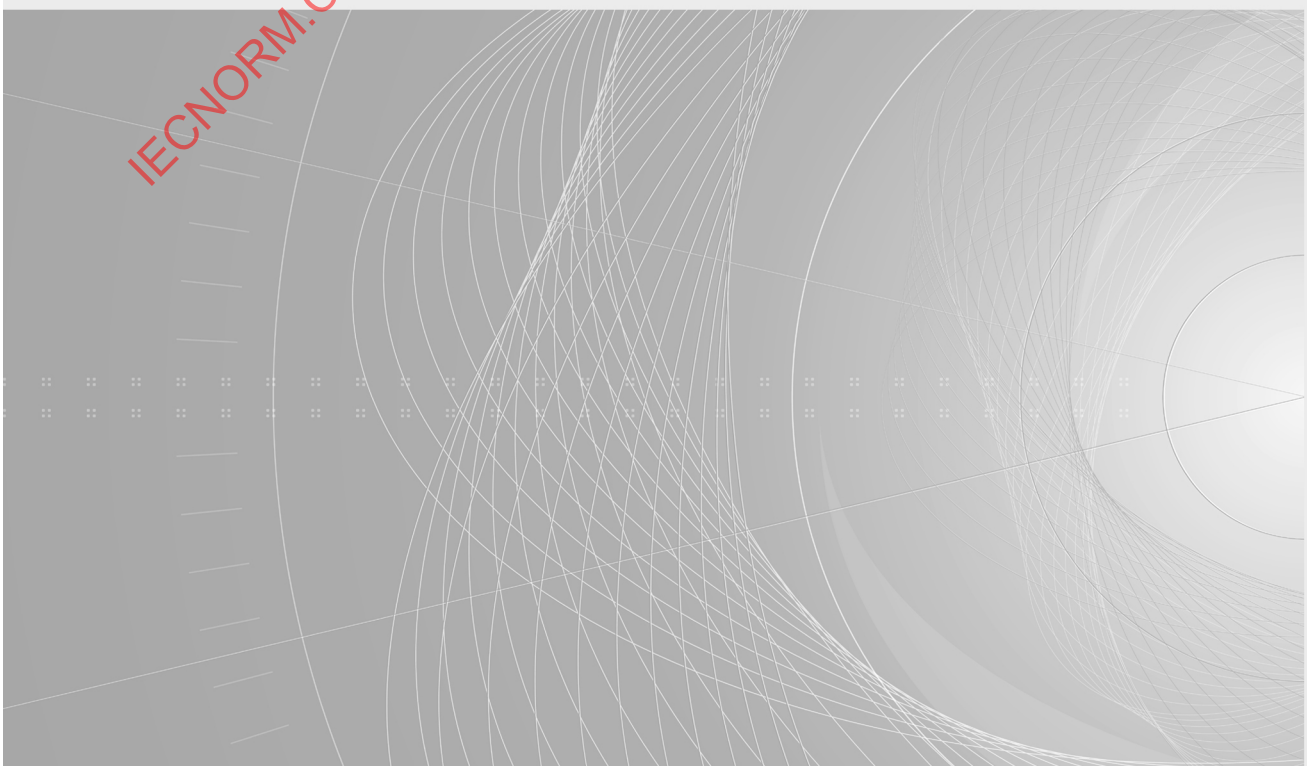
IEC TS 62893-4-2

Edition 1.0 2021-06

TECHNICAL SPECIFICATION

Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV –
Part 4-2: Cables for DC charging according to mode 4 of IEC 61851-1 – Cables intended to be used with a thermal management system



IEC TS 62893-4-2:2021-06(en)

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

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

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC TS 62893-4-2

Edition 1.0 2021-06

TECHNICAL SPECIFICATION

Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV –
Part 4-2: Cables for DC charging according to mode 4 of IEC 61851-1 – Cables intended to be used with a thermal management system

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.060.20; 43.120

ISBN 978-2-8322-9915-9

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

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

Part 4-2: Cables for DC charging according to mode 4 of IEC 61851-1 – Cables intended to be used with a thermal management system

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TS 62893-4-2 has been prepared by IEC technical committee 20: Electric cables. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

DTS	Report on voting
20/1942/DTS	20/1961/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

This document is to be read in conjunction with IEC 62893-1:2017, IEC 62893-1:2017/AMD1:2020 and IEC 62893-2:2017.

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 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.

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

Part 4-2: Cables for DC charging according to mode 4 of IEC 61851-1 – Cables intended to be used with a thermal management system

1 Scope

This part of IEC 62893 applies to cables for DC charging according to mode 4 of IEC 61851-1. These cables are intended to be used with a thermal management system such as that specified in IEC 61851-23.

Charging cables specified in IEC 62893 (all parts) are intended to be used for electrical appliances of class II equipment.

Maximum conductor operating temperature for the cables in this document is 90 ºC.

The test methods specified are given in IEC 62893-2, IEC 60227-2, IEC 60245-2, IEC 60332-1-2, IEC 62821-1:2015, Annex B and in the relevant parts of IEC 60811.

IEC 62440 is intended to be used as guidance on the safe use of cables in this document together with specific guidance in Clause 6 of this document.

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 60227-2:1997, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 2: Test methods*
IEC 60227-2:1997/AMD1:2003

IEC 60245-2, *Rubber insulated cables – Rated voltages up to and including 450/750 V – Part 2: Test methods*
IEC 60245-2:1994/AMD1:1997
IEC 60245-2:1994/AMD2:1997

IEC 60332-1-2, *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 60364-5-54, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

IEC 60445:2017, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

IEC 60811-401:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*
IEC 60811-401:2012/AMD1:2017

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

IEC 61851-23, *Electric vehicle conductive charging system – Part 23: DC electric vehicle charging station*

IEC 62440:2008, *Electrical cables with a rated voltage not exceeding 450/750 V – Guide to use*

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

IEC 62893-1:2017 *Charging cables for electric vehicles of rated voltages up to and including 0,6/1 kV – Part 1: General requirements*
IEC 62893-1:2017/AMD1:2020

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

IEC Guide 117:2010, E*lectrotechnical equipment – Temperatures of touchable hot surfaces*

ISO 1402, *Rubber and plastics hoses and hose assemblies – Hydrostatic testing*

EN 50289-1-12:2005, *Communication cables – Specifications for test methods – Part 1-12: Electrical test methods – Inductance*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 62893-1 and the following 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
auxiliary power core
core in the cable that is used to provide auxiliary power to operate on-vehicle electrical devices during the charging process without using battery power (e.g. climate control)

3.2
temperature sensor core
core in the cable that is used to provide temperature signals to operate an electric vehicle supply equipment (EVSE)

3.3
tube
element in the cable carrying a cooling medium

4 General purpose cables – Heavy duty flexible cables

4.1 Code designation

The code designation is 62893 IEC 129 for halogen free cables with sheath compound EVM-1 and 62893 IEC 130 for halogen free cables with sheath compound EVM-2.

The code designation is 62893 IEC 131 for cables with sheath compound EVM-3.

4.2 Rated voltage

0,6/1 kV AC up to and including 1,5 kV DC conductor to conductor.

4.3 Construction

4.3.1 Conductor material

The conductor material and its construction shall be in accordance with 8.1 of IEC 62893-1:2017.

4.3.2 Sizes of cable

The sizes of cable shall be:

- Power cores:

  16 mm^2 to 150 mm^2 – two or more cores.
- Control or pilot cores:

  Number not specified, for size see 8.2 d) of IEC 62893-1:2017.
- Optional PE conductor – one core:

  Minimum size of PE or PEM conductor shall be in accordance with either Table B.1 or Table B.2 or, in the case where there is agreement between manufacturer and customer about the short-circuit requirements, the nominal cross-section of the PE or PEM conductor shall comply with the calculations specified in IEC 60364-5-54 or with IEC 61851-23.
- Auxiliary power cores (optional):

  2,5 mm^2 to 6 mm^2 – two cores.
- Temperature sensor cores (optional):

  Number not specified, for size see 8.2 d) of IEC 62893-1:2017.

In case the copper conductor is in direct contact with the coolant media, a corrosion test of the conductor shall be made in accordance with Annex F (see Table A.1, Ref No. 14).

4.3.3 Insulation

The insulation for power cores shall be a compound of Type EVI-2 in accordance with IEC 62893-1:2017.

In case the insulation is also used as a tube of the power core, a space between the conductor and insulation is permitted.

The insulation for control or pilot cores, auxiliary power cores and temperature sensor cores shall be a compound of Type EVI-1 or EVI-2 in accordance with IEC 62893-1:2017.

4.3.4 Screen(s) (optional)

The screen over a core or an assembly of cores (such as pairs or quads) shall consist of a copper braid with minimum 80 % optical coverage, as specified in Annex D.

4.3.5 Tubes

Fluid filled tubes shall be made of materials resistant to the media used as a coolant. The compatibility of the tube materials shall be tested with the cable materials in accordance with IEC 60811-401:2012 (see Table A.1, Ref. No. 5).

The tube material shall withstand an aging of 120 °C for 168 h in dry air. The variation of the mechanical properties shall not exceed ±30 % of the unaged specimen.

In case the insulation is also used as a tube, the material shall comply with the relevant requirements of EVI-2 and shall comply with the requirements of Table A.1, Ref. No. 14.

4.3.6 Core identification

Identification of the power cores of a cable shall be in accordance with Table A.1 of IEC 60445:2017. Each power core of a cable shall have only one colour, except the core identified by a combination of the colours green and yellow shall comply with the requirement of 7.2.3 of IEC 62893-1:2017.

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

Except for the power cores and the protective conductor, the core identification using numbers could be applied if core identification by numbers is in accordance with 7.3 of IEC 62893-1:2017.

4.3.7 Assembly

The cores shall be twisted together.

A centre filler may be used. A centre-core is not permitted.

A separator (e.g. tape) and/or filler may be applied around the core assembly before application of the sheath.

A screen according to 8.6 of IEC 62893-1:2017 may be applied over the core assembly.

4.3.8 Sheath

The sheath shall be a compound of type EVM-1 in accordance with IEC 62893-1:2017 for cable type 62893 IEC 129, EVM-2 in accordance with IEC 62893-1:2017 for cable type 62893 IEC 130 and EVM-3 in accordance with IEC 62893-1:2017 for cable type 62893 IEC 131.

The sheath shall not adhere to the cores.

The application of the sheath shall give the finished cable an essentially circular shape.

4.3.9 Marking

The cable shall be marked with the corresponding code designation in accordance with 4.1.

Each cable shall have its full code designation, in accordance with the requirements in this document, marked continuously (Clause 6 of IEC 62893-1:2017) on the sheath and in addition:

- the number and nominal cross-section of power cores and PE conductor, if any,
- the rated voltage, and
- the following marking "USE FOR DEDICATED ACTIVELY COOLED SYSTEMS".

Additional markings, for example the year of manufacture, are permitted, but are not required by this document. If an additional marking is applied, it shall neither conflict nor interfere with the required markings. Continuity, durability and legibility of the marking shall comply with 6.2, 6.3 and 6.4 of IEC 62893-1:2017.

4.3.10 Inductance between power cores

See Annex E.

4.4 Requirements

Each cable shall comply with the appropriate requirements given in IEC 62893-1, and the particular requirements of this document.

Testing shall be in accordance with Annex A, and the relevant tests indicated in columns 6 and 7 of Table A.1.

a) The thicknesses of insulation and sheath shall conform to Table B.1 for type 129 and Table B.2 for types 130 and 131.

b) The insulation thickness of auxiliary power cores shall not be less than 0,8 mm. For pilot and control cores and any other core other than power cores or auxiliary power cores see 8.3.3 of IEC 62893-1:2017.

c) The requirements for the compatibility test shall be as given in Annex A of IEC 62893-1:2017.

d) The test conditions and requirements for the cold impact test shall be as given in 5.8 of IEC 62893-2:2017.

e) The tests conditions and requirements for the crush resistance test shall be as given in 5.7 of IEC 62893-2:2017.

f) The bending test (Table A.1, Ref. No. 8.1) shall be in accordance with Annex C.

5 Liquid coolants

5.1 Type of coolant

The type of liquid coolant used in the system shall be specified by the system manufacturer and indicated for the cable assembly.

The tube material and the cooling liquid shall be agreed between the cable manufacturer and assembly and/or system manufacturer. The material compatibility shall be tested by the assembly and/or system manufacturer in accordance with Annex F.

5.2 Pressure tests for tubes

The liquid coolant confining parts of the cable shall be capable of withstanding the maximum allowed pressure without bursting or rupturing.

The burst pressure of tubes shall be at least 3 times the rated operating pressure at room temperature and 1,5 times the rated operating pressure of the maximum rated temperature of the cable.

The test conditions and requirements are given under Ref. No. 15 of Table A.1.

NOTE The rated operating pressure is provided by the assembly and/or system manufacturer.

6 Guidance on use of cables

General guidance information given in IEC 62440 (guide to use for low voltage cables) shall be used. In addition, the specific information from Table 1 and Table 2 shall be taken into account for the products specified in this document.

Table 1 – Intended use of charging cables for EV (environmental conditions)

1	2
Code designation	62893 IEC 129, 130 and 131
Shape of cable	Round
Conductor construction	Class 5
1 Duty [a]	
1.1 Heavy	+
2 Presence of water	
2.1 Condition AD 7 [b]	+
3 Corrosive of polluting substances	
3.1 Condition AF 3 [b]	+
4 Impact	
4.1 Condition AG 2 [b]	+
5 Vibrations	
5.1 Condition AH 3 [b]	+
6 Flora	
6.1 Condition AK 2 [b]	–
7 Fauna	
7.1 Condition AL 2 [b]	–
8 Outdoor use	
8.1 Condition AN 3 [b]	+
8.2 Permanent [c]	+
9 Frequent flexing	+
10 Frequent torsion	+
Key	
"+" = acceptable "–" = not suitable	
[a] See Annex C of IEC 62440:2008 for definitions.	
[b] See Annex A of IEC 62440:2008 for definitions.	
[c] See Annex B of IEC 62440:2008 for definitions.	

Table 2 – Recommended use of charging cables for EV

1	2	3
Code designation	**Recommended use**	**Comments**
62893 IEC 129 and 130	Intended for use for charging mode 4 of IEC 61851-1 with a thermal management system.	Max. storage temperature: +45 °C. Min. temperature for installation and handling: –25 °C. Intended for use indoors and outdoors.
62893 IEC 131	Intended for use for charging mode 4 of IEC 61851-1. Only for outdoor use (due to halogen content in case of fire) with a thermal management system.	Max. storage temperature: +45 °C. Min. temperature for installation and handling: –25 °C. Intended for use outdoors.

The maximum cable surface shall not exceed 60 °C under normal conditions. With reference to IEC Guide 117, the limitation of plastic surfaces shall be used.

NOTE Any protection for direct contact on hot surfaces enables higher cable surface temperatures.

Annex A
(normative)

Tests for completed cables

Table A.1 – Tests for cable types 62893 IEC 129, 130 and 131 *(1 of 2)*

1	2	3	4	5	6	7
Ref. No.	**Tests** [a]	**Category of test**	**Test method described in**		**Applicability of test**	
			IEC standard	**(Sub)-clause**	**62893 IEC 129 and IEC 130**	**62893 IEC 131**
1	*Electrical tests* [b]					
1.1	Resistance of conductors	T, S	60245-2:1994	2.1	X	X
1.2	Voltage test on completed cable	T, S	60245-2:1994	2.2		
	– at 3 500 V AC, or 7 000 V DC				X	X
1.3	Voltage test at 3 500 V AC on all cores	T	60245-2:1994	2.3	X	X
1.4	Insulation resistance at 90 °C	T	60227-2:1997	2.4	X	X
1.5	Long term resistance of insulation to d.c. on power cores at nominal voltage	T	62893-2:2017	5.1.1	X	X
	– voltage applied 0,9 kV DC					
	– duration of test (240 ± 2) h					
	– temperature (85 ± 2) °C					
2	*Constructional and dimensional tests*					
2.1	Checking of compliance with constructional provisions	T, S	62893-1:2017		X	X
2.2	Measurement of thickness of insulation	T, S	60245-2:1994	1.9	X	X
2.3	Measurement screen optical coverage	T, S	TS 62893-4-2	Annex D	X	X
2.4	Measurement of thickness of sheath	T, S	60245-2:1994	1.10	X	X
2.5	Measurement of overall dimensions					
2.5.1	Mean value	T, S	60245-2:1994	1.11	X	X
2.5.2	Ovality	T, S	60245-2:1994	1.11	X	X
3	*Insulation material tests*	T	62893-1:2017[c,]	8.3.1	X	X
4	*Sheath material tests*	T	62893-1:2017[c,]	8.7.1	X	X
5	*Compatibility test*	T	62893-1:2017	Annex A	X	X
6	*Impact test at −35 °C* [d,f]	T	62893-2:2017	5.8	X	X
7	*Shrinkage test*	T	62893-1:2017	8.8.6	X	X

Table A.1 *(2 of 2)*

1	2	3	4	5	6	7
Ref No.	**Tests** [a]	**Category of test**	**Test method described in**		**Applicability of test**	
			IEC standard	**(Sub)-clause**	**62893 IEC 129 and IEC 130**	**62983 IEC 131**
8	*Mechanical strength of completed cable*					
8.1	Bending test followed, after immersion in water, by a voltage test on cores as per 1.3 of this table.	T	TS 62893-4-2	Annex C	X	X
9	*Crush resistance test* [f]	T	62893-2:2017	5.7	X	X
10	*Weathering/UV resistance test*	T	62893-2:2017	5.2	X	X
11	*Resistance against chemicals*	T	62893-2:2017	5.3	X	X
12	*Tests under fire conditions*					
12.1	Test on single vertical cable [f]	T	60332-1-2		X	X
13	*Assessment of halogens for all non-metallic materials* [e]	T, S	62821-1:2015	Annex B	X	–
14	*Compatibility test of coolant*	T	TS 62893-4-2	Annex F	X	X
15	*Burst pressure test*					
15.1	*at room temperature: min. 3 × max. operating pressure*	S	ISO 1402		X	X
15.2	*at max. temperature (90 °C): min. 1,5 × max. operating pressure*	T	ISO 1402		X	X

[a] The order given does not imply a sequence of testing.

[b] Particular test conditions and requirements are given in column 6 of Table 4 of IEC 62893-1:2017 and column 6 of Table 4 of IEC 62893-1:2017/AMD1:2020.

[c] This document includes all the test methods and requirements for the material. The material to be tested is taken from the finished cable.

[d] In countries with extreme low temperatures other values may be used.

[e] Type IEC 129 (EVM-1) shall comply with IEC 62893-1:2017, 8.8.5.

[f] The cable shall be tested without liquid coolant.

Annex B
(normative)

Tables for cable dimensions and insulation resistance

NOTE 1 The overall dimensions of cables have been calculated in accordance with IEC 60719.

NOTE 2 Mean overall dimension values in Table B.1 and Table B.2 refer to constructions with two or fewer control core(s). The mean overall dimension is calculated without any tube.

NOTE 3 If the core diameter (including tube) exceeds the maximum diameter according to Table C.1 of IEC 60228:2004 for the relevant cross-section, the equivalent/proper diameter can be used for reference.

Table B.1 – General data for type 129 (EVM-1)

1	2	3	4	5	6	7
Number and nominal cross-sectional area power conductors [b]	**nominal cross-sectional area PE conductor**	**Thickness of insulation** [c] **Specified value**	**Thickness of sheath Specified value**	**Mean overall dimensions** [a] **Lower value**	**Upper value**	**Minimum insulation resistance at 90 °C** [e]
mm^2	mm^2	mm	mm	mm	mm	MΩ · km
2 × 16	25	0,8	1,5	16,6	20,7	0,004 4
2 × 25	25	1,0	1,7	20,7	25,9	0,004 3
2 × 35	25	1,0	1,9	23,8	29,7	0,003 7
2 × 50	25	1,1	2,2	27,9	34,8	0,003 4
2 × 70	25[d]	1,2	2,5	32,6	40,7	0,003 1
2 × 95	25[d]	1,2	2,7	36,1	45,1	0,002 8
2 × 120	25[d]	1,3	2,9	40,4	50,5	0,002 7
2 × 150	25[d]	1,5	3,2	45,1	56,4	0,002 8

[a] Indicative values, for information only (see Note 2).

[b] Power cores could be split in two smaller cores.

[c] Thicknesses are given for power conductors. For PE conductors the thickness corresponding to the same cross-section as per power conductor applies.

[d] Mininum 25 mm^2.

[e] Only the test method of IEC 60227-2:1997.

Table B.2 – General data for type 130 (EVM-2) and type 131 (EVM-3)

1	2	3	4	5	6	7
Number and nominal cross-sectional area power conductors[b]	nominal cross-sectional area PE conductor	Thickness of insulation [c]	Thickness of sheath	Mean overall dimensions [a]		Minimum insulation resistance at 90 °C [e]
		Specified value	Specified value	Lower value	Upper value	
mm^2	mm^2	mm	mm	mm	mm	MΩ · km
2 × 16	25	0,8	2,4	17,9	22,3	0,004 4
2 × 25	25	1,0	2,8	22,4	28,0	0,004 3
2 × 35	25	1,0	3,2	25,8	32,3	0,003 7
2 × 50	25	1,1	3,6	30,1	37,7	0,003 4
2 × 70	25[d]	1,2	4,0	35,1	43,8	0,003 1
2 × 95	25[d]	1,2	4,4	38,9	48,7	0,002 8
2 × 120	25[d]	1,3	4,8	43,6	54,5	0,002 7
2 × 150	25[d]	1,5	5,3	48,7	60,9	0,002 8

[a] Indicative values, for information only (see Note 2).

[b] Power cores could be split in two smaller cores.

[c] Thicknesses are given for power conductors. For PE conductors the thickness corresponding to the same cross-section as per power conductor applies.

[d] Minimum 25 mm^2.

[e] Only the test method of IEC 60227-2:1997.

Annex C
(normative)

Bending test

C.1 Test method

See 8.8.3.3 of IEC 62893-1:2017.

NOTE ISO 14572:2011, 5.9 (cyclic bending) is referred to in 8.8.3.3 of IEC 62893-1:2017, however since its publication, ISO 19642-2:2019, 5.3.4 applies.

C.2 Apparatus

This bending test shall be performed without any liquid coolant.

Additionally, the apparatus shall be similar to the one shown in Figure C.1. Any apparatus is acceptable as long as it meets the requirements for the test:

- 15 cycles per minute;
- No. of cycles: 5 000.

NOTE One cycle is from position 0° to −90° and back and from 0° to +90° and back.

Bending radius R = 5 times the outside of the cable diameter (bending radius tolerance: $^{0}_{-20}$ %).

C.3 Results and calculations

a) Visible inspection of the sheath

See 8.8.3.3 of IEC 62893-1:2017.

b) Air leakage test

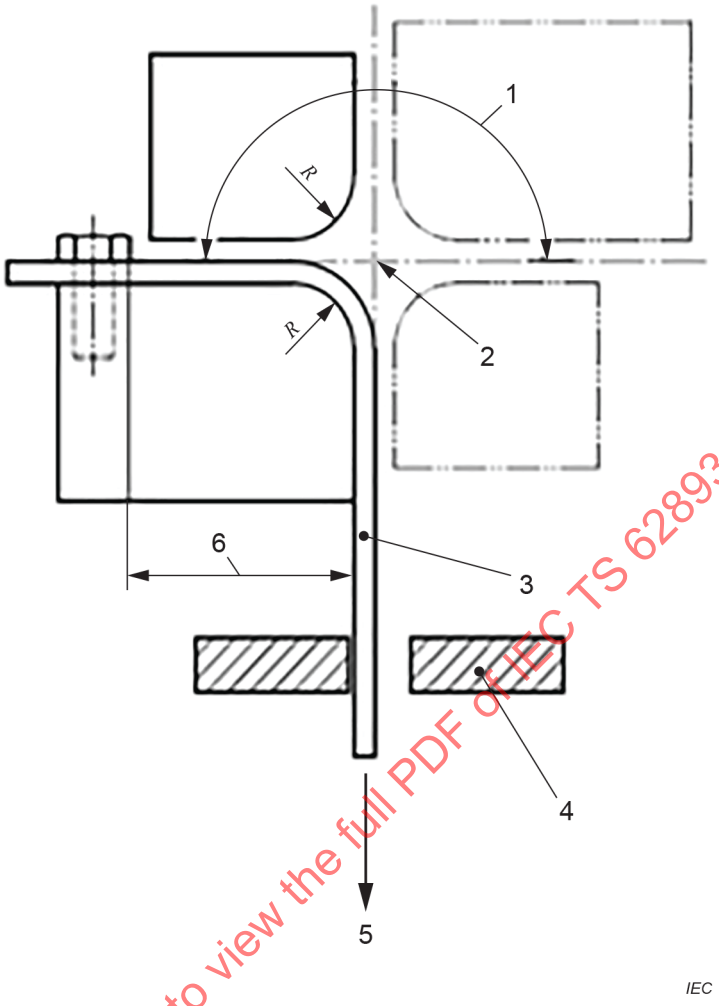
After the required number of cycles the tubes shall be examined for cracks and brakes. A pressure test with 300 kPa shall be performed in order to detect any leakage. A maximum leakage rate of 25 ml/min is acceptable.

c) Electrical voltage test

An electrical voltage test is needed to examine the core insulation as described in 8.8.3.3 of IEC 62893-1:2017.

In the case where one of the samples fails the requirements set above, then two additional samples (taken from the same cable length) shall be tested. The test shall be deemed satisfactory if both tests meet the stated requirements.

In the case where there is no sufficient cable length available, the retest samples may be taken from another production length or order of the same construction.



Key

1 one cycle (90° to each side)
2 pivot
3 cable
4 fixed guide (optional)
5 force, F
6 fixing point distance (recommended minimum of 100 mm)
R bending radius

Figure C.1 – Apparatus for cyclic bending

Annex D
(normative)

Screen

The percentage of optical coverage B of a screen shall be calculated in accordance with the following formula:

$$B = \frac{100d}{q}\left(m_1 n_1 + m_2 n_2 - m_1 n_1 m_2 n_2 \frac{d}{q}\right)$$

where

q $= \dfrac{\pi DS}{\sqrt{\pi^2 D^2 + S^2}}$;

D is the average diameter of the screen (diameter under the screen plus 2 d in mm);

d is the nominal wire diameter in mm (used for the screen);

S is the lay length of wires in the screen in mm;

m_1 is the number of bunched wires in one direction (number of small spools);

m_2 is the number of bunched wires in opposite direction (number of small spools);

n_1, n_2 are the number of wires used for each bunch.

Annex E
(informative)

Cable inductance between DC+ and DC−

E.1 General

This test establishes the method for determining the cable inductance between the power lines DC+ and DC−.

E.2 Test method

The test method shall be in reference to EN 50289-1-12:2005.

The test frequency is 800 Hz.

E.3 Specimen

The test specimen shall be a 10 m straight cable.

E.4 Results and calculations

The test results shall be calculated on 1 m. The total cable inductance should not exceed 1 µH/m between DC+ and DC− on a straight cable.