

INTERNATIONAL STANDARD



Power cables with extruded insulation and their accessories for rated voltages above 150 kV ($U_m = 170$ kV) up to 500 kV ($U_m = 550$ kV) – Test methods and requirements

Câbles d'énergie à isolation extrudée et leurs accessoires pour des tensions assignées supérieures à 150 kV ($U_m = 170$ kV) et jusqu'à 500 kV ($U_m = 550$ kV) – Méthodes et exigences d'essai



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2011 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 It also gives information on projects, withdrawn and replaced publications.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



Power cables with extruded insulation and their accessories for rated voltages above 150 kV ($U_m = 170$ kV) up to 500 kV ($U_m = 550$ kV) – Test methods and requirements

Câbles d'énergie à isolation extrudée et leurs accessoires pour des tensions assignées supérieures à 150 kV ($U_m = 170$ kV) et jusqu'à 500 kV ($U_m = 550$ kV) – Méthodes et exigences d'essai

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

Withdrawing

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

IEC 62067:2011

<https://standards.iteh.ai/catalog/standards/iec/84cd91fb-7bd9-4302-a5e6-ed4c6ddff9fb/iec-62067-2011>

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Power cables with extruded insulation and their accessories for rated voltages above 150 kV ($U_m = 170$ kV) up to 500 kV ($U_m = 550$ kV) – Test methods and requirements

Câbles d'énergie à isolation extrudée et leurs accessoires pour des tensions assignées supérieures à 150 kV ($U_m = 170$ kV) et jusqu'à 500 kV ($U_m = 550$ kV) – Méthodes et exigences d'essai

CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references.....	9
3 Terms and definitions	10
3.1 Definitions of dimensional values (thicknesses, cross-sections, etc.).....	10
3.2 Definitions concerning tests	11
3.3 Other definitions	11
4 Voltage designations and materials	12
4.1 Rated voltages	12
4.2 Cable insulating materials	12
4.3 Cable metal screens/sheaths	12
4.4 Cable oversheathing materials	12
5 Precautions against water penetration in cables	12
6 Cable characteristics	13
7 Accessory characteristics.....	13
8 Test conditions	14
8.1 Ambient temperature	14
8.2 Frequency and waveform of power frequency test voltages	14
8.3 Wave form of impulse test voltages	14
8.3.1 Lightning impulse voltage.....	14
8.3.2 Switching impulse voltage.....	14
8.4 Relationship of test voltages to rated voltages.....	14
8.5 Determination of the cable conductor temperature	14
9 Routine tests on cables and on the main insulation of prefabricated accessories	15
9.1 General	15
9.2 Partial discharge test.....	15
9.3 Voltage test	15
9.4 Electrical test on oversheath of the cable	15
10 Sample tests on cables.....	16
10.1 General	16
10.2 Frequency of tests	16
10.3 Repetition of tests.....	16
10.4 Conductor examination	16
10.5 Measurement of electrical resistance of conductor and of metal screen/sheath.....	16
10.6 Measurement of thickness of insulation and cable oversheath.....	17
10.6.1 General	17
10.6.2 Requirements for the insulation.....	17
10.6.3 Requirements for the cable oversheath	17
10.7 Measurement of thickness of metal sheath.....	17
10.7.1 Lead or lead alloy sheath	18
10.7.2 Plain or corrugated aluminium sheath	18
10.8 Measurement of diameter	18
10.9 Hot set test for XLPE and EPR insulations	19
10.9.1 Procedure.....	19
10.9.2 Requirements	19
10.10 Measurement of capacitance	19

10.11	Measurement of density of HDPE insulation	19
10.11.1	Procedure.....	19
10.11.2	Requirements	19
10.12	Lightning impulse voltage test	19
10.13	Water penetration test	19
10.14	Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath	19
11	Sample tests on accessories.....	20
11.1	Tests on components	20
11.2	Tests on complete accessory.....	20
12	Type tests on cable systems	20
12.1	General	20
12.2	Range of type approval.....	20
12.3	Summary of type tests	21
12.4	Electrical type tests on complete cable systems	22
12.4.1	Test voltage values	22
12.4.2	Tests and sequence of tests	22
12.4.3	Bending test	23
12.4.4	Partial discharge tests	23
12.4.5	Tan δ measurement.....	24
12.4.6	Heating cycle voltage test.....	24
12.4.7	Impulse voltage tests.....	24
12.4.8	Examination.....	25
12.4.9	Resistivity of semi-conducting screens.....	25
12.5	Non-electrical type tests on cable components and on complete cable	26
12.5.1	Check of cable construction.....	26
12.5.2	Tests for determining the mechanical properties of insulation before and after ageing.....	26
12.5.3	Tests for determining the mechanical properties of oversheaths before and after ageing.....	27
12.5.4	Ageing tests on pieces of complete cable to check compatibility of materials	27
12.5.5	Loss of mass test on PVC oversheaths of type ST ₂	28
12.5.6	Pressure test at high temperature on oversheaths.....	28
12.5.7	Test on PVC oversheaths (ST ₁ and ST ₂) at low temperature	28
12.5.8	Heat shock test for PVC oversheaths (ST ₁ and ST ₂).....	28
12.5.9	Ozone resistance test for EPR insulation.....	29
12.5.10	Hot set test for EPR and XLPE insulations	29
12.5.11	Measurement of density of HDPE insulation.....	29
12.5.12	Measurement of carbon black content of black PE oversheaths (ST ₃ and ST ₇).....	29
12.5.13	Test under fire conditions	29
12.5.14	Water penetration test.....	29
12.5.15	Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath.....	30
13	Prequalification test of the cable system.....	30
13.1	General and range of prequalification test approval	30
13.2	Prequalification test on complete cable system	30
13.2.1	Summary of prequalification tests	30
13.2.2	Test voltage values	31
13.2.3	Test arrangement	31

13.2.4 Heating cycle voltage test	31
13.2.5 Lightning impulse voltage test	32
13.2.6 Examination.....	32
13.3 Tests for the extension of the prequalification of a cable system.....	32
13.3.1 Summary of the extension of prequalification test.....	32
13.3.2 Electrical part of the extension of prequalification tests on complete cable system.....	32
14 Type test on cables.....	34
15 Type test on accessories	34
16 Electrical test after installation	34
16.1 General	34
16.2 DC voltage test of the oversheath	35
16.3 AC voltage test of the insulation.....	35
Annex A (informative) Determination of the cable conductor temperature.....	42
Annex B (normative) Rounding of numbers.....	47
Annex C (informative) List of type and prequalification and extension of prequalification tests of cable systems.....	48
Annex D (normative) Method of measuring resistivity of semi-conducting screens.....	50
Annex E (normative) Water penetration test	52
Annex F (normative) Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath.....	54
Annex G (normative) Tests of outer protection for joints	57
Bibliography	60
Figure 1 – Extension of prequalification test arrangement for the prequalification of a system with another joint, designed for rigid as well as for flexible installation.....	33
Figure A.1 – Typical test set-up for the reference loop and the main test loop	43
Figure A.2 – Example of an arrangement of the temperature sensors on the conductor of the reference loop.....	44
Figure D.1 – Preparation of samples for measurement of resistivity of conductor and insulation screens	51
Figure E.1 – Schematic diagram of apparatus for water penetration test	53
Figure F.1 – Adhesion of metal foil	54
Figure F.2 – Example of overlapped metal foil	55
Figure F.3 – Peel strength of overlapped metal foil	55
Table 1 – Insulating compounds for cables	35
Table 2 – Oversheathing compounds for cables.....	35
Table 3 – Tan δ requirements for insulating compounds for cables	35
Table 4 – Test voltages	36
Table 5 – Non-electrical type tests for insulating and oversheathing compounds for cables.....	37
Table 6 – Test requirements for mechanical characteristics of insulating compounds for cables (before and after ageing).....	38
Table 7 – Test requirements for mechanical characteristics of oversheathing compounds for cables (before and after ageing)	39
Table 8 – Test requirements for particular characteristics of insulating compounds for cables.....	40

Table 9 – Test requirements for particular characteristics of PVC oversheathing for cables	41
Table C.1 – Type tests on cable systems.....	48
Table C.2 – Prequalification tests on cable systems.....	49
Table C.3 – Extension of prequalification tests on cable systems	49
Table G.1 – Impulse voltage tests	58

Witholdrawn

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

IEC 62067:2011
<https://standards.itih.ai/standards/iec/84cd91fb-7bd9-4302-a5e6-ed4c6ddff9fb/iec-62067-2011>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**POWER CABLES WITH EXTRUDED INSULATION AND
THEIR ACCESSORIES FOR RATED VOLTAGES
ABOVE 150 kV ($U_m = 170$ kV) UP TO 500 kV ($U_m = 550$ kV) –
TEST METHODS AND REQUIREMENTS**

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.

International Standard IEC 62067 has been prepared by IEC technical committee 20: Electric cables.

This second edition of IEC 62067 cancels and replaces the first edition, published in 2001, and its Amendment 1 (2006), and constitutes a technical revision.

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

- addition of the extension of prequalification test, requiring significant less time to be completed compared with the full prequalification test;
- during the routine tests on the main insulation of prefabricated accessories the required sensitivity level for the partial discharge test is reduced from 10 pC to 5 pC.

NOTE For a more detailed history of events leading up to this second edition, see the Introduction.

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

FDIS	Report on voting
20/1268/FDIS	20/1278A/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.

The committee has decided that the contents of this 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

IEC 62067:2011

<https://standards.itih.ai/standards/iec/84cd91fb-7bd9-4302-a5e6-ed4c6ddff9fb/iec-62067-2011>

WITHDRAWN

INTRODUCTION

As a result of major developments in cable systems with extruded insulation for voltages above 150 kV, CIGRE Study Committee (SC) 21 set up Working Group (WG) 21.03 in 1990. The terms of reference of WG 21.03 were *"to prepare recommendations for electrical type tests, sample and routine tests, based on extending IEC 60840:1988 up to 400 kV and to make proposals for prequalification/development tests which, as a minimum, should be performed"*.

WG 21.03 reported that the extension of IEC 60840 to voltages above 150 kV needed extra consideration because of the following factors:

- such cables form part of the backbone of the transmission system and, therefore, reliability considerations are of the highest priority;
- these cables and their accessories operate with higher electrical stresses than cables up to 150 kV and, as a result, have a smaller safety margin with respect to the intrinsic performance boundaries of the cable system;
- such cables and accessories have a thicker insulation wall than those up to 150 kV and, as a result, are subjected to greater thermomechanical effects;
- the design and coordination of the cables and accessories becomes more difficult with increasing system voltage levels.

The recommendations of the WG 21.03 were published in Electra No. 151 in December 1993 and taken into account by IEC in 1995 in the preparation of this standard for cable systems with extruded insulation for voltages above 150 kV. IEC considered that the new standard should also cover the 500 kV level. Thus, at its meeting in September 1996, CIGRE SC 21 set up task force 21.18 to study the extension of the initial recommendations to the 500 kV level. The updated recommendations were cited in Electra No. 193 in December 2000 and thus were also taken into account by IEC Technical Committee (TC) 20 in the preparation of the first edition of this standard.

On the advice of CIGRE, a long term accelerated ageing test was introduced in the first edition, in order to gain some indication of the long term reliability of a cable system. This test, known as the "prequalification test", was to be performed on the complete system comprising the cable, joints and terminations in order to demonstrate the performance of the system.

In addition, CIGRE WG 21.09, published recommendations for "tests after installation on high-voltage extruded insulation cable systems" in Electra No 173 in August 1997. These recommendations (which state, amongst other things, that d.c. tests should be avoided on the main insulation, as they are both ineffective and potentially damaging) were also taken into account in the first edition of this standard.

At its meeting in November 2004, TC 20 concluded that the next revision of IEC 62067 should include the recommendation for testing of HV and EHV extruded cables that was under preparation by the CIGRE SC B1 (previously SC 21) WG B1.06. This was made available as a CIGRE Technical Brochure 303 before the meeting of TC 20 in October 2006, which confirmed this view. Therefore Technical Brochure 303 has been considered by TC 20 and major parts implemented in this standard. This has resulted in some modifications to the prequalification test requirements, a major change being the addition of the extension of prequalification test. The latter test requires approximately one quarter of the time to complete when compared with the full prequalification test.

A list of relevant CIGRE references is given in the bibliography.

POWER CABLES WITH EXTRUDED INSULATION AND THEIR ACCESSORIES FOR RATED VOLTAGES ABOVE 150 kV ($U_m = 170$ kV) UP TO 500 kV ($U_m = 550$ kV) – TEST METHODS AND REQUIREMENTS

1 Scope

This International Standard specifies test methods and requirements for power cable systems, cables with extruded insulation and their accessories for fixed installations, for rated voltages above 150 kV ($U_m = 170$ kV) up to and including 500 kV ($U_m = 550$ kV).

The requirements apply to single-core cables and to their accessories for usual conditions of installation and operation, but not to special cables and their accessories, such as submarine cables, for which modifications to the standard tests may be necessary or special test conditions may need to be devised.

This standard does not cover transition joints between cables with extruded insulation and paper insulated cables.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE The IEC 60811 series is currently undergoing a revision, which will lead to a restructuring of its parts. A description of this, as well as a cross-reference table between the current and planned parts will be given in IEC 60811-100.

IEC 60060-1 *High-voltage test techniques – Part 1: General definitions and test requirements*

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

IEC 60228, *Conductors of insulated cables*

IEC 60229:2007, *Electric cables – Tests on extruded oversheaths with a special protective function*

IEC 60230, *Impulse tests on cables and their accessories*

IEC 60287-1-1:2006, *Electric cables – Calculation of the current rating – Part 1-1: Current rating equations (100 % load factor) and calculation of losses – General*

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 60811-1-1:1993, *Common test methods for insulating and sheathing materials of electric cables and optical cables – Section 1-1: Methods for general application – Measurement of thickness and overall dimensions – Tests for determining the mechanical properties*
Amendment 1 (2001)

IEC 60811-1-2:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Two: Thermal ageing methods*
Amendment 1 (1989)
Amendment 2 (2000)

IEC 60811-1-3:1993, *Common test methods for insulating and sheathing materials of electric cables – Part 1-3: General application – Methods for determining the density – Water absorption tests – Shrinkage test*
Amendment 1 (2001)

IEC 60811-1-4:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 1: Methods for general application – Section Four: Tests at low temperature*
Amendment 1 (1993)
Amendment 2 (2001)

IEC 60811-2-1:1998, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 2-1: Methods specific to elastomeric compounds – Ozone resistance, hot set and mineral oil immersion tests*
Amendment 1 (2001)

IEC 60811-3-1:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 3: Methods specific to PVC compounds – Section 1: Pressure test at high temperature – Tests for resistance to cracking*
Amendment 1 (1994)
Amendment 2 (2001)

IEC 60811-3-2:1985, *Common test methods for insulating and sheathing materials of electric cables – Part 3: Methods specific to PVC compounds – Section two: Loss of mass test – Thermal stability test*
Amendment 1 (1993)
Amendment 2 (2003)

IEC 60811-4-1:2004, *Insulating and sheathing materials of electric and optical cables – Common test methods – Part 4-1: Methods specific to polyethylene and polypropylene compounds – Resistance to environmental stress cracking – Measurement of the melt flow index – Carbon black and/or mineral filler content measurement in polyethylene by direct combustion – Measurement of carbon black content by thermogravimetric analysis (TGA) – Assessment of carbon black dispersion in polyethylene using a microscope*

IEC 60885-3, *Electrical test methods for electric cables – Part 3: Test methods for partial discharge measurements on lengths of extruded power cables*

3 Terms and definitions

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

3.1 Definitions of dimensional values (thicknesses, cross-sections, etc.)

3.1.1

nominal value

value by which a quantity is designated and which is often used in tables

NOTE Usually, in this standard, nominal values give rise to values to be checked by measurements taking into account specified tolerances.