

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**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 4: Test requirements on accessories for cables with rated voltages from 6 kV ( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV)**

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**Câbles d'énergie à isolant extrudé et leurs accessoires pour des tensions assignées de 1 kV ( $U_m = 1,2$  kV) à 30 kV ( $U_m = 36$  kV) –**

**Partie 4: Exigences d'essai pour accessoires de câbles de tensions assignées de 6 kV ( $U_m = 7,2$  kV) à 30 kV ( $U_m = 36$  kV)**



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**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 4: Test requirements on accessories for cables with rated voltages from 6 kV ( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV)**

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**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 4: Test requirements on accessories for cables with rated voltages  
from 6 kV ( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV)**

## FOREWORD

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International Standard IEC 60502-4 has been prepared by IEC technical committee 20: Electric cables.

This third edition cancels and replaces the second edition, published in 2005, and constitutes a technical revision.

Significant technical changes with respect to the previous edition are as follows:

- a) the range of approval has been revised;
- b) a water immersion test requirement for outdoor terminations has been introduced;
- c) examination of accessories at the end of the test sequence is to be recorded in a test report for information only;
- d) both the a.c. and d.c. test are to be carried out;

e) the heating cycle test has been added to Table 11.

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

FDIS	Report on voting
20/1181/FDIS	20/1208/RVD

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

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

IEC 60502 consists of the following parts, under the general title *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 1: Cables for rated voltages of 1 kV ( $U_m = 1,2$  kV) and 3 kV ( $U_m = 3,6$  kV);
- Part 2: Cables for rated voltages from 6 kV ( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV);
- Part 3: Reserved;
- Part 4: Test requirements on accessories for cables with rated voltages from 6 kV ( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV).

The committee has decided that the contents of this amendment and the base publication 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

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# 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 4: Test requirements on accessories for cables with rated voltages from 6 kV ( $U_m = 7,2$ kV) up to 30 kV ( $U_m = 36$ kV)

### 1 Scope

This part of IEC 60502 specifies the test requirements for type testing of accessories for power cables with rated voltages from 3,6/6 (7,2) kV up to 18/30 (36) kV, complying with IEC 60502-2.

Accessories for special applications, such as aerial cables, submarine or ship cables or hazardous situations (explosive environments, fire-resistant cables or seismic conditions), are not included.

It is not necessary to repeat these tests, once successfully completed, unless changes are made in the materials, design or manufacturing process which might affect the performance characteristics.

Test methods are included in IEC 61442.

NOTE This standard does not invalidate existing approvals of products achieved on the basis of national standards and specifications and/or the demonstration of satisfactory service performance. However, products approved according to such national standards or specifications cannot directly claim approval to this IEC standard. It may be possible, subject to agreement between supplier and purchaser, and/or the relevant conformity assessment body, to demonstrate that conformity to the earlier standard can be used to claim conformity to this standard, provided an assessment is made of any additional type testing that may need to be carried out. Any such additional testing that is part of a sequence of testing cannot be done separately.

### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including amendments) applies.

IEC 60183, *Guide to the selection of high-voltage cables*

IEC 60502-2:2005, *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)*

IEC 61238-1, *Compression and mechanical connectors for power cables for rated voltages up to 30 kV ( $U_m = 36$  kV) – Part 1: Test methods and requirements*

IEC 61442:2005, *Test methods for accessories for power cables with rated voltages from 6 kV ( $U_m = 7,2$  kV) up to 30 kV ( $U_m = 36$  kV)*

### 3 Terms and definitions

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



**3.1****connector**

metallic device to connect cable conductors together

[IEC 60050-461:2008, 461-17-03] [1]<sup>1</sup>

**3.2****termination**

device fitted to the end of a cable to ensure electrical connection with other parts of the system and to maintain the insulation up to the point of connection

[IEC 60050-461:2008, 461-10-01]

**3.3****indoor termination**

termination intended for use where it is not exposed to either solar radiation or weathering

**3.4****outdoor termination**

termination intended for use where it is exposed to either solar radiation or weathering or both

**3.5****terminal box**

air- or compound-filled box fully enclosing a termination

[IEC 60050-461:2008, 461-10-03, modified]

**3.6****shrouded termination**

indoor termination with additional insulation at the bushing connection and used in an air-filled terminal box

**3.7****straight joint**

accessory making a connection between two cables to form a continuous circuit

[IEC 60050-461:2008, 461-11-01]

**3.8****branch joint**

accessory making a connection of a branch cable to a main cable

[IEC 60050-461:2008, 461-11-17]

**3.9****transition joint**

straight or branch joint making a connection between cables having different types of insulation

[IEC 60050-461:2008, 461-11-04, modified]

**3.10****stop end**

accessory providing a means of insulating the unconnected end of an energized cable

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<sup>1</sup> References in square brackets refer to the Bibliography.

[IEC 60050-461:2008, 461-10-07, modified]

### 3.11

#### **separable connector**

fully insulated termination permitting the connection and the disconnection of a cable to other equipment

### 3.12

#### **screened separable connector**

separable connector which has a fully screened external surface

### 3.13

#### **unscreened separable connector**

separable connector which does not have an external screen

### 3.14

#### **plug-in type separable connector**

separable connector in which the electrical contact is made by a sliding device

### 3.15

#### **bolted-type separable connector**

separable connector in which the electrical contact is made by a bolted device

### 3.16

#### **deadbreak connector**

separable connector designed to be connected and disconnected on de-energized circuits only

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### 3.17

#### **loadbreak connector**

separable connector designed to be connected and disconnected on energized circuits

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### 3.18

#### **range-taking accessory**

accessory designed to take more than one cross-section of cable

### 3.19

#### **tracking**

irreversible degradation by formation of paths, which are conductive even under dry conditions, starting and developing on the surface of an insulating material and which may occur on surfaces in contact with air and also on the interfaces between different insulating materials

### 3.20

#### **erosion**

irreversible and non-conducting degradation of the surface of the insulator that occurs by loss of material, and which may be uniform, localized or tree shaped

NOTE Shallow surface traces, commonly tree-shaped, may occur on terminations, after partial flashover. These traces are acceptable as long as they are non-conductive. When they are conductive they are classed as tracking.

### 3.21

#### **metallic housing**

metal enclosure in intimate contact with the outer screen of a separable connector and having at least the same current carrying capacity to earth as the metallic screen of the cable with which the separable connector is to be used

## 4 Types of accessory

The accessories covered by this standard are listed below:

- indoor and outdoor terminations of all designs, including terminal boxes;
- straight joints, branch joints and stop ends of all designs, suitable for use underground or in air;
- screened or unscreened plug-in type or bolted type separable connectors.

NOTE Transition joints connecting cables with extruded insulation to paper-insulated cables are not included in the scope of this standard. The requirements for these accessories are dealt with in IEC 60055 [2].

## 5 Voltage designations and maximum conductor temperatures

### 5.1 Rated voltages

The rated voltages  $U_0/U$  ( $U_m$ ) of accessories considered in this standard are given in 4.1 of IEC 60502-2:2005.

For a given application, the rated voltage of an accessory shall be consistent with that of the cable, and shall be suitable for the operating condition of the system in which they are used, in accordance with the recommendations of IEC 60183.

### 5.2 Maximum conductor temperatures

The accessories shall be suitable for use on cables having the conductor temperatures specified in 4.2 of IEC 60502-2:2005 for normal operation.

The maximum conductor temperatures of the cables under short-circuit conditions are given in Table 3 of IEC 60502-2:2005.

## 6 Assembly of accessories to be tested

### 6.1 Identification

**6.1.1** Cables used for testing shall comply with IEC 60502-2 and shall be of the same rated voltage as the accessories to be tested.

Constructional details of the cables shall be identified (refer to Annex A).

**6.1.2** Connectors used within the accessories shall be correctly identified with respect to

- assembly technique,
- tooling, dies and necessary setting,
- preparation of contact surfaces, if applicable,
- type, reference number and any other identification of the connector,
- details of the type test approval,
- the standard with which they comply (i.e. IEC 61238-1).

**6.1.3** Accessories to be tested shall be correctly identified with respect to

- name of manufacturer.
- type, designation, manufacturing date or code.
- minimum and maximum cable cross-sections, material and shape of cable conductor.

- minimum and maximum cable insulation diameters,
- rated voltage (see 5.1),
- installation instructions (reference and date),
- inside dimensions or type of terminal box if applicable.

**6.2 Installation and connections**

**6.2.1** Unless otherwise specified, the conductor cross-sectional area shall be as follows:

- a) for terminations, joints and stop ends: 120 mm<sup>2</sup> or 150 mm<sup>2</sup> or 185 mm<sup>2</sup>;
- b) for separable connectors: each rating shall be tested as indicated in Table 1, using either aluminium or copper conductors.

**Table 1 – Conductor cross-sectional area for testing of separable connectors**

Rating  A	Conductor cross-sectional area mm <sup>2</sup>	
	Cu	Al
200/250	50	70
400	95	150
600/630	185	300
800	300	400
1 250	500	630

NOTE 1 The current value should be sufficient to achieve the specified conductor temperature (see 9.1 of IEC 61442:2005).

NOTE 2 The use of these conductor cross-sectional areas may lead to overheating of the bushing while achieving the required conductor temperature. Under these circumstances, it is permissible to use a conductor cross-sectional area one size smaller. If a bushing failure occurs, the test should be declared void (see 9.2 of this standard).

**6.2.2** Accessories shall be assembled in the manner specified by the manufacturer's instructions, with the grade and quantity of materials supplied, including lubricants, if any.

**6.2.3** Accessories shall be dry and clean, but neither the cables nor the accessories shall be subjected to any form of conditioning which might modify the electrical or thermal or mechanical performance of the test assemblies.

NOTE Contact with chemicals, e.g. transformer oil, may affect the properties of the accessory and should be avoided.

**6.2.4** Unless otherwise specified, separable connectors shall be connected to their mating bushing.

**6.2.5** Where terminations or separable connectors are to be tested, the connection between either lugs or bushings shall have the same electrical cross-sectional area as that of the cable conductor.

**6.2.6** For unscreened separable connectors, the minimum phase-to-phase and phase-to-earth clearances, recommended by the manufacturer, shall be tested.

**6.2.7** Where branch joints are to be tested, only the main cable shall carry the heating current.

**6.2.8** The main details regarding test mounting, especially supporting devices, shall be recorded.

**6.2.9** Test arrangements and number of samples are detailed in Figures 1 to 5.

## 7 Range of approval

**7.1** For terminations, joints and stop ends, compliance for one type of accessory for the range of cable conductor cross-sections from 95 mm<sup>2</sup> to 300 mm<sup>2</sup> shall be obtained by successfully completing all the appropriate tests of Tables 5 to 7 on one of the cross-sections specified in 6.2.1.

For separable connectors, compliance for one type of accessory for the range of cable conductor cross-sections given in Table 2 shall be obtained by successfully completing all the appropriate tests of Table 8 to 10 on the cross-section specified in Table 1 in 6.2.1 b).

Extension of the range of compliance for the same type of accessory to larger or smaller cable conductor cross-sections shall be obtained by successfully completing the additional test sequence in Table 11, on the appropriate larger or smaller cross-section.

For extension of compliance of separable connectors to larger cable conductor cross-sections, the test current shall be limited to the rating of the mating bushing.

**Table 2 – Range of compliance for separable connectors**  
(standards.iteh.ai)

Rating of separable connector	Cable conductor cross-sectional area	
	Range of compliance mm <sup>2</sup>	
A	Min	Max.
200/250	25	95
400	95	240
600/630	95	300
800	150	400
1 250	240	630

**7.2** Approval is independent of the cable conductor material: tests may therefore be carried out using cables with either aluminium or copper conductors.

**7.3** Tests performed on accessories installed on cables having shaped conductors shall be deemed to cover the same type of accessory when used on cables having circular conductors; however, the converse does not apply.

In order to achieve extension of approval from round to sector-shaped conductors, additional tests shall be performed according to Table 12. Stop ends shall be tested as in Table 7 using half the number of samples in Figure 3.

**7.4** Approval is dependent on the cable insulation tested as detailed in Table 3.

**Table 3 – Range of approval for cable insulation**

Insulation of test cable	Range of approval
XLPE	XLPE, EPR, HEPR and PVC
EPR or HEPR	EPR, HEPR and PVC
PVC	PVC

**7.5** The additional tests specified in Table 12 shall be carried out to achieve extension of approval for different types of cable insulation semiconducting screens. Stop ends shall be tested as in Table 7 using half the number of samples in Figure 3.

**7.6** Approval obtained by testing on a non longitudinally water-blocked type of cable shall be extended to a cable with means of longitudinal water-blocking in the metallic screen area but otherwise of the same design. The converse shall not apply.

**7.7** Tests performed on three-core accessories shall be deemed to cover single-core accessories of the same design. The converse shall not apply.

**7.8** Compliance of an accessory tested for a specified  $U_0$  shall extend to operation of the accessory at a lower  $U_0$  provided that the radial electrical stress at the insulation screen of the cable of lower  $U_0$  is not greater than that of the test cable.

In addition, for separable connectors, the screen fault current initiation test shall be carried out at the lowest  $U_0$  for which compliance is required.

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**8 Test sequences**

[IEC 60502-4:2010](https://standards.iteh.ai/catalog/standards/sist/6b269980-ddcb-4162-a2b2-695214455ca1/iec-60502-4-2010)

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The tests applicable to accessories shall be carried out in the sequences listed in the tables and figures mentioned in Table 4.

**Table 4 – Test sequences**

Accessories	Table	Figure
Terminations	5	1
Straight or branch joints	6	2
Stop ends	7	3
Screened deadbreak separable connectors	8	4
Unscreened deadbreak separable connectors	9	5
Loadbreak separable connectors	10 <sup>a</sup>	6 <sup>a</sup>
Additional tests for smallest and largest conductor cross-sectional areas	11	–
Additional tests for different types of cable insulations screen and approval from round to shaped conductors	12	–
NOTE In Tables 5 to 9, the symbols have the meaning given in IEC 61442, i.e:		
$I_{sc}$	short-circuit current (r.m.s. value) in the metallic screen;	
$I_d$	short-circuit current (initial peak value) in the conductor;	
$\theta_{sc}$	maximum permissible short-circuit temperature of the cable conductor.	
<sup>a</sup> Under consideration.		

Tests on terminations and joints may be combined, provided the sequences and requirements are the same.

A summary of the tests required is given in Table 13. The test voltages and requirements are summarized in Table 14.

## 9 Test results

### 9.1 General remarks

All test samples, tested as indicated in Clause 7 and Tables 5 to 12, shall meet the requirements for all test sequences.

If any of the test samples do not meet the requirements, they shall be dismantled, inspected to determine if 9.2 or 9.3 applies and the result of the inspection recorded.

The examination at the end of a test sequence is for information only, but the results shall be recorded in the test report.

### 9.2 Accessory failure

If an accessory fails to meet the requirements due to either installation or test procedure errors, the test shall be declared void without discrediting the accessories.

The complete test sequence shall be repeated on a new set of samples.

If there is no evidence of such error, the type of accessory is not approved.

### 9.3 Cable failure

If a cable fails beyond any part of an accessory, the tests shall be declared void without discrediting the accessories. Tests may be repeated using new accessories (start testing from the beginning of the test sequence) or alternatively by repair of the cable (continue testing from the point of break).

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