

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)**

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)



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2005 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: 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 corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,...). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:

Email: csc@iec.ch

Tél.: +41 22 919 02 11

Fax: +41 22 919 03 00

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)**

**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)**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX



CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references.....	6
3 Terms and definitions	7
4 Types of accessory.....	9
5 Voltage designations and maximum conductor temperatures.....	9
5.1 Rated voltages	9
5.2 Maximum conductor temperatures	9
6 Assembly of accessories to be tested.....	9
6.1 Identification.....	9
6.2 Installation and connections.....	10
7 Range of approval	11
8 Test sequences	12
9 Test results	13
9.1 Accessory failure.....	13
9.2 Cable failure.....	13
Annex A (informative) Identification of test cable (see 6.1.1).....	31
Figure 1 – Test arrangements and number of samples for terminations (see Table 4)	25
Figure 2 – Test arrangements and number of samples for straight or branch joints (see Table 5)	26
Figure 3 – Test arrangements and number of samples for stop ends (see Table 6)	27
Figure 4 – Test arrangements and number of samples for screened deadbreak separable connectors (see Table 7).....	28
Figure 5 – Test arrangements and number of samples for unscreened deadbreak separable connectors (see Table 8).....	29
Figure 6 – Test arrangements and number of samples for loadbreak separable connectors (see Table 9).....	30
Table 1 – Conductor cross-sectional area for testing of separable connectors.....	10
Table 2 – Range of approval for cable insulation.....	12
Table 3 – Test sequences	12
Table 4 – Test sequences and requirements for terminations.....	14
Table 5 – Test sequences and requirements for straight or branch joints	15
Table 6 – Test sequence and requirements for stop ends	16
Table 7 – Test sequences and requirements for screened deadbreak separable connectors	17
Table 8 – Test sequences and requirements for unscreened separable connectors (excluding shrouded terminations).....	19
Table 9 – Test sequences and requirements for loadbreak separable connectors	20

Table 10 – Additional tests for smallest and largest conductor cross-sectional areas (see 7.1)	21
Table 11 – Additional tests for different types of cable insulation screen and approval from round to shaped conductors (not applicable to stop ends, see 7.1 and 7.3)	22
Table 12 – Summary of tests	23
Table 13 – Summary of test voltages and requirements (see Clause 9)	24

Withheld

iTech Standards
(<https://standards.itih.ai>)
Document Preview

IEC 60502-4:2005
<https://standards.itih.ai/standards/iec/60502-4:2005>

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 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

- 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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.

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

This second edition cancels and replaces the first edition published in 1997 and constitutes a technical revision.

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

- a) the scope clarifies the validation of former product approvals;
- b) definitions have been given for tracking, erosion and metallic housing, and substantial damage has been more detailed;

- c) the range of approval has been revised;
- d) test sequences have been simplified by removing initial heating cycles;
- e) additional information has been provided for testing separable connectors with a metallic housing;
- f) an examination has been added to all test sequences for information only.

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

FDIS	Report on voting
20/743/FDIS	20/756/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 publication will remain unchanged until the maintenance result 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.

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.

Formerly, approvals of products now covered by this IEC standard have been achieved on the basis of national standards and specifications and/or the demonstration of satisfactory service performance. The publication of this IEC standard does not invalidate existing approvals. However, products approved according to these earlier standards or specifications cannot claim approval to this IEC standard unless specifically tested to it.

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.

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 60183:1984, *Guide to the selection of high-voltage cables*

IEC 60502-2:1998, *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 61442:1997, *Electric cables – 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

[IEV 461-17-03]¹

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

[IEV 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

[IEV 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

[IEV 461-11-01]

3.8

branch joint

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

[IEV 461-11-07, modified]

3.9

transition joint

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

[IEV 461-11-04, modified]

¹ IEC 60050(461):1984, *International Electrotechnical Vocabulary (IEV) – Chapter 461: Electric cables*

3.10

stop end

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

[IEV 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

3.17

loadbreak connector

separable connector designed to be connected and disconnected on energized circuits

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*.

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.

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 for normal operation.

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

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.

It is recommended that cables be correctly identified as in Annex A.

* IEC 60055 (all parts), *Paper-insulated metal-sheathed cables for rated voltages up to 18/30 kV (with copper or aluminium conductors and excluding gas-pressure and oil-filled cables)*.

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.

NOTE See IEC 61238-1: 2003, *Compression and mechanical connectors for power cables for rated voltages up to 30 kV (U_m = 36 kV) – Part 1 : Test methods and requirements.*

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 mm² or 150 mm² or 185 mm²;
- 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 ²	
	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).

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 9.1).

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 Approval of a range of conductor cross-sectional areas from 95 mm² to 300 mm² of one type of accessory for both range-taking and non-range-taking shall be obtained by successfully completing the full range of type tests of this standard as listed in Tables 4 to 9, on a conductor cross-sectional area as indicated in 6.2.1.

Extension of approval to a range wider than that given above shall be achieved by carrying out the additional tests listed in Table 10 on the smallest and/or largest conductor cross-sectional areas of the required range.

Approval of a range of conductor cross-sectional areas for a separable connector shall be obtained by successfully completing the full range of type tests of this standard, as listed in Tables 7 to 9, on a conductor cross-sectional area as indicated in Table 1 and in 6.2.1b). In addition, the type tests listed in Table 10 shall be successfully completed on the smallest and/or largest conductor cross-sectional areas in the range.

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. The converse will not apply.

In order to achieve extension of approval from round to sector-shaped conductors, additional tests shall be performed according to Table 11. Stop ends shall be tested as in Table 6 using half the number of samples in Figure 3.

7.4 Approval is dependent on the cable insulation tested as detailed in Table 2.

Table 2 – 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 11 shall be carried out to achieve extension of approval for different types of cable insulation screen. Stop ends shall be tested as in Table 6 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 will not apply.

7.8 Approval of an accessory tested for a specified U_0 shall extend to operation of the accessory at a lower U_0 .

8 Test sequences

The tests applicable to accessories shall be carried out in the sequences listed in the tables and figures mentioned in Table 3.

Table 3 – Test sequences

Accessories	Table	Figure
Terminations	4	1
Straight or branch joints	5	2
Stop ends	6	3
Screened deadbreak separable connectors	7	4
Unscreened deadbreak separable connectors	8	5
Loadbreak separable connectors	9*	6*
Additional tests for smallest and largest conductor cross-sectional areas	10	–
Additional tests for different types of cable insulations screen and approval from round to shaped conductors	11	–
* Under consideration.		
NOTE In Tables 4 to 8, 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;	
θ_{sc}	maximum permissible short-circuit temperature of the cable conductor.	

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 12. The test voltages and requirements are summarized in Table 13.