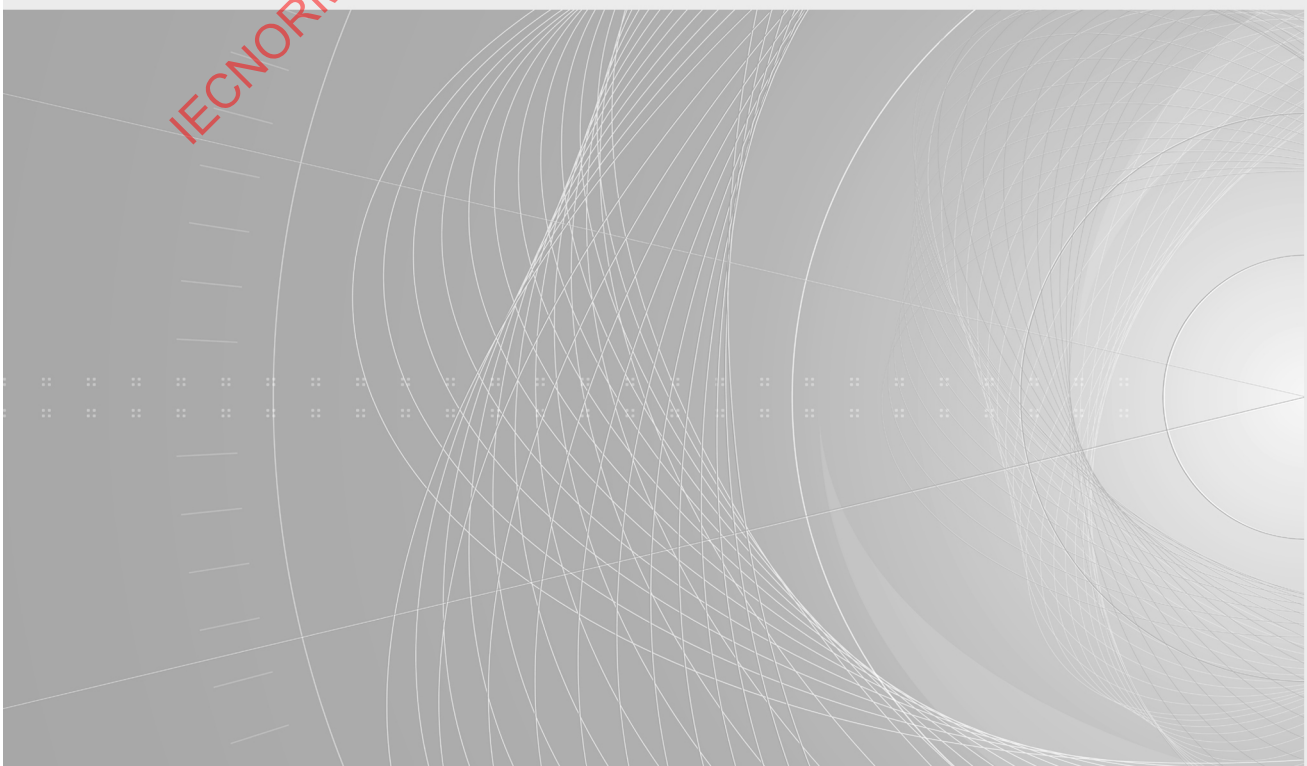
Edition 1.0 2017-11

INTERNATIONAL STANDARD

Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV – Part 2: Test methods



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Part 2: Test methods

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CHARGING CABLES FOR ELECTRIC VEHICLES OF RATED VOLTAGES UP TO AND INCLUDING 0,6/1 kV –

Part 2: Test methods

FOREWORD

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International Standard IEC 62893-2 has been prepared by IEC technical committee 20: Electric cables.

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

FDIS	Report on voting
20/1763/FDIS	20/1774/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62893 series, published under the general title *Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

CHARGING CABLES FOR ELECTRIC VEHICLES OF RATED VOLTAGES UP TO AND INCLUDING 0,6/1 kV –

Part 2: Test methods

1 Scope

This part of IEC 62893 specifies test methods which are particular for cables with extruded insulation and sheath having a voltage rating of up to and including 0,6/1 kV AC or up to and including 1 500 V DC for flexible applications under harsh conditions for the power supply between the electricity supply point or the charging station and the electric vehicle (EV).

General requirements are specified in IEC 62893-1 and particular types of cables are specified in IEC 62893-3 and the intended future IEC 62893-4 on DC charging.

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 60811-501:2012, *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 60811-506, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 506: Mechanical tests – Impact test at low temperature for insulations and sheaths*

IEC 62893-1, *Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV – Part 1: General requirements*

ISO 1817, *Rubber vulcanized or thermoplastic – Determination of the effect of liquids*

ISO 6722-1, *Road vehicles – 60 V and 600 V single-core cables – Part 1: Dimensions, test methods and requirements for copper conductor cables*

ISO 22241-1, *Diesel engines – NOx reduction agent AUS 32 – Part 1: Quality requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62893-1 apply.

ISO and IEC 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 Pre-conditioning

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

4.2 Test temperature

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

4.3 Test voltage

Unless otherwise specified in the individual clause of this document or in the product standard, the test voltage shall be AC of approximately sine wave form and of frequency between 49 Hz and 61 Hz. The ratio of peak value to r.m.s. value shall be equal to √2 with a tolerance of ± 7 %.

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

4.4 Test values

Full test conditions (such as temperatures, durations, etc.) and full test requirements are not specified in this document; it is intended that they should be specified by the standard dealing with the relevant type of cable.

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 Test methods

5.1 Electrical test methods

5.1.1 Long term resistance of insulation to DC

5.1.1.1 Test sample

Carry out the test on a sample of cable of 5 m length from which all coverings have been removed.

Take care to avoid damage to the core(s) during removal of the coverings.

5.1.1.2 Procedure

Immerse the sample for (240 ± 2) h at (85 ± 2) °C in an aqueous solution of sodium chloride having a concentration of 30 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 600 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.

5.1.1.3 Requirement

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.

5.2 Weathering/UV resistance test

5.2.1 General

This test is to determine the UV stability of the sheathing material of the cable in the condition as manufactured. This is done by assessment of cracks in the condition as manufactured and after exposure to ultraviolet light and water.

NOTE Additional information on weathering/UV resistance testing can be found in ISO 4892-1 (2000) and ISO 4892-2.

5.2.2 Apparatus

The testing apparatus is equipped with the following:

– a ray source consisting of a xenon arc lamp with borosilicate filters so that the typical irradiance should be 43 W/m^2 ± 15 % with a spectrum between 300 nm and 400 nm;

– a means to provide automatic control of temperature, humidity and cycles;

– a generator of deionised water with a conductivity not greater than 5 µS/cm; the rate of flow should be sufficient to guarantee that all the test specimens can be washed;

– a means to control the irradiance.

5.2.3 Procedure

A sample of the finished cable shall be selected to prepare 10 test pieces in accordance with IEC 60811-501.

Five test pieces shall be exposed to the treatment for 720 h in 360 cycles of 120 min defined as follows:

a) 102 min of dry radiation exposure at a temperature of (60 ± 3) ºC and relative humidity of (50 ± 10) %, followed by

b) 18 min of rain exposure, without radiation, at a temperature of (50 ± 3) ºC without control of the relative humidity.

After the exposure, the test specimens shall be removed from the equipment and conditioned at ambient temperature for at least 16 h.

5.2.4 Requirements

The five exposed test pieces and the five not exposed test pieces shall be tested separately and in close succession for tensile strength and elongation at break. The respective median values shall be calculated from the five tensile-strength and elongation at break values obtained for the conditioned test pieces and shall be divided by the median values of the five tensile-strength and elongation at break values obtained for the unconditioned test pieces.

It is required that the tensile-strength and elongation at break after 720 h (360 cycles) of exposure is at least 70 % of the values measured on not exposed test pieces.

5.3 Resistance against chemicals

5.3.1 Test conditions

A piece of completed cable shall be immersed for 1 h in test-medium defined in Table 1 at room temperature. The testing shall be performed between 24 h and 48 h after the end of immersion.

Table 1 – Test-medium for resistance against chemicals

1	2
Item	**Test-medium**
1	Lubricating oil engine severe duty Diesel & gasoline service (15W40)
2	Brake fluid, automotive polyglycol base; ISO 6722-1
3	Hydraulic fluid synthetic; ISO 6722-1
4	Gasoline automotive unleaded; ISO 1817
5	Urea solution(32,5 %) in acc. with ISO 22241-1
6	Diesel fuel ISO 6722-1 Table 15
7	Anti freezing agent, Ethylenglycol ($C_2H_6O_2$) – water (mixing 1:1)
8	Solvent cleansing compound, for example: P3-Solvclean AK (Fa. Henkel)

5.3.2 Requirements to resistance against chemicals

The tested cable shall show no crack when examined with normal or corrected vision without magnification after bending around a mandrel with a diameter of five times the outer diameter of the cable or smaller.

5.4 Water resistance test

5.4.1 General

Test pieces shall be prepared according to 4.3 of IEC 60811-501:2012. The cross-sectional area of the test pieces shall be determined before immersion in water.

5.4.2 Procedure

The test pieces shall be immersed in deionised (or distilled) water at the temperature and for the time specified in the particular specification. At the end of the immersion time, the test pieces shall be removed from the water and suspended in air at ambient temperature avoiding direct sunlight for at least 16 h but not more than 24 h.

The test pieces shall be subjected to the tensile strength test procedure as per IEC 60811-501.

5.4.3 Requirements

The percentage of the maximum variation for the tensile strength, the percentage of the minimum of the elongation at break and the percentage of the maximum variation of the elongation at break shall be determined.

The results shall be in accordance with the requirements specified in the particular specification.

5.5 Tear resistance test

5.5.1 Sampling and preparation of the test piece

Take a sample of the sheath from the cable and prepare three test specimens, having the dimensions shown in Figure 1, by accurately cutting or punching them from the sample.

For cables having an outer diameter less than 10 mm, the width of the test piece may be approximately equal to the circumference of the sheath.

NOTE Due to the relatively small outer diameter and the nature of the material, it is not possible to prepare flat test pieces.

Using a sharp blade, make a central longitudinal cut, as shown in Figure 1, perpendicular to the width of the test piece. Where grooves caused by the cores are present, make the cut at the thinnest part of one of the grooves nearest the centre of the test specimen.

Determine the mean thickness of each test piece from three measurements taken at points equidistant along the expected tear length.

5.5.2 Conditioning of test pieces

Before commencing the test, all test pieces shall be kept for at least three hours at the temperature of (20 ± 5) °C.

5.5.3 Test procedure

Place one half of the split end of the test piece as shown in Figure 2, in the jaws of a tensile testing machine.

Separate the jaws at a rate of (250 ± 50) mm/min.

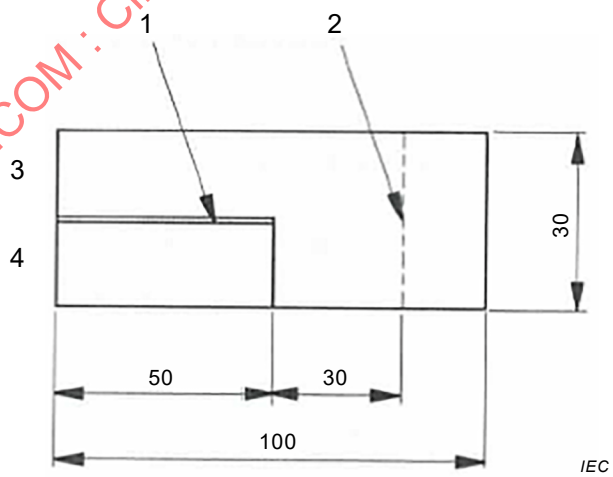
5.5.4 Expression of results

If the tear reaches the marker-line indicated in Figure 1 the test shall be deemed valid. If the tear runs towards one of the sides of the test piece before this marker-line, it shall be ignored. At least two valid results shall be obtained otherwise more test pieces shall be prepared and tested.

The tear resistance of each test piece shall be determined by dividing the maximum tear load, in N, by the mean thickness in mm.

The value of the tear resistance recorded shall be the mean value of the valid values obtained.

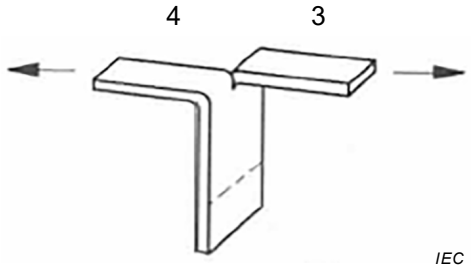
Dimensions in millimetres



Key

1	Cut	3	Upper section for clamping
2	Marker line	4	Lower section for clamping

Figure 1 – Test piece for tear resistance test



Key

3 Upper section for clamping 4 Lower section for clamping

Figure 2 – Test piece before being placed in the jaws of the tensile testing machine

5.6 Determination of saponification value

5.6.1 Definitions

5.6.1.1 Saponification value

The quantity of potassium hydroxide, expressed in mg, and required for the saponification of 1 g of the sample being examined.

5.6.1.2 Saponification

The formation of alkali salts, regardless of the form in which the corresponding acids occur.

5.6.2 Test equipment and material

- 250 ml flask with ground-in stopper, narrow necked with standard ground joint
- Reflux condenser, standard ground joint
- Burette
- Accurate laboratory balance reading to 0,1 mg
- Electrically heated heating cabinet with natural air flow
- Electrically heated water bath
- Caustic potash solution, c(KOH) 0,5 mol/l, ethanolic
- Hydrochloric acid solution, c(HCl) 0,5 mol/l
- Phenolphthalein, 1 % in ethanol
- Tetrahydrofuran, stabilised with 2,6 Di-tert-butyl-4 methylphenol
- Boiling stones or similar
- Distilled or deionised water

5.6.3 Preparation

The sample shall be taken from the test specimen. The sample shall be sufficient for at least two tests.

5.6.4 Test procedure

Using the accurate laboratory balance approximately 0,5 g of finely granulated material are weighed into the 250 ml flask with ground-in stopper to the nearest 0,001 g (quantity E). After addition of 50 ml of tetrahydrofuran, the flask is sealed with the ground-in stopper and placed in the heating cabinet at a temperature of 60 °C until the sample has completely dissolved. Shaking of the flask from time to time can speed up the dissolving process. Then 25 ml of caustic potash solution shall be added from a burette along with some boiling stones. The sample is saponified for 3 h in the water bath under reflux and at boiling temperature.

Immediately afterwards and without cooling, after addition of 50 ml of distilled water and three drops of phenolphthalein solution, back titration is performed with hydrochloric acid (consumption a). A blank test shall be carried out in the same way (consumption b). The test shall be carried out on a least two samples.

5.6.5 Evaluation of test result

The saponification value of mg KOH/g shall be calculated according the following numerical equation:

$$\text{saponification value} = \frac{(b - a) \times 28{,}05}{E}$$

where

a = consumption in ml of hydrochloric acid solution c(HCl) = 0,5 mol/l in titration of the sample

b = consumption in ml of hydrochloric acid solution c(HCl) = 0,5 mol/l in the blank test

E = weight in g

5.6.6 Requirement

The saponification value shall not exceed the maximum figure in the relevant cable standard.

5.7 Crush resistance test

5.7.1 General

This test specifies the method for determining resistance to crushing.

NOTE The cable usage has a risk of being exposed to drive over situations.

5.7.2 Test conditions – Apparatus

The apparatus shall consist of

a) a power-driven compression machine provided with a device to measure and indicate the compression force at rupture accurate to 2 % or better of the value read. The machine shall be capable of operating at a power-actuated jaw speed of 10 ± 1 mm/min;

b) two flat steel plates 50 mm wide;

c) a 20 mm diameter solid steel drill rod of the same length as the plate mounted to one of the steel plates; and

d) a power supply 30 V DC or less, with a means of indicating contact between the conductor and the steel plate or drill rod.

5.7.3 Test conditions – Preparation of specimens

The test specimen shall be taken from a sample of finished wire or cable, or from the wire or cable during manufacture without any conditioning. The specimen shall be a minimum of 2 500 mm in length. One end of the conductor shall be made bare.

The bare end of the specimen shall be connected to one side of the power supply. Both plates shall be connected to the other side of the power supply.

5.7.4 Test conditions – Method

Each steel plate shall be mounted horizontally in the compression machine. The longitudinal axes of the plates shall be in the same vertical plane. The specimen, apparatus, and surrounding air shall be in thermal equilibrium at room temperature. The test specimen shall be laid over the steel rod.