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Edition 1.1 2020-11
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INTERNATIONAL STANDARD

colour inside

Charging cables for electric vehicles for rated voltages up to and including 0,6/1 KV –
Part 1: General requirements

IEC 62893-1:2017-11+AMD1:2020-11 CSV(en)

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Part 1: General requirements

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 1: General requirements

FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 62893-1 edition 1.1 contains the first edition (2017-11) [documents 20/1761/FDIS and 20/1772/RVD] and its amendment 1 (2020-11) [documents 20/1916/CDV and 20/1933/RVC].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 62893-1 has been prepared by IEC technical committee 20: Electric cables.

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 the base publication and its amendment will remain unchanged until the stability 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- withdrawn,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.

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

Part 1: General requirements

1 Scope

This part of IEC 62893 specifies construction, dimensions and test requirements 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 of the charging station and the electric vehicle (EV).

The EV charging cable is intended to supply power and, if needed, communication (for details see the IEC 62196 series and IEC 61851-1) to an EV or plug-in hybrid vehicle (PHEV). The charging cables are applicable for charging modes 1 to 4 of IEC 61851-1. Ordinary duty cables with rated voltage 300/500 V are only permitted for charging mode 1 of IEC 61851-1. Maximum conductor temperature for the cables in this part of IEC 62893 is 90 ºC.

The particular types of cables are specified in IEC 62893-3 (modes 1 to 3 for AC charging) and in the future IEC 62893-4 (mode 4 for DC charging).

These parts are collectively referred to hereafter as “the particular specifications”.

The test methods specified are given in IEC 62893-2, IEC 60245-2, IEC 60332-1-2, IEC 62821-1:2015, Annex B, and in the relevant parts of IEC 60811, as listed in the normative references.

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 60245-2:1994, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 2: Test methods*

IEC 60228:2004, *Conductors of insulated cables*

IEC 60332-1-2:2004, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*
IEC 60332-1-2:2004/AMD1:2015

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

IEC 60811-403, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 403: Miscellaneous tests – Ozone resistance test on cross-linked compounds*

IEC 60811-404, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths*

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 60811-505:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: Mechanical tests – Elongation at low temperature for insulations and sheaths*

IEC 60811-507, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 507: Mechanical tests – Hot set test for cross-linked materials*

IEC 60811-508:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths*

IEC 60811-509, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)*

IEC 62821-1:2015, *Electric cables – Halogen-free, low smoke, thermoplastic insulated and sheathed cables of rated voltages up to and including 450/750 V – Part 1: General requirements*

IEC 62893-2:2017, *Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV – Part 2: Test methods*

ISO 48, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 7619-1, *Rubber, vulcanized or thermoplastic – Determination of indentation hardness – Part 1: Durometer method (Shore hardness)*

ISO 14572:2011, *Road vehicles – Round, sheathed, 60 V and 600 V screened and unscreened single or multi-core cables – Test methods and requirements for basic- and high-performance cables*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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

3.1 Definitions relating to insulating and sheathing materials

3.1.1
halogen-free compound
compound not containing halogens which meets the requirements given in this document

3.1.2
type of compound
category in which a compound is placed according to its properties, as determined by specific tests

Note 1 to entry: The type designation is not directly related to the composition of the compound.

3.1.3
EVI
designation of insulation compound for cables in this document

3.1.4
EVM
designation of sheathing compound for cables in this document

3.1.5
control core (CC) and pilot core (CP)
designation for those cores in the cable that serve the basic control function to operate an EV supply system

Note 1 to entry: For further information see IEC 61851-1.

3.2 Definitions relating to the tests

3.2.1
type tests (symbol *T*)
tests required to be carried out before supplying a type of cable covered by this document on a general commercial basis in order to demonstrate satisfactory performance characteristics to meet the intended application

Note 1 to entry: Type 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 or design which might change the performance characteristics.

3.2.2
sample tests (symbol *S*)
tests carried out on samples of completed cable or components taken from a completed cable, adequate to verify that the finished product meets the design specifications

3.2.3
routine test (symbol *R*)
tests carried out by the manufacturer on each manufactured length of cable to check that each length meets the specified requirements

4 Code designation

The cables shall be marked, for example: IEC 62893 IEC 121.

NOTE The code designations for specific cable types are given in the particular specification, for instance in IEC 62893-3.

5 Rated voltage

The rated voltage of a cable is the reference voltage for which the cable is designed.

The rated voltage in an alternating current system is expressed by the combination of two values U_0/U, expressed in volts, where:

a) U_0 is the r.m.s. value between any insulated conductor and “earth” (metal covering of the cable or the surrounding medium);

b) U is the r.m.s. value between any two phase conductors of a multicore cable or of a system of single core cables.

In an alternating current system, the rated voltage of a cable or cord shall be at least equal to the nominal voltage of the system for which it is intended. This condition applies to the values of both U_0 and U.

The maximum permanent operating voltage of the system (AC or DC) is stated in Table 1.

Table 1 – Examples of maximum permitted voltages against rated voltage of cable

Rated voltage of cable	Maximum permanent permitted operating voltage of the system			
	AC	3-phase AC	DC	
U_0/U	Conductor-earth	Conductor-conductor	Conductor-earth	Conductor-conductor
	U_0 max	U max		
300/500 V	320 V	550 V	410 V	820 V
450/750 V	480 V	825 V	620 V	1240 V
0,6/1 kV	0,7 kV	1,2 kV	0,9 kV	1,8 kV

6 Marking

6.1 Indication of origin

Cables shall be provided with an indication of the manufacturer, which shall be either an identification thread or a repetitive marking of the manufacturer's name or trademark.

Marking may be by printing or by reproduction in relief on or in the insulation or sheath.

6.2 Continuity of marks

Each specified mark shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed

– 550 mm if the marking is on the outer sheath of the cable;

– 275 mm if the marking is on the insulation or on a tape within the sheathed cable.

6.3 Durability

Printed markings shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of IEC 60245-2:1994.

6.4 Legibility

All markings 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 suitable solvent.

7 Core identification

7.1 General

Each power core shall be identified as specified in 7.2.

Each pilot, control, or any other additional core shall be identified as specified in 7.2 or 7.3.

7.2 Identification by colours

7.2.1 General requirements

Identification of the cores of a cable shall be achieved by the use of coloured insulation.

Each power core of a cable shall have only one colour, except the core identified by a combination of the colours green and yellow.

The colour of control (CC), pilot (CP) or any other additional core shall be clearly identified and different to the power cores.

The colours green and yellow, when not in combination, shall not be used.

7.2.2 Colour scheme for power cores

The preferred colour scheme (AC cables):

– three-core cable: green and yellow, blue, brown;
– four-core cable: green and yellow, brown, black , grey;
– five-core cable: green and yellow, blue, brown, black, grey.

The preferred colour scheme (DC cables):

– two-core cable: no preferred colour scheme
– three-core cable: green and yellow, no preference for other cores

The colours shall be clearly identifiable and durable. Durability shall be checked by the test given in 1.8 of IEC 60245-2:1994.

7.2.3 Colour combination green and yellow

The distribution of the colours for the core coloured green and yellow shall comply with the following condition: for every 15 mm length of core, one of these colours shall cover at least 30 % and not more than 70 % of the surface of the core, the other colour covering the remainder.

NOTE Information on the use of the colours green and yellow, and blue. It is understood that the colours green and yellow, when they are combined as specified above, are recognized exclusively as a means of identification of the core intended for use as earth connection or similar protection, and that the colour blue is intended for the identification of the core intended to be connected to neutral.

7.3 Core identification by numbers

7.3.1 General requirements

The colour of control (CC), pilot (CP) or any other core shall be clearly identified and different to the power cores.

The insulation of the cores shall be of the same colour and numbered sequentially, starting at number 1.

The numbers shall be printed in arabic numerals on the outer surface of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of the insulation. The numerals shall be legible.

7.3.2 Preferred arrangement of marking

The numbers shall be repeated, at regular intervals along the core, consecutive numbers being inverted in relation to each other.

When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing *d* between consecutive numbers shall not exceed 50 mm.

The arrangement of the marks is shown in Figure 1.

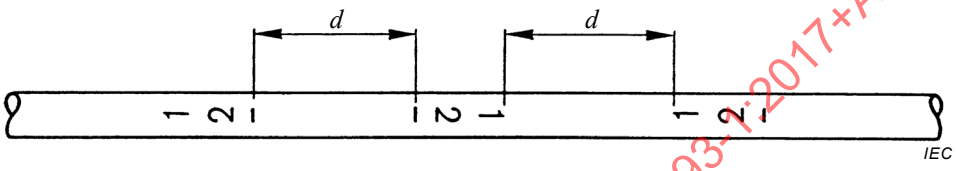

Figure 1 – Core marking by numbers

7.3.3 Durability

Printed numerals shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of IEC 60245-2:1994.

8 General requirements for the construction of cables

8.1 Conductors

8.1.1 Material

The conductors shall consist of annealed copper. The wires may be plain or tinned.

8.1.2 Construction

The conductor shall comply with Class 5, according to IEC 60228.

8.1.3 Check on construction

Compliance with the requirements of 8.1.1 and 8.1.2, including the requirements of IEC 60228, shall be checked by inspection and by measurement.

8.1.4 Electrical resistance

The resistance of each conductor at 20 °C shall be in accordance with the requirements of IEC 60228 for the given class of the conductor.

Compliance shall be checked by the test given in IEC 60228:2004, Annex A.

8.2 Sizes of cable

The sizes of cable shall be:

a) Power cores 300/500 V: 1,5 mm^2 and 2,5 mm^2 to 3 core.

b) Power cores 450/750 V: 1,5 mm^2 to 35 mm^2 to 3, 4 and 5 core.

c) Power cores 0,6/1 kV: 10 mm² to 95 mm² to 2 and 3 core (DC only)

d) Pilot or control cores: minimum 0,5 mm^2 to number not specified. Size of these core(s) shall be different from size of power cores.

8.3 Insulation

8.3.1 Material

The insulation shall be a compound of the types specified in Table 2. The insulation of power cores shall be compound EVI-2. The insulation of pilot, control and any other additional cores shall be compound EVI-1 or EVI-2.

Insulation resistance shall be in accordance with the specified values in the particular specifications.

The test requirements for these compounds are specified in Table 2.

8.3.2 Application to the conductor

The insulation shall be so applied that it fits closely on the conductor. However it shall be possible to remove the insulation without damaging the insulation, the conductor, or the tin coating if any.

It is permitted to place a separator between the conductor and the insulation.

Compliance shall be checked by inspection and by manual test.

8.3.3 Thickness

The mean value of the thickness of insulation shall be not less than the specified value for each type and size of cable shown in the particular table in the particular specifications. The thickness at any point may be less than the specified value provided that the difference does not exceed 0,1 mm + 10 % of the specified value.

For pilot and control cores and any other core other than power cores up to and including 0,75 mm^2 the minimum wall thickness shall not be less than 0,33 mm. For pilot and control cores and any other core other than power cores of 1,0 mm^2 the minimum wall thickness shall not be less than 0,41 mm. For bigger cross sections see corresponding tables in the particular specifications.

Compliance shall be checked by the test given in 1.9 of IEC 60245-2:1994.

8.3.4 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 in Table 2.

The applicable test methods and the results to be obtained are specified in Table 2.

Table 2 – Requirements for insulating compounds

1	2	3	4	5	6	7
Ref. No.	**Test**	**Unit**	**Type of compound**		**Test method described in**	
			EVI-1	**EVI-2**	**IEC**	**Clause**
1	**Tensile strength and elongation at break**				60811-501	
1.1	Properties in the state as delivered					
1.1.1	Values to be obtained for the tensile strength:					
	– median, min.	N/mm^2	15,0	8,0		
1.1.2	Values to be obtained for the elongation at break:					
	– median, min.	%	300	200		
1.2	Properties after ageing in air oven				60811-401 and 60811-501	
1.2.1	Ageing conditions:					
	– temperature	°C	135 ± 2	135 ± 2		
	– duration of treatment	h	7 x 24	7 x 24		
1.2.2	Values to be obtained for the tensile strength:					
	– variation [a], max.	%	±30	±30		
1.2.3	Values to be obtained for the elongation at break:					
	– variation [a], max.	%	±30	±30		
2	**Hot set test**				60811-507	
2.1	Test conditions:					
	– temperature	°C	–	200 ± 3		
	– time under load	min	–	15		
	– mechanical stress	N/cm^2	–	20		
2.2	Values to be obtained:					
	– elongation under load, max.	%	–	100		
	– permanent elongation after cooling, max.	%	–	25		
3	**Pressure test at high temperature**				60811-508	
3.1	Test conditions:					
	– temperature	°C	120 ± 2	–		
3.2	Values to be obtained:					
	– median of the depth of indentation, max.	%	50	–		
4	Bending at low temperature				60811-504	
	For core diameter ≤ 12,5 mm					
4.1	Test conditions:					
	– temperature	°C	-40 ± 2	-40 ± 2		
	– duration of treatment		See 4.2 of IEC 60811-504:2012			
4.2	Values to be obtained:		No cracks			

1	2	3	4	5	6	7
Ref. No.	**Test**	**Unit**	**Type of compound**		**Test method described in**	
			EVI-1	**EVI-2**	**IEC**	**Clause**
5	**Elongation test at low temperature**				60811-505	
	For core diameter > 12,5 mm					
5.1	Test conditions:					
	– temperature	°C	-40 ± 2	-40 ± 2		
	– duration of treatment		See 4.2 of IEC 60811-505:2012			
5.2	Values to be obtained:					
	– elongation at break, min.	%	30	30		
6	**Hardness**					
6.1	Values to be obtained [b]		≥ 50 (Shore D)	≥ 80 (IRHD)	ISO 7619-1 ISO 48	

[a] Variation: difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

[b] Test can be performed on pressed plaques where it is not possible to use extruded insulation (pilot and control cores)

8.4 Filler (optional)

8.4.1 Material

Fillers when used shall be composed of one of the following or of any combination of the following:

– compound; or
– natural or synthetic textiles; or
– paper.

When a compound is used as filler, there shall be no harmful interactions between its constituents and the insulation and/or the sheath. Compliance with this requirement shall be checked by the compatibility test given in Annex A.

8.4.2 Application

The fillers shall fill the spaces between the cores giving the assembly a practically circular shape. The fillers shall not adhere to the cores. The assembly of cores and fillers may be held together by film or tape.

8.5 Assembly

The cores shall be twisted together.

A tape may be applied around the core assembly before application of the sheath.

8.6 Metallic screen (optional)

A metallic screen, consisting of a braid of plain or tinned copper wires, may be included in the construction. A suitable filler or tape shall be applied between assembly of cores and the metallic screen.

Requirements for the metallic screen shall be agreed between manufacturer and customer.

8.7 Sheath

8.7.1 Material

The sheath shall be a compound of the types specified in Table 3.

The test requirements for these compounds are specified in Table 3.

8.7.2 Application

The sheath shall be extruded in a single layer on the assembly of cores and fillers or screen, if any.

The sheath shall not adhere to the cores. A separator, consisting of a film or tape, may be placed under the sheath.

In certain cases, the sheath may penetrate into the spaces between the cores, thus forming a filler (see 8.4.2).

8.7.3 Thickness

The mean value of the thickness shall not be less than the specified value for each type and size of cable shown in the tables of the specific part of these standards.

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, unless otherwise specified.

Compliance shall be checked by the test given in 1.10 of IEC 60245-2:1994.

8.7.4 Mechanical properties before and after ageing

The sheath 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 in Table 3.

Table 3 – Requirements for the non-electrical test for sheathing compounds

1	2	3	4	5	6	7	8
Ref. No.	Test	Unit	Type of compound			Test method described in	
			EVM-1	EVM-2	EVM-3	IEC	Clause
1	**Tensile strength and elongation at break**					60811-501	
1.1	Properties in the state as delivered						
1.1.1	Values to be obtained for the tensile strength:						
	– median, min.	N/mm^2	20,0	10,0	10,0		
1.1.2	Values to be obtained for the elongation at break:						
	– median, min.	%	300	150	300		
1.2	*Properties after ageing in air oven*					60811-401 and -501	
1.2.1	Ageing conditions:						
	– temperature	°C	110 ± 2	130 ± 2	100 ± 2		
	– duration of treatment	h	7 x 24	7 x 24	7 x 24		
1.2.2	Values to be obtained for the tensile strength:						
	– variation [a], max.	%	±30	±30	±30		
1.2.3	Values to be obtained for the elongation at break:						
	– median, min.	%	300	-	250		
	– variation [a], max.	%	±30	±30	±40		
1.3	*Properties after immersion in mineral oil*					60811-404	
1.3.1	Ageing conditions:						
	– temperature	°C	100 ± 2	100 ± 2	100 ± 2		
	– duration of treatment	h	7 x 24	7 x 24	7 x 24		
1.3.2	Values to be obtained for the tensile strength:						
	– variation [a], max.	%	±40	±40	±40		
1.3.3	Values to be obtained for the elongation at break:						
	– median, min.	%	300	–	-		
	– variation [a], max.	%	±30	±40	±40		
2	**Hot set test**					60811-507	
2.1	Test conditions:						
	– temperature	°C	–	250 ± 3	250 ± 3		
	– time under load	min	–	15	15		
	– mechanical stress	N/cm^2	–	20	20		
2.2	Values to be obtained:						
	– elongation under load, max.	%	–	100	175		
	– permanent elongation after cooling, max.	%	–	25	15		

1	2	3	4	5	6	7	8
Ref. No.	**Test**	**Unit**	**Type of compound**			**Test method described in**	
			EVM-1	**EVM-2**	**EVM-3**	**IEC**	**Clause**
3	**Pressure test at high temperature**					60811-508	
3.1	Test conditions:						
	– temperature	°C	100 ± 2		- -		
3.2	Values to be obtained:						
	– median of the depth of indentation, max.	%	50		-		
4	**Bending at low temperature**					60811-504	
	For overall cable diameter ≤ 12,5 mm						
4.1	Test conditions:						
	– temperature	°C	-40 ± 2	-40 ± 2	-35 ± 2		
	– duration of treatment		See 4.2 of IEC 60811-504:2012				
4.2	Values to be obtained:						
	– elongation at break, min.		No cracks				
5	**Elongation test at low temperature**					60811-505	
	For overall cable diameter > 12,5 mm						
5.1	Test conditions:						
	– temperature	°C	-40 ± 2	-40 ± 2	-40 ± 2		
	– duration of treatment		See 4.2 of IEC 60811-505:2012				
5.2	Values to be obtained:						
	– elongation at break, min.	%	30	30	30		
6	**Heat shock test**					60811-509	
6.1	Test conditions:						
	– temperature	°C	150 ± 2	–	–		
	– duration of treatment	h	1	–	–		
6.2	Values to be obtained		No cracks	–	–		
7	**Water resistance test**					62893-2	5.4
7.1	Test conditions:						
	– temperature	°C	80 ± 2	70 ± 2	70 ± 2		
	– time under load	h	7 x 24	7 x 24	7 x 24		
7.2	Values to be obtained:						
	– median, elongation at break, min.	%	300	–	–		
	– variation, elongation at break, max.	%	±30	±30	±30		
	– variation, tensile strength, max.	%	±30	±30	±30		

1	2	3	4	5	6	7	8
Ref. No.	**Test**	**Unit**	**Type of compound**			**Test method described in**	
			EVM-1	**EVM-2**	**EVM-3**	**IEC**	**Clause**
8	**Ozone resistance**					60811-403	
8.1	Test conditions:						
	– temperature	°C	40 ± 2	40 ± 2	40 ± 2		
	– relative humidity	%	55 ± 5	55 ± 5	55 ± 5		
	– duration of treatment	h	72	72	72		
	– ozone concentration (by volume)	%	(200 ± 50) x 10^{-6}	(200 ± 50) x 10^{-6}	(200 ± 50) x 10^{-6}		
8.2	Results to be obtained:		Absence of cracks				
9	**Tear resistance**					62893-2	5.5
9.1	Values to be obtained:						
	– mean value, min .	N/mm	25	10	10		
10	**Determination of saponification value**					62893-2	5.6
	Mean value to be obtained, max	mg of KOH/g	200	-	-		
11	**Resistance against acid and alkaline solution of outer sheath**					60811-404	
11.1	Test conditions:						
	Acid: 1 Normal-oxalic-acid or acetic acid						
	Alkaline solution: 1Normal-sodium hydroxide solution						
	– temperature	°C	23 ± 2	23 ± 2	23 ± 2		
	– duration	h	~~5~~ 168	~~5~~ 168	~~5~~ 168		
11.2	Values to be obtained:						
	variation, tensile strength, max	%	± 40	± 40	± 40		
	median, elongation at break, min	%	100	100	100		
12	**Weathering/UV resistance of outer sheath**					62893-2	5.2
12.1	Test conditions		See 5.2.3 of IEC 62893-2				
12.2	Results to be obtained:		See 5.2.4 of IEC 62893-2				

a) Variation: difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

8.8 Tests on completed cables

8.8.1 Electrical properties

The cables shall have adequate dielectric strength and insulation resistance.

Compliance shall be checked by carrying out the tests specified in Table 4.

Table 4 – Requirements for electrical tests

1	2	3	4	5	6	7	8
Ref. No.	**Tests**	**Unit**	**Rated voltage of cables**			**Test method described in**	
			300/500 V	**450/750 V**	**0,6/1 kV**	**IEC standard**	**(Sub)clause**
1	**Measurement of the resistance of conductors**					60245-2	2.1
1.1	Values to be obtained		See IEC 60228				
2	**Voltage test on completed cable:**					60245-2	2.2
2.1	Test conditions:						
	– minimum length of the sample	m	10	10	10		
	– minimum period of immersion in water	h	1	1	1		
	– temperature of the water	°C	20 ± 5	20 ± 5	20 ± 5		
2.2	~~Voltage applied~~ Applied voltage (AC)	V	2 000	2 500	3 500		
	or						
	~~Voltage applied~~ Applied voltage (DC)	V	4 000	5 000	7 000		
2.3	Duration of each application of voltage, min.	min	5	5	5		
2.4	Results to be obtained		No breakdown				
3	**Voltage test on cores**					60245-2	2.3
3.1	Test conditions:						
	– length of the sample	m	5	5	5		
	– minimum period of immersion in water	h	1	1	1		
	– temperature of the water	°C	20 ± 5	20 ± 5	20 ± 5		
3.2	~~Applied voltage (AC)~~						
	~~– up to and including 0,6 mm~~	~~V~~	~~1 500~~	~~-~~	~~-~~		
	~~– exceeding 0,6 mm~~	~~V~~	~~2 000~~	~~2 500~~	~~3 500~~		
	~~or~~						
	~~Applied voltage (DC)~~						
	~~– up to and including 0,6 mm~~	~~V~~	~~3 000~~	~~-~~	~~-~~		
	~~– exceeding 0,6 mm~~	~~V~~	~~4 000~~	~~5 000~~	~~7 000~~		
	Applied voltage (AC) on all cores	V	1 500	2 500	3 500		
	or						
	Applied voltage (DC) on all cores	V	3 000	5 000	7 000		
3.3	Duration of each application of voltage, min.	min	5	5	5		
3.4	Results to be obtained		No breakdown				

1	2	3	4	5	6	7	8
Ref. No.	**Tests**	**Unit**	**Rated voltage of cables**			**Test method described in**	
			300/500 V	**450/750 V**	**0,6/1 kV**	**IEC standard**	**(Sub)clause**
4	**Measurement of insulation resistance**					~~60245-2~~ 60227-2	2.4
4.1	Test conditions:						
	– length of the sample	m	5	5	5		
	– minimum period of immersion in hot water	h	2	2	2		
	– temperature of the water	°C	See tables in the particular specification				
4.3	Results to be obtained		See tables in the particular specification				
5	**Long term resistance of insulation to DC**		See IEC 62893-2			62893-2	5.1.1

8.8.2 Overall dimensions

The mean overall dimensions of the cables should be within the limits specified in the tables in the particular specifications.

The difference between any two values of the overall diameter of sheathed cables of the same cross-section (ovality) shall not exceed 15 % of the mean measured overall diameter.

8.8.3 Mechanical strength of flexible cables

8.8.3.1 General

The flexible cables shall be capable of withstanding bending and other mechanical stresses occurring in normal use.

Compliance shall be checked by the test given in 3.1 of IEC 60245-2:1994.

8.8.3.2 Flexing test for cables up to conductor cross section of 4 mm²

The test shall be carried out in accordance with 3.1 of IEC 60245-2:1994.

During the test with 30 000 cycles, i.e. 60 000 single movements, neither interruption of the current, short circuit between the conductors nor short circuit between the cores and the screen (if any) nor short circuit between the cables and pulleys (the flexing apparatus) shall occur.

After the required number of cycles, the sheath of the cable shall be examined under normal or corrected vision. There shall be no point at which any underlying component of the cable (for instance inner sheath, tapes, insulated cores, screen, etc) shall be visible through a break in the sheath. The sheath and the screen (if any) of the cable shall then be removed.

The cores from the cable without its sheath and screen (if any) shall then withstand the voltage test carried out in accordance with Ref.No.3 of Table 4.

8.8.3.3 Bending test for cables with conductor cross section larger than 4 mm²

The test shall be carried out in accordance with ISO 14572:2011, 5.9. The mechanical load exerted on the cable shall be according to Table 5.

Table 5 – Mechanical load for flexing test

1	2	3
Cross-section of power cores		Force
above	up to and including	
mm^2	mm^2	N
-	2,5	20
2,5	6	25
6	16	50
16	70	75
70	-	100

During the test with 10 000 bends, i.e. 20 000 single movements, neither interruption of the current nor short circuit between the conductors or between the conductors and the screen (if any) shall occur.

After the required number of cycles, the sheath of the cable shall be examined under normal or corrected vision. There shall be no point at which any underlying component of the cable (for instance inner sheath, tapes, insulated cores, screen, etc.) shall be visible through a break in the sheath. The sheath and the screen (if any) of the cable shall then be removed.

The cores from the cable without its sheath and screen (if any) shall then withstand the voltage test carried out in accordance with Ref. No. 3 of Table 4.

8.8.4 Tests under fire conditions

All the cables shall comply with the test specified in IEC 60332-1-2:2004 and IEC 60332-1-2:2004/AMD1:2015 and requirements as given in Annex A of this document.

8.8.5 Assessment of halogens

Halogen-free components of the cables shall comply with the test and requirements specified in Annex B of IEC 62821-1:2015.When using halogen-free materials, the value obtained for the conductivity test for material type EVM-1 shall be not higher than 35 µS/mm.

8.8.6 Shrinkage test

The test shall be carried out in accordance with IEC 60811-503.

The test conditions shall be:

– Temperature of (80 ± 2) ºC.
– Heating duration of 5 hours.

All the cables shall comply with a maximum shrinkage percentage of 4 %.

8.8.7 Compatibility test

All the cables shall comply with the test and requirements as given in Annex A of this document.

8.8.8 Cold impact test

All the cables shall comply with the test and requirements as given in 5.8 of IEC 62893-2:2017.

8.8.9 Crush resistance test

All the cables shall comply with the test and requirements as given in 5.7 of IEC 62893-2:2017.

Annex A
(normative)

Requirements for compatibility test

A.1 Test conditions

The sample shall be aged for 7 days at (100 ± 2) °C in accordance with IEC 60811-401.

A.2 Requirements

At the conclusion of the ageing period the insulation and sheath shall meet the requirements given in Table A.1.

Table A.1 – Requirements for compatibility test

1	2	3	4
Parameter	**Units**	**Insulation** **EVI-1 and EVI-2**	**Sheath** **EVM-1 or EVM-2 or EVM-3**
Tensile strength – variation [a], max	%	± 30	± 30
Elongation at break – variation [a], max	%	± 30	± 30

[a] The variation is the difference between the respective median values obtained prior to and after heat treatment, expressed as a percentage of the former.

Bibliography

IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 1: Cables for rated voltages of 1 kV (Um = 1,2 kV) and 3 kV (Um = 3,6 kV)*

IEC 61851-1, *Electric vehicle conductive charging system – Part 1: General requirements*

IEC 62440, *Electric cables with a rated voltage not exceeding 450/750 V – Guide to use*

IEC 62893-3, *Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV – Part 3: Cables for AC charging according to modes 1, 2 and 3 of IEC 61851-1 of rated voltages up to and including 450/750 V*

IEC 62893-4, *Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV – Part 4: Cables for DC charging according to mode 4 of IEC 61851-1 of rated voltage 0,6/1 kV*[1]

1 Under consideration.

IEC 62893-1

Edition 1.1 2020-11
CONSOLIDATED VERSION

FINAL VERSION

Charging cables for electric vehicles for rated voltages up to and including 0,6/1 KV –
Part 1: General requirements

IEC 62893-1:2017-11+AMD1:2020-11 CSV(en)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 1: General requirements

FOREWORD

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This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 62893-1 edition 1.1 contains the first edition (2017-11) [documents 20/1761/FDIS and 20/1772/RVD] and its amendment 1 (2020-11) [documents 20/1916/CDV and 20/1933/RVC].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

International Standard IEC 62893-1 has been prepared by IEC technical committee 20: Electric cables.

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 the base publication and its amendment will remain unchanged until the stability 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.

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

Part 1: General requirements

1 Scope

This part of IEC 62893 specifies construction, dimensions and test requirements 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 of the charging station and the electric vehicle (EV).

The EV charging cable is intended to supply power and, if needed, communication (for details see the IEC 62196 series and IEC 61851-1) to an EV or plug-in hybrid vehicle (PHEV). The charging cables are applicable for charging modes 1 to 4 of IEC 61851-1. Ordinary duty cables with rated voltage 300/500 V are only permitted for charging mode 1 of IEC 61851-1. Maximum conductor temperature for the cables in this part of IEC 62893 is 90 ºC.

The particular types of cables are specified in IEC 62893-3 (modes 1 to 3 for AC charging) and in the future IEC 62893-4 (mode 4 for DC charging).

These parts are collectively referred to hereafter as “the particular specifications”.

The test methods specified are given in IEC 62893-2, IEC 60245-2, IEC 60332-1-2, IEC 62821-1:2015, Annex B, and in the relevant parts of IEC 60811, as listed in the normative references.

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 60245-2:1994, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 2: Test methods*

IEC 60228:2004, *Conductors of insulated cables*

IEC 60332-1-2:2004, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*
IEC 60332-1-2:2004/AMD1:2015

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

IEC 60811-403, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 403: Miscellaneous tests – Ozone resistance test on cross-linked compounds*

IEC 60811-404, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths*

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 60811-505:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: Mechanical tests – Elongation at low temperature for insulations and sheaths*

IEC 60811-507, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 507: Mechanical tests – Hot set test for cross-linked materials*

IEC 60811-508:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths*

IEC 60811-509, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)*

IEC 62821-1:2015, *Electric cables – Halogen-free, low smoke, thermoplastic insulated and sheathed cables of rated voltages up to and including 450/750 V – Part 1: General requirements*

IEC 62893-2:2017, *Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV – Part 2: Test methods*

ISO 48, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 7619-1, *Rubber, vulcanized or thermoplastic – Determination of indentation hardness – Part 1: Durometer method (Shore hardness)*

ISO 14572:2011, *Road vehicles – Round, sheathed, 60 V and 600 V screened and unscreened single or multi-core cables – Test methods and requirements for basic- and high-performance cables*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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

3.1 Definitions relating to insulating and sheathing materials

3.1.1
halogen-free compound
compound not containing halogens which meets the requirements given in this document

3.1.2
type of compound
category in which a compound is placed according to its properties, as determined by specific tests

Note 1 to entry: The type designation is not directly related to the composition of the compound.

3.1.3
EVI
designation of insulation compound for cables in this document

3.1.4
EVM
designation of sheathing compound for cables in this document

3.1.5
control core (CC) and pilot core (CP)
designation for those cores in the cable that serve the basic control function to operate an EV supply system

Note 1 to entry: For further information see IEC 61851-1.

3.2 Definitions relating to the tests

3.2.1
type tests (symbol *T*)
tests required to be carried out before supplying a type of cable covered by this document on a general commercial basis in order to demonstrate satisfactory performance characteristics to meet the intended application

Note 1 to entry: Type 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 or design which might change the performance characteristics.

3.2.2
sample tests (symbol *S*)
tests carried out on samples of completed cable or components taken from a completed cable, adequate to verify that the finished product meets the design specifications

3.2.3
routine test (symbol *R*)
tests carried out by the manufacturer on each manufactured length of cable to check that each length meets the specified requirements

4 Code designation

The cables shall be marked, for example: IEC 62893 IEC 121.

NOTE The code designations for specific cable types are given in the particular specification, for instance in IEC 62893-3.

5 Rated voltage

The rated voltage of a cable is the reference voltage for which the cable is designed.

The rated voltage in an alternating current system is expressed by the combination of two values U_0/U, expressed in volts, where:

a) U_0 is the r.m.s. value between any insulated conductor and “earth” (metal covering of the cable or the surrounding medium);

b) U is the r.m.s. value between any two phase conductors of a multicore cable or of a system of single core cables.

In an alternating current system, the rated voltage of a cable or cord shall be at least equal to the nominal voltage of the system for which it is intended. This condition applies to the values of both U_0 and U.

The maximum permanent operating voltage of the system (AC or DC) is stated in Table 1.

Table 1 – Examples of maximum permitted voltages against rated voltage of cable

Rated voltage of cable	Maximum permanent permitted operating voltage of the system			
	AC	3-phase AC	DC	
U_0/U	Conductor-earth	Conductor-conductor	Conductor-earth	Conductor-conductor
	U_0 max	U max		
300/500 V	320 V	550 V	410 V	820 V
450/750 V	480 V	825 V	620 V	1240 V
0,6/1 kV	0,7 kV	1,2 kV	0,9 kV	1,8 kV

6 Marking

6.1 Indication of origin

Cables shall be provided with an indication of the manufacturer, which shall be either an identification thread or a repetitive marking of the manufacturer's name or trademark.

Marking may be by printing or by reproduction in relief on or in the insulation or sheath.

6.2 Continuity of marks

Each specified mark shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed

– 550 mm if the marking is on the outer sheath of the cable;

– 275 mm if the marking is on the insulation or on a tape within the sheathed cable.

6.3 Durability

Printed markings shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of IEC 60245-2:1994.

6.4 Legibility

All markings 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 suitable solvent.

7 Core identification

7.1 General

Each power core shall be identified as specified in 7.2.

Each pilot, control, or any other additional core shall be identified as specified in 7.2 or 7.3.

7.2 Identification by colours

7.2.1 General requirements

Identification of the cores of a cable shall be achieved by the use of coloured insulation.

Each power core of a cable shall have only one colour, except the core identified by a combination of the colours green and yellow.

The colour of control (CC), pilot (CP) or any other additional core shall be clearly identified and different to the power cores.

The colours green and yellow, when not in combination, shall not be used.

7.2.2 Colour scheme for power cores

The preferred colour scheme (AC cables):

– three-core cable: green and yellow, blue, brown;
– four-core cable: green and yellow, brown, black , grey;
– five-core cable: green and yellow, blue, brown, black, grey.

The preferred colour scheme (DC cables):

– two-core cable: no preferred colour scheme
– three-core cable: green and yellow, no preference for other cores

The colours shall be clearly identifiable and durable. Durability shall be checked by the test given in 1.8 of IEC 60245-2:1994.

7.2.3 Colour combination green and yellow

The distribution of the colours for the core coloured green and yellow shall comply with the following condition: for every 15 mm length of core, one of these colours shall cover at least 30 % and not more than 70 % of the surface of the core, the other colour covering the remainder.

NOTE Information on the use of the colours green and yellow, and blue. It is understood that the colours green and yellow, when they are combined as specified above, are recognized exclusively as a means of identification of the core intended for use as earth connection or similar protection, and that the colour blue is intended for the identification of the core intended to be connected to neutral.

7.3 Core identification by numbers

7.3.1 General requirements

The colour of control (CC), pilot (CP) or any other core shall be clearly identified and different to the power cores.

The insulation of the cores shall be of the same colour and numbered sequentially, starting at number 1.

The numbers shall be printed in arabic numerals on the outer surface of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of the insulation. The numerals shall be legible.

7.3.2 Preferred arrangement of marking

The numbers shall be repeated, at regular intervals along the core, consecutive numbers being inverted in relation to each other.

When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing *d* between consecutive numbers shall not exceed 50 mm.

The arrangement of the marks is shown in Figure 1.

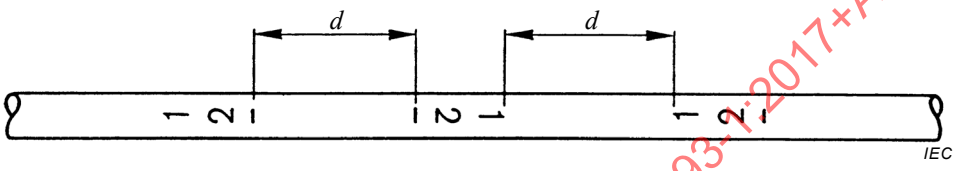

Figure 1 – Core marking by numbers

7.3.3 Durability

Printed numerals shall be durable. Compliance with this requirement shall be checked by the test given in 1.8 of IEC 60245-2:1994.

8 General requirements for the construction of cables

8.1 Conductors

8.1.1 Material

The conductors shall consist of annealed copper. The wires may be plain or tinned.

8.1.2 Construction

The conductor shall comply with Class 5, according to IEC 60228.

8.1.3 Check on construction

Compliance with the requirements of 8.1.1 and 8.1.2, including the requirements of IEC 60228, shall be checked by inspection and by measurement.

8.1.4 Electrical resistance

The resistance of each conductor at 20 °C shall be in accordance with the requirements of IEC 60228 for the given class of the conductor.

Compliance shall be checked by the test given in IEC 60228:2004, Annex A.

8.2 Sizes of cable

The sizes of cable shall be:

a) Power cores 300/500 V: 1,5 mm^2 and 2,5 mm^2 to 3 core.

b) Power cores 450/750 V: 1,5 mm^2 to 35 mm^2 to 3, 4 and 5 core.

c) Power cores 0,6/1 kV: 10 mm² to 95 mm² to 2 and 3 core (DC only)

d) Pilot or control cores: minimum 0,5 mm^2 to number not specified. Size of these core(s) shall be different from size of power cores.

8.3 Insulation

8.3.1 Material

The insulation shall be a compound of the types specified in Table 2. The insulation of power cores shall be compound EVI-2. The insulation of pilot, control and any other additional cores shall be compound EVI-1 or EVI-2.

Insulation resistance shall be in accordance with the specified values in the particular specifications.

The test requirements for these compounds are specified in Table 2.

8.3.2 Application to the conductor

The insulation shall be so applied that it fits closely on the conductor. However it shall be possible to remove the insulation without damaging the insulation, the conductor, or the tin coating if any.

It is permitted to place a separator between the conductor and the insulation.

Compliance shall be checked by inspection and by manual test.

8.3.3 Thickness

The mean value of the thickness of insulation shall be not less than the specified value for each type and size of cable shown in the particular table in the particular specifications. The thickness at any point may be less than the specified value provided that the difference does not exceed 0,1 mm + 10 % of the specified value.

For pilot and control cores and any other core other than power cores up to and including 0,75 mm^2 the minimum wall thickness shall not be less than 0,33 mm. For pilot and control cores and any other core other than power cores of 1,0 mm^2 the minimum wall thickness shall not be less than 0,41 mm. For bigger cross sections see corresponding tables in the particular specifications.

Compliance shall be checked by the test given in 1.9 of IEC 60245-2:1994.

8.3.4 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 in Table 2.

The applicable test methods and the results to be obtained are specified in Table 2.

Table 2 – Requirements for insulating compounds

1	2	3	4	5	6	7
Ref. No.	**Test**	**Unit**	**Type of compound**		**Test method described in**	
			EVI-1	**EVI-2**	**IEC**	**Clause**
1	**Tensile strength and elongation at break**				60811-501	
1.1	Properties in the state as delivered					
1.1.1	Values to be obtained for the tensile strength:					
	– median, min.	N/mm^2	15,0	8,0		
1.1.2	Values to be obtained for the elongation at break:					
	– median, min.	%	300	200		
1.2	Properties after ageing in air oven				60811-401 and 60811-501	
1.2.1	Ageing conditions:					
	– temperature	°C	135 ± 2	135 ± 2		
	– duration of treatment	h	7 x 24	7 x 24		
1.2.2	Values to be obtained for the tensile strength:					
	– variation [a], max.	%	±30	±30		
1.2.3	Values to be obtained for the elongation at break:					
	– variation [a], max.	%	±30	±30		
2	**Hot set test**				60811-507	
2.1	Test conditions:					
	– temperature	°C	–	200 ± 3		
	– time under load	min	–	15		
	– mechanical stress	N/cm^2	–	20		
2.2	Values to be obtained:					
	– elongation under load, max.	%	–	100		
	– permanent elongation after cooling, max.	%	–	25		
3	**Pressure test at high temperature**				60811-508	
3.1	Test conditions:					
	– temperature	°C	120 ± 2	–		
3.2	Values to be obtained:					
	– median of the depth of indentation, max.	%	50	–		
4	Bending at low temperature				60811-504	
	For core diameter ≤ 12,5 mm					
4.1	Test conditions:					
	– temperature	°C	-40 ± 2	-40 ± 2		
	– duration of treatment		See 4.2 of IEC 60811-504:2012			
4.2	Values to be obtained:		No cracks			

1	2	3	4	5	6	7
Ref. No.	**Test**	**Unit**	**Type of compound**		**Test method described in**	
			EVI-1	**EVI-2**	**IEC**	**Clause**
5	**Elongation test at low temperature**				60811-505	
	For core diameter > 12,5 mm					
5.1	Test conditions:					
	– temperature	°C	-40 ± 2	-40 ± 2		
	– duration of treatment		See 4.2 of IEC 60811-505:2012			
5.2	Values to be obtained:					
	– elongation at break, min.	%	30	30		
6	**Hardness**					
6.1	Values to be obtained [b]		≥ 50 (Shore D)	≥ 80 (IRHD)	ISO 7619-1 ISO 48	

[a] Variation: difference between the median value after ageing and the median value without ageing, expressed as a percentage of the latter.

[b] Test can be performed on pressed plaques where it is not possible to use extruded insulation (pilot and control cores)

8.4 Filler (optional)

8.4.1 Material

Fillers when used shall be composed of one of the following or of any combination of the following:

– compound; or
– natural or synthetic textiles; or
– paper.

When a compound is used as filler, there shall be no harmful interactions between its constituents and the insulation and/or the sheath. Compliance with this requirement shall be checked by the compatibility test given in Annex A.

8.4.2 Application

The fillers shall fill the spaces between the cores giving the assembly a practically circular shape. The fillers shall not adhere to the cores. The assembly of cores and fillers may be held together by film or tape.

8.5 Assembly

The cores shall be twisted together.

A tape may be applied around the core assembly before application of the sheath.

8.6 Metallic screen (optional)

A metallic screen, consisting of a braid of plain or tinned copper wires, may be included in the construction. A suitable filler or tape shall be applied between assembly of cores and the metallic screen.

Requirements for the metallic screen shall be agreed between manufacturer and customer.

8.7 Sheath

8.7.1 Material

The sheath shall be a compound of the types specified in Table 3.

The test requirements for these compounds are specified in Table 3.

8.7.2 Application

The sheath shall be extruded in a single layer on the assembly of cores and fillers or screen, if any.

The sheath shall not adhere to the cores. A separator, consisting of a film or tape, may be placed under the sheath.

In certain cases, the sheath may penetrate into the spaces between the cores, thus forming a filler (see 8.4.2).

8.7.3 Thickness

The mean value of the thickness shall not be less than the specified value for each type and size of cable shown in the tables of the specific part of these standards.

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, unless otherwise specified.

Compliance shall be checked by the test given in 1.10 of IEC 60245-2:1994.

8.7.4 Mechanical properties before and after ageing

The sheath 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 in Table 3.