SLOVENSKI STANDARD
SIST IEC 60840:2018

01-december-2018

Elektroenergetski kabli z ekstrudirano izolacijo in njihov pribor za naznačene napetosti nad 30 kV (Um = 36 kV) do 150 kV (Um = 170 kV) - Preskusne metode in zahteve

Power cables with extruded insulation and their accessories for rated voltages above 30 kV (Um = 36 kV) up to 150 kV (Um = 170 kV) - Test methods and requirements

Câbles d'énergie à isolation extrudée et leurs accessoires pour des tensions assignées supérieures à 30 kV (Um = 36 kV) et jusqu'à 150 kV (Um = 170 kV) - Méthodes et exigences d'essai

Ta slovenski standard je istoveten z: **IEC 60840**

ICS:

29.060.20 Kabli Cables

SIST IEC 60840:2018 **en,fr**

IEC 60840

Edition 4.0 2011-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX XB

ICS 29.060.20

ISBN 978-2-88912-752-8

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER CABLES WITH EXTRUDED INSULATION AND THEIR ACCESSORIES FOR RATED VOLTAGES ABOVE 30 kV (U_m = 36 kV) UP TO 150 kV (U_m = 170 kV) – TEST METHODS AND REQUIREMENTS

FOREWORD

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International Standard IEC 60840 has been prepared by IEC technical committee 20: Electric cables.

This fourth edition cancels and replaces the third edition, published in 2004, and constitutes a major technical revision.

The significant technical change with respect to the previous edition is as follows:

– introduction of a prequalification test procedure for cables with high electrical stresses and tested as a cable system including accessories.

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

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

FDIS	Report on voting
20/1267/FDIS	20/1277A/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- withdrawn,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.

INTRODUCTION

The first edition of IEC 60840, published in 1988, dealt only with cables. Accessories were added to the second edition, published in February 1999, which separately covered test methods and test requirements for

a) cables alone,

b) cables together with accessories (a cable system).

Some countries then suggested that a better discrimination be made between systems, cables and accessories, particularly for the lower voltages of the scope, e.g. 45 kV. This was taken into account in the third edition and is retained in this revision, which gives the type approval requirements and the range of approvals for

a) cable systems,

b) cables alone,

c) accessories alone.

Manufacturers and users may choose the most appropriate option for type approval.

At its meeting in November 2004, TC 20 decided to prepare a further major revision of IEC 60840 and concluded that this edition should incorporate the recommendations for testing HV and EHV extruded cables that were under preparation by CIGRE study committee B1 WG B1.06. This work was made available as CIGRE technical brochure No. 303, before the meeting of TC 20 in October 2006. The brochure, entitled "Revision of qualification procedures for extruded (extra) high voltage a.c. underground cables", has therefore been considered by TC 20, and considerable parts implemented in this standard. Cables with high electrical stresses at the conductor screen and/or insulation screen are now required to undergo a prequalification test procedure (simplified compared to that in IEC 62067) as a cable system inclusive of accessories.

Additionally the following other significant changes to this standard have been introduced:

a) The clause numbering of this standard and IEC 62067 (which has been revised at the same time as this standard) has been coordinated to achieve as much commonality as possible to assist users who use both standards.

b) In the case of the sample test, the lightning impulse voltage test is no longer followed by a power frequency voltage test.

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

POWER CABLES WITH EXTRUDED INSULATION AND THEIR ACCESSORIES FOR RATED VOLTAGES ABOVE 30 kV (U_m = 36 kV) UP TO 150 kV (U_m = 170 kV) – TEST METHODS AND REQUIREMENTS

1 Scope

This International Standard specifies test methods and requirements for power cable systems, cables alone and accessories alone, for fixed installations and for rated voltages above 30 kV (U_m = 36 kV) up to and including 150 kV (U_m = 170 kV).

The requirements apply to single-core cables and to individually screened three-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 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 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 – Part 1: Methods for general application – Section 1: 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 3-1: Methods specific to PVC compounds –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 –Loss of mass test – Section two: 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*

ISO 48, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

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.

3.1.2
median value
when several test results have been obtained and ordered in an increasing (or decreasing) succession, middle value if the number of available values is odd, and mean of the two middle values if the number is even

3.2 Definitions concerning tests

3.2.1
routine test
tests made by the manufacturer on each manufactured component (length of cable or accessory) to check that the component meets the specified requirements

3.2.2
sample test
tests made by the manufacturer on samples of completed cable or components taken from a completed cable or accessory, at a specified frequency as to verify that the finished product meets the specified requirements

3.2.3
type test
tests made before supplying on a general commercial basis a type of cable system or cable or accessory covered by this standard, in order to demonstrate satisfactory performance characteristics to meet the intended application

NOTE Once successfully completed, these tests need not be repeated, unless changes are made in the cable or accessory with respect to materials, manufacturing process, design or design electrical stress levels, which might adversely change the performance characteristics.

3.2.4
prequalification test
test made before supplying on a general commercial basis a type of cable system covered by this standard, in order to demonstrate satisfactory long term performance of the complete cable system

3.2.5
extension of prequalification test
tests made before supplying on a general commercial basis a type of cable system covered by this standard, in order to demonstrate satisfactory long term performance of the complete cable system, taking into account an already prequalified cable system

3.2.6
electrical test after installation
tests made to demonstrate the integrity of the cable system as installed

3.3 Other definitions

3.3.1
cable system
cable with installed accessories including components used for thermo-mechanical restraint of systems limited to those used for terminations and joints only

3.3.2
nominal electrical stress
electrical stress calculated at U_0 using nominal dimensions

4 Voltage designations and materials

4.1 Rated voltages

In this standard, the symbols U_0, U and U_m are used to designate the rated voltages of cables and accessories where these symbols have the meanings given in IEC 60183.

4.2 Cable insulating materials

This standard applies to cables insulated with one of the materials listed in Table 1. It also specifies for each type of insulating compound the maximum operating conductor temperatures on which the specified test conditions are based.

4.3 Cable metal screens/sheaths

This standard applies to the various designs in use. It covers designs providing a radial watertightness and other designs.

Designs that provide radial watertightness mainly consist of

- metal sheaths,
- longitudinally applied metal tapes or foils bonded to the oversheath,
- composite screens, involving a bunch of wires and, in addition, either a metal sheath or a metal tape or foil bonded to the oversheath, acting as a radial water impermeable barrier (see Clause 5),

and other designs such as

- metal tapes or foils not bonded to the oversheath,
- bunch of metal wires only.

NOTE In all cases the metal screen/sheath should be able to carry the total fault current.

4.4 Cable oversheathing materials

Tests are specified for four types of oversheath, as follows:

– ST_1 and ST_2 based on polyvinyl chloride (PVC);
– ST_3 and ST_7 based on polyethylene (PE).

The choice of the type of oversheath depends on the design of the cable and the mechanical, thermal and fire constraints during installation and operation.

The maximum conductor temperatures in normal operation for the different types of oversheathing materials covered by this standard are given in Table 2.

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

5 Precautions against water penetration in cables

When cable systems are installed in ground, in easily flooded galleries or in water, a radial water impermeable barrier around the cable is recommended.

NOTE A test for radial water penetration is currently not available.

Longitudinal water barriers may also be applied in order to avoid the need to replace long sections of cable in case of damage in the presence of water.

A test for longitudinal water penetration is given in 12.5.14.

6 Cable characteristics

For the purpose of carrying out the cable system or cable tests described in this standard and recording the results, the cable shall be identified. The following characteristics shall be known or declared:

a) Name of manufacturer, type, designation and manufacturing date or date code.

b) Rated voltage: values shall be given for U_0, U, U_m (see 4.1 and 8.4).

c) Type of conductor, its material and nominal cross-sectional area, in square millimetres; conductor construction; presence, if any, and nature of measures taken to reduce skin effect; presence, if any, and nature of measures taken to achieve longitudinal watertightness; if the nominal cross-sectional area is not in accordance with IEC 60228, the d.c. conductor resistance, corrected to 1 km length and to 20 °C.

d) Material and nominal thickness of insulation (t_n) (see 4.2). If the insulation is XLPE, special additives shall be declared if the higher value of tan δ according to Table 3 is applicable.

e) Type of manufacturing process for insulation system.

f) Presence, if any, and nature of watertightness measures in the screening area.

g) Material and construction of metal screen, e.g. number and diameter of wires. (The d.c. resistance of the metal screen shall be declared.) Material, construction and nominal thickness of metal sheath, or longitudinally applied metal tape or foil bonded to the oversheath, if any.

h) Material and nominal thickness of oversheath.

i) Nominal diameter of the conductor (d).

j) Nominal overall diameter of the cable (D).

k) Nominal inner diameter (d_{ii}) and calculated nominal outer diameter (D_{io}) of the insulation.

l) Nominal capacitance, corrected to 1 km length, between conductor and metal screen/sheath.

m) Calculated nominal electrical stress at conductor screen (E_i) and at insulation screen (E_o):

$$E_i = \frac{2U_0}{d_{ii} \times \ln(D_{io} / d_{ii})}$$

$$E_o = \frac{2U_0}{D_{io} \times \ln(D_{io} / d_{ii})}$$

where

$D_{io} = d_{ii} + 2t_n$;

D_{io} is the calculated nominal outer diameter of the insulation;

d_{ii} is the declared nominal inner diameter of the insulation;

t_n is the declared nominal insulation thickness.

The value of U_0 is given in Table 4.

7 Accessory characteristics

For the purpose of carrying out the cable system or accessory tests described in this standard and recording the results, the accessory shall be identified.