

# INTERNATIONAL STANDARD

## AMENDMENT 1

**Power cables with extruded insulation and their accessories for rated voltages from 1 kV ( $U_m = 1,2$  kV) up to 30 kV ( $U_m = 36$  kV) –  
Part 2: Cables for rated voltages from 6 kV ( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV)**

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Part 2: Cables for rated voltages from 6 kV ( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV)**

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**POWER CABLES WITH EXTRUDED INSULATION AND THEIR  
ACCESSORIES FOR RATED VOLTAGES FROM 1 kV  
( $U_m = 1,2$  kV) UP TO 30 kV ( $U_m = 36$  kV) –****Part 2: Cables for rated voltages from 6 kV  
( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV)**

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Amendment 1 to IEC 60502-2:2014 has been prepared by IEC technical committee 20: Electric cables.

The text of this Amendment is based on the following documents:

Draft	Report on voting
20/2166/FDIS	20/2181/RVD

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

The language used for the development of this Amendment 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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications/](http://www.iec.ch/standardsdev/publications/).

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## 2 Normative references

Add the following new references:

IEC 60332-3-24, *Tests on electric and optical fibre cables under fire conditions – Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category C*

IEC 60684-2, *Flexible insulating sleeving – Part 2: Methods of test*

IEC 60754-1, *Test on gases evolved during combustion of materials from cables – Part 1: Determination of the halogen acid gas content*

IEC 60754-2, *Test on gases evolved during combustion of materials from cables – Part 2: Determination of acidity (by pH measurement) and conductivity*

IEC 60754-3, *Test on gases evolved during combustion of materials from cables – Part 3: Measurement of low level of halogen content by ion chromatography*

IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

### 4.3 Sheathing compounds

#### Table 4

Add, in the existing Table 4, under item a) Thermoplastic, below "polyethylene", the following two new types of halogen free compound, as follows:

**Table 4 – Maximum conductor temperatures for different types of sheathing compound**

Sheathing compound	Abbreviated designation	Maximum conductor temperature in normal operation °C
halogen free	ST <sub>8</sub>	90
	ST <sub>12</sub>	90

### 13 Metal armour

#### 13.1 Types of metal armour

Add, after item c), the following new item d):

d) interlock metal tape armour.

#### 13.2 Materials

Add, after the second paragraph, the following new note:

NOTE Other metal materials can be used upon agreement between the manufacturer and customer.

#### 13.4 Dimensions of the armour wires and armour tapes

Replace the existing title of 13.4 and, consequently, the existing first paragraph with the following new title and paragraph:

#### 13.4 Dimensions of the armour wires, armour tapes and armour strips

The nominal dimensions of the armour wires, armour tapes and armour strips shall be one of the following values:

Add, at the end of 13.4, the following new text:

strips of the interlocked armour:

0,65 – 0,90 – 1,05 mm thickness (before forming).

#### 13.5 Correlation between cable diameters and armour dimensions

Replace the existing first paragraph with the following new paragraph:

The nominal diameters of round armour wires, nominal thickness of armour tapes and the thickness of armour strips, shall not be less than the values given in Table 9, Table 10 and Table 24 respectively.

Add, at the end of the existing Table 10, the following new Table 24:

**Table 24 – Nominal thickness of armour strips**

Fictitious diameter under interlock armour		Nominal thickness of strip (before forming) mm
Above mm	Up to and including mm	
-	20	0,65
20	40	0,90
40	-	1,05

Add, at the end of 13.7, the following new Subclause 13.8:

### 13.8 Interlock metal tape armour

Interlocking armour is the process of continuously forming a metal strip(s) into helical coil(s) in which the leading edge of the formed strip engages with the trailing edge of the adjacent strip to form a continuous flexible tube which is applied over the underlying cable layer (assembly of cores, bedding, or separation sheath).

The interlocked metal tape armour shall, with the oversheath removed, allow bending without opening at any point or damaging the cable when bent around a mandrel having a diameter not more than 10 times the diameter over the armour.

## 14 Oversheath

### 14.1 General

Replace the existing text of 14.1 with the following new text:

All cables shall have an oversheath.

The oversheath is normally black but a colour other than black may be provided by agreement between the manufacturer and customer, subject to its suitability for the particular conditions under which the cable is to be used.

If there is concern that the oversheath will be deteriorated by UV radiation, the oversheath shall be protected against UV radiation, which will be mutually agreed with the customer. Black polyethylene oversheaths containing the required amount of a suitable and well-dispersed grade of carbon black (see Table 22) can provide protection against UV radiation depending on geographical regions and meteorological conditions.

NOTE 1 For some applications the oversheath can be covered by a functional layer (e.g. semi-conductive).

NOTE 2 Halogen free fire retardant oversheaths are not intended for installations outdoors and are not normally considered as UV protected.

## 14.2 Material

*Replace the existing text of 14.2 with the following new text:*

The oversheath shall consist of an extruded compound selected from the types listed in Table 4.

Halogen free sheathing material ST<sub>8</sub> or ST<sub>12</sub> shall be used on cables which exhibit properties of reduced flame spread, low levels of smoke emission and halogen free gas emission when exposed to fire. The oversheath (ST<sub>8</sub> or ST<sub>12</sub>) of halogen free cables shall meet the requirements given in Table 20 and Table 25.

These two oversheath material grades have different mechanical requirements. They depend on installation conditions and cable designs, and on which of these two are suitable. Further guidance on selection can be given in regional or national standards.

The sheathing material shall be suitable for the operating temperature in accordance with Table 4.

NOTE Chemical additives can be requested for use in the oversheath for special purposes, for example termite protection.

## 17 Sample tests

### 17.1 General

*Add, after item d), the following new item e):*

e) bending test on interlock armour cable followed by examination (see 17.11).

### 17.7 Measurement of armour wires and tapes

*Replace the existing title of 17.7 with the following new title:*

### 17.7 Measurement of armour wires, tapes and armour strips

#### 17.7.2 Measurement on tapes

*Replace the existing title of 17.7.2 and paragraph with the following new title and paragraphs:*

#### 17.7.2 Measurement on tapes and armour strips

The measurements shall be made with a micrometer having two flat noses of approximately 5 mm in diameter for measuring tapes, or having two ball noses of maximum 2 mm in diameter for measuring armour strips. The accuracy of the micrometer shall be  $\pm 0,01$  mm.

For tapes up to 40 mm in width the thickness shall be measured at the centre of the width. For wider tapes the measurements shall be made 20 mm from each edge of the tape and the average of the results taken as the thickness.

For armour strips the thickness shall be measured in a position that allows a measurement without disturbance by the shape of the formed strip.

#### 17.7.3 Requirements

*Replace, in the first sentence, "and tapes" with ", tapes and armour strips".*

*Add, after the last dashed item, the following new dashed item:*

– 5 % for armour strips.

*Add, at the end of 17.10, the following new Subclause 17.11:*

#### **17.11 Bending test on interlock armour cable followed by examination**

The interlocked metal tape armour cable, with the oversheath removed, shall be bent at a 180° turn around a mandrel having a diameter not more than 10 times the diameter over the armour. The examination shall not reveal any opening at any point of the interlocking armour nor mechanical damages caused by the armour on the underlying cable layer (assembly of cores, bedding, or separation sheath).

#### **18.2.4 Bending test**

*Add, above the existing last paragraph, the following new paragraph:*

After bending sequences are completed, a visual examination of the cable oversheath shall not show cracks, or plastic deformation of oversheath in such a way that the thickness of the oversheath at the stretched point goes below the minimum value  $t_{\min}$  allowed.

#### **19.9.1 Procedure**

*Replace, in the existing paragraph, "Tables 18, 21 and 22" with "Table 18, Table 21, Table 22 and Table 25".*

#### **19.10 Test on PVC insulation and sheaths at low temperatures**

*Replace the existing title of 19.10 with the following new title:*

#### **19.10 Test on PVC insulation, PVC sheaths and halogen free sheaths at low temperatures**

##### **19.10.1 Procedure**

*Replace, in the existing paragraph of 19.10.1, "Tables 18 and 21" with "Table 18, Table 21 and Table 25".*

#### **19.16 Flame spread test on single cables**

*Replace the existing Subclause 19.16, including its title, with the following new Subclause 19.16:*

#### **19.16 Test under fire conditions**

##### **19.16.1 General**

The test in 19.16.2 shall be carried out on ST<sub>1</sub>, ST<sub>2</sub> or SE<sub>1</sub> oversheathed cables, as specified in the relevant subclause.

The tests in 19.16.3 to 19.16.8 shall be carried out on ST<sub>8</sub> or ST<sub>12</sub> oversheathed cables, as specified in each relevant subclause.

##### **19.16.2 Flame spread test for single cables**

This test shall be carried out on ST<sub>1</sub>, ST<sub>2</sub> or SE<sub>1</sub> oversheathed cables only when such a fire performance is specially required or declared.

The test method and requirements shall be those specified in IEC 60332-1-2.

### 19.16.3 Flame spread test for bunched cables

This test shall be carried out on ST<sub>8</sub> or ST<sub>12</sub> oversheathed halogen free cables.

The test method and requirements shall be those specified in IEC 60332-3-24.

NOTE Higher performance to meet the requirements of IEC 60332-3-22 or IEC 60332-3-23 can be agreed between the manufacturer and customer.

### 19.16.4 Measurement of smoke density of cables burning under defined conditions

This test shall be carried out on ST<sub>8</sub> or ST<sub>12</sub> oversheathed halogen free cables.

The test method and requirements shall be those specified in IEC 61034-2. The results shall comply with the requirements given in Table 25.

### 19.16.5 Determination of acidity (by pH measurement) and conductivity of gases evolved during combustion of the non-metallic materials in the cable

This test shall be carried out on the non-metallic components of ST<sub>8</sub> or ST<sub>12</sub> oversheathed halogen free cables.

The test specified in IEC 60754-2 shall be carried out on the non-metallic components of the cable. It is not necessary to test non-metallic components if their mass is less than or equal to 1 % of the total non-metallic mass.

The weighted values of pH and conductivity of the non-metallic components of the cable shall be calculated according to IEC 60754-2 and shall comply with the requirements given in Table 25.

### 19.16.6 Fire performance tests on halogen free oversheath material ST<sub>8</sub>

#### 19.16.6.1 Acid gas emission test

##### 19.16.6.1.1 General

This test shall be carried out on the non-metallic components of ST<sub>8</sub> oversheathed halogen free cables.

##### 19.16.6.1.2 Procedure

The test method shall be that specified in IEC 60754-1.

##### 19.16.6.1.3 Requirements

The results of the test shall comply with the requirements of Table 25.

#### 19.16.6.2 Fluorine content test

##### 19.16.6.2.1 General

This test shall be carried out on the non-metallic components of ST<sub>8</sub> oversheathed halogen free cables.

##### 19.16.6.2.2 Procedure

The test method shall be that specified in IEC 60684-2.

### 19.16.6.2.3 Requirements

The results of the test shall comply with the requirements of Table 25.

### 19.16.7 Fire performance tests on halogen free oversheath material ST<sub>12</sub>

#### 19.16.7.1 Determination of acidity (by pH measurement) and conductivity of gases evolved during combustion of oversheath

The test specified in IEC 60754-2 shall be carried out on the oversheath of the cable.

The results shall comply with the requirements given in Table 25.

#### 19.16.7.2 Measurement of halogen content of gases evolved during combustion of the oversheath

The value for the oversheath,  $H_j$ , of the individual halogen content for each of the four halogens F, Cl, Br, and I, shall be determined by carrying out the test in accordance with IEC 60754-3.

The values for each of four individual halogens,  $H_j$ , and the sum of the values for the oversheath for the four halogens, i.e.  $\Sigma H_j$ , shall comply with the requirements given in Table 25.

#### 19.16.8 Measurement of halogen content of gases evolved during combustion of the non-metallic materials in the cable

This test shall be carried out on the non-metallic components of ST<sub>12</sub> oversheathed halogen free cables.

The weighted value for the cable,  $H'_j$ , for the four halogens F, Cl, Br, and I, shall be determined by carrying out the test in accordance with IEC 60754-3 either:

- individually on each non-metallic component of the cable, and calculating the weighted value for the cable, for each halogen, as described in Annex I,
- or on a sample representative of the cable construction prepared as described in Annex I, in which case the result for each halogen shall be taken as the weighted value for the cable.

It is not necessary to test non-metallic components if their mass is less than or equal to 1 % of the total non-metallic mass.

The weighted value for the cable,  $H'_j$ , for each of the four individual halogens and the sum of the weighted values for the non-metallic components of the cable for the four halogens, i.e.  $\Sigma H'_j$ , shall comply with the requirements given in Table 25.

### 19.22 Shrinkage test for PE oversheaths

*Replace the existing title of 19.22 with the following new title:*

### 19.22 Shrinkage test for PE and halogen free oversheaths

#### 19.22.1 Procedure

*Add, after "Table 22", "and Table 25".*

#### 19.22.2 Requirements

*Add, after "Table 22", "and Table 25".*

## 19.24 Water penetration test

*Add, in the last paragraph, after "Annex F", "and Annex H"*

*Add, at the end of 19.24, the following new Subclauses 19.25 and 19.26:*

## 19.25 Additional tests on halogen free oversheath of type ST<sub>8</sub>

### 19.25.1 General

These tests are intended to check that the halogen free oversheaths are not liable to damage during installation and operation.

### 19.25.2 Water absorption test for halogen free oversheath of type ST<sub>8</sub>

#### 19.25.2.1 Procedure

The sampling and test procedure shall be carried out in accordance with IEC 60811-402 employing the conditions and method specified in Table 25 for ST<sub>8</sub>.

#### 19.25.2.2 Requirements

The results of the test shall comply with the requirements of Table 25 for ST<sub>8</sub>.

### 19.25.3 Abrasion test on halogen free oversheath of type ST<sub>8</sub>

The test method and requirements are under consideration.

## 19.26 Bending test on interlock armour

The test and examination shall be carried out according to 17.11.

## 20.3 Insulation test

*Replace the existing Subclause 20.3, including its title, up to and including the existing note in 20.3.2, with the following new Subclause 20.3:*

### 20.3 AC voltage test of the insulation

By agreement between the customer and the contractor, an a.c. voltage test in accordance with IEC 60060-3 and in accordance with item a), b) or c) as below may be used:

- a) test for 15 min with the phase-to-phase voltage  $U$ , at a frequency between 20 Hz to 300 Hz shall be applied between the conductor and the metal screen/sheath;
- b) test for 24 h with the normal rated voltage  $U_0$  of the system;
- c) test for 15 min with the RMS rated voltage value of  $3 U_0$  at a frequency of 0,1 Hz applied between the conductor and the metal screen/sheath.

NOTE 1 During the a.c. test,  $\tan \delta$  and/or partial discharge can be monitored.

NOTE 2 For installations which have been in use, lower voltages and/or shorter durations can be used. Values can be negotiated, taking into account the age, environment, history of breakdowns and the purpose of carrying out the test.

NOTE 3 A differentiation in test voltage levels for sinusoidal and cosine-rectangular VLF voltages is under consideration.



NOTE x indicates that the type test is applied.

\* For black oversheaths only.

\*\* To be applied to those designs of cable where the manufacturer claims that the insulation screen is strippable.

\*\*\* To be applied to those designs of cable where the manufacturer claims that barriers to longitudinal water penetration have been included.

Replace the existing Table 20 with the following new Table 20:

**Table 20 – Test requirements for mechanical characteristics of sheathing compounds (before and after ageing)**

Designation of compounds (see 4.3)		ST <sub>1</sub>	ST <sub>2</sub>	ST <sub>3</sub>	ST <sub>7</sub>	ST <sub>8</sub>	ST <sub>12</sub>	SE <sub>1</sub>
<b>Maximum conductor temperature in normal operation (see 4.3)</b>	°C	<b>80</b>	<b>90</b>	<b>80</b>	<b>90</b>	<b>90</b>	<b>90</b>	<b>85</b>
<i>Without ageing (IEC 60811-501)</i>								
Tensile strength, minimum	N/mm <sup>2</sup>	12,5	12,5	10,0	12,5	9,0	12,5	10,0
Elongation-at-break, minimum	%	150	150	300	300	125	300	300
<i>After ageing in air oven (IEC 60811-401)</i>								
Treatment:								
– temperature (tolerance ±2 K)	°C	100	100	100	110	100	110	100
– duration	h	168	168	240	240	168	240	168
Tensile strength:								
a) value after ageing, minimum	N/mm <sup>2</sup>	12,5	12,5	–	–	9,0	10	–
b) variation *, maximum	%	±25	±25	–	–	±40	±30	±30
Elongation-at-break:								
a) value after ageing, minimum	%	150	150	300	300	100	300	250
b) variation *, maximum	%	±25	±25	–	–	±40	–	±40
* Variation: difference between the median value obtained after ageing and the median value obtained without ageing expressed as a percentage of the latter.								

Add, after the existing Table 23, the following new Table 25:

**Table 25 – Test requirements for particular characteristics of halogen free sheathing compounds**

Designation of compound (see 4.3)	Unit	ST <sub>8</sub>	ST <sub>12</sub>
<i>Behaviour at low temperature *</i>			
Tests to be carried out without previous ageing:			
a) Cold elongation test on dumb-bells (IEC 60811-505)			
Test temperature (tolerance ±2 K)	°C	-15	-15
Requirement	%	≥ 20	≥ 20
b) Cold impact test (IEC 60811-506)			
Test temperature (tolerance ±2 K)	°C	-15	-15
Requirement	–	no cracks	no cracks
<i>Pressure test at high temperature (IEC 60811-508)</i>			
Test temperature (tolerance ±2 K)	°C	80	110
Maximum indentation	%	50	50

Designation of compound (see 4.3)	Unit	ST <sub>8</sub>	ST <sub>12</sub>
<i>Shrinkage test</i> (IEC 60811-503)			
Test temperature (tolerance ±2 K)	°C	–	80
Duration	h	–	5
Number of heating cycles		–	5
Maximum shrinkage allowed	%	–	3,0
<i>Water absorption test</i> (IEC 60811-402)			
Gravimetric method:			
Treatment:			
– temperature (tolerance ±2 K)	°C	70	–
– duration	h	24	–
Maximum increase of mass	mg/cm <sup>2</sup>	10	–
<i>Flame spread test on bunched cables (complete cable)</i> (IEC 60332-3-24)			
Upper limit of char above bottom edge of burner	m	≤ 2,5	≤ 2,5
<i>Smoke density test on cables (complete cables)</i> (IEC 61034-2)			
– light transmittance T min	%	60	60
<i>Acid gas emission test</i> (IEC 60754-1)			
– Bromine and chlorine content (expressed as HCl), maximum	%	0,5	–
<i>Fluorine content test</i> (IEC 60684-2)			
– Fluorine content, maximum	%	0,1	–
<i>pH value and conductivity tests, for the oversheath or as weighted values for the cable</i> (IEC 60754-2)			
– pH	–	≥ 4,3	≥ 4,3
– conductivity	µS/mm	≤ 10	≤ 10
<i>Measurement of halogen content of gases evolved during combustion of the oversheath (19.16.7.2)</i> (IEC 60754-3)			
– Value for each of the 4 individual halogens (F, Cl, Br, I)	$H_i$ mg/g	–	≤ 2
– Sum of values for the 4 individual halogens (F, Cl, Br, I)	$\Sigma H_i$ mg/g	–	≤ 5
<i>Measurement of halogen content of gases evolved during combustion of the non-metallic materials in the cable (19.16.8)</i> (IEC 60754-3)			
– Value for each of the 4 individual halogens (F, Cl, Br, I)	$H'_i$ mg/g	–	≤ 2
– Sum of values for the 4 individual halogens (F, Cl, Br, I)	$\Sigma H'_i$ mg/g	–	≤ 5
* Because of climatic conditions, national standards can require the use of a lower or higher test temperature.			

**Annex A**

**A.2.4 Inner coverings**

Add, at the end of item a), after "A.2.7 applies instead", the following new text: "(in which case  $D_u = D_f$ )".

**A.2.10 Armour**

Add, at the end of item b), the following new item c):

c) for interlock metal tape armour by increase in diameter according to Table A.4:

**Table A.4 – Increase of diameter over interlocked armour**

Fictitious diameter under the armour		Increase in diameter over interlocked armour mm
Above mm	Up to and including mm	
-	20	4,5
20	40	6,5
40	-	8,5

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Add, at the end of Annex G, the following new Annex H and Annex I:

## **Annex H** (normative)

### **Test for water penetration in the conductor**

#### **H.1 General**

This test is applied only for stranded conductors having a nominal cross-sectional area larger than 630 mm<sup>2</sup>.

#### **H.2 Test piece**

A 1,5 m sample of cable which has been subjected to the bending test of 18.2.4 shall be placed horizontally.

All layers external to the insulation screen shall be removed from the sample and the full cross-section of the conductor shall be exposed at both ends of the test piece.

Arrange a suitable chamber to enclose one end of the test piece. The chamber shall be fitted with an air vent and a separate vertical tube, both of at least 10 mm internal diameter, with a header tank to allow the application of a 1 m head of water (see Figure H.1). The chamber shall be sealed to the surface of the insulation screen. The seal where the cable exits the chamber shall not deform the insulation during the test.

NOTE The response of certain barriers to longitudinal penetration can be dependent on the composition of the water (e.g. pH, ion concentration). Normal tap water is used for the test unless otherwise specified.

#### **H.3 Test**

The tube shall be filled within 5 min with tap water at a temperature of  $(20 \pm 10)$  °C so that the height of the water in the tube is 1 m above the cable centre (see Figure H.1). The sample shall be allowed to stand for 11 days at ambient temperature.

#### **H.4 Requirements**

During the period of testing, no water shall emerge from the end of the test piece.