IEC 60230

Edition 2.1 2021-12
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Impulse tests on cables and their accessories

Essais de choc des câbles et de leurs accessoires

IEC 60230:2018-01+AMD1:2021-12 CSV(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC online collection - oc.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) 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 IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 60230

Edition 2.1 2021-12
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Impulse tests on cables and their accessories

Essais de choc des câbles et de leurs accessoires

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.060.20

ISBN 978-2-8322-4042-7

IEC 60230

Edition 2.1 2021-12
CONSOLIDATED VERSION

REDLINE VERSION

VERSION REDLINE

colour inside

Impulse tests on cables and their accessories

Essais de choc des câbles et de leurs accessoires

IEC 60230:2018-01+AMD1:2021-12 CSV(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

IMPULSE TESTS ON CABLES AND THEIR ACCESSORIES

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.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60230 edition 2.1 contains the second edition (2018-01) [documents 20/1769A/FDIS and 20/1779/RVD] and its amendment 1 (2021-12) [documents 20/1957/CDV and 20/1989/RVC].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 60230 has been prepared by IEC technical committee 20: Electric cables.

This second edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the structure of the standard takes into account the current style of IEC standards;
b) this document is no longer a “Recommendation” but an “International Standard”;
c) the test installation is no longer related to gas-pressure and oil-filled cables only;
d) switching-impulse voltage and superimposed impulse voltage tests have been included;
e) for the measuring system the reference to IEC 60060-2 has been added. The reference to the sphere gap method has been moved to Annex B.

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

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under 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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

IMPULSE TESTS ON CABLES AND THEIR ACCESSORIES

1 Scope

This document defines the procedure for carrying out withstand lightning and switching impulse tests and withstand superimposed impulse test on cables and their accessories.

This document applies solely to the methods of carrying out the tests as such, independently of the problem of selecting the test levels to be specified. The voltages pertaining to the system on which cables and accessories are to be used are given in IEC 60183 or in the relevant product standard.

This document specifies the following requirements:

- the characteristics and state of the test installation and those parts of the procedure which are common to withstand tests and tests above the withstand level;
- the procedure for carrying out withstand lightning and switching impulse tests and superimposed impulse test;
- the procedure for carrying out tests above the withstand level which is intended for research purposes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in the relevant product standards and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
superimposed impulse voltage
impulse voltage applied to a test object which is at the same time energized by a DC voltage

Note 1 to entry: The superimposed impulse voltage falls under the definition of composite voltage given in IEC 60060-1:2010, 9.2.

4 Characteristics of the test object to be subjected to the tests

The test object shall have been previously subjected to the test protocol as required by the relevant IEC product standards.

If not specified in the reference IEC product standards, the following conditions shall be maintained:

- If the test object is not intended to include any other accessory, the length of the sample taken shall be such that the length of free cable between the terminations is at least 5 m.
- Where one joint is included in the test object, the minimum length of free cable, between the joint and terminations shall be 5 m. Where more than one joint is included, the same requirement shall be observed and in addition there shall be a minimum length of 3 m of free cable between successive joints.

5 State of the test object to be subjected to the test

The test object shall be maintained under the following conditions.

- Pressure conditions, if any:

  For gas-pressure and oil-filled cables, the pressure shall be adjusted in accordance with the relevant IEC standard.

- Temperature conditions:

  The temperature conditions and the method of temperature measurement shall be as described in the relevant IEC standard, but other methods of temperature measurement may be used by agreement between the purchaser and the manufacturer.

6 Lightning impulse voltage

The peak voltage level of the lightning impulse is specified in the relevant product standard or contractual agreements. The lightning impulse voltage to be applied shall be a standard lightning-impulse voltage as specified in IEC 60060-1 with the exception that the front time T_1 shall be between 1 µs and 5 µs.

7 Switching impulse voltage

The peak voltage level of the switching impulse is specified in the relevant product standard.

The switching impulse voltage to be applied shall be a standard switching impulse voltage as specified in IEC 60060-1.

8 Superimposed impulse voltage test

8.1 General

The superimposed impulse voltage test shall be carried out on HVDC cable systems. The peak voltage level of the switching impulse is specified in the relevant product standard.

When a superimposed impulse voltage test is required, Clause 8 shall be applied in addition to the other clauses of this document.

8.2 Test setup

Some possibilities are given to apply an impulse voltage to a test object which is at the same time energized by a DC voltage; Annex C illustrates the possible superimposed impulse test circuit arrangements.

8.3 Time parameters

The time parameters shall meet the requirements of Clause 6 or Clause 7 and shall be determined with the DC voltage source set to zero output or disconnected, i.e. without energizing the test object by a DC voltage and with the spark gap (as applicable) short-circuited. Once the time parameters have been determined, there shall be no changes to the test setup other than connecting the DC voltage source and removing the short-circuit across the spark gap.

The time parameters are to be determined in this way because a base level around 0 kV is required by IEC 60060-1.

8.4 Application of the DC voltage

Before the impulses are applied to the test object, if required, the test object shall be energized by a DC voltage with a level and duration and polarity as specified in the product standard.

The application of the impulses is given in Clause 10.

9 Measuring system

The preferred method to measure the impulse voltage is by using an approved measuring system according to IEC 60060-2.

Alternatively, the method described in Annex B may be used at the discretion of the manufacturer.

10 Application of the impulses

Both ends of the test object shall be connected to the impulse generator (via the spark gap or blocking capacitor in the case of a superimposed impulse test).

For an impulse test, the test object shall be subjected to a series of 10 positive impulses and 10 negative impulses at the voltage and shape as specified. For a superimposed impulse test the polarity, method of application of impulses and rest periods between DC polarity changes shall be as given in the relevant product standard.

The time interval between two successive impulses shall be just sufficient to ensure that the impulse generator is charged at the correct voltage. Scheduled interruption of the test is not allowed, however, an unintentional interruption during impulse testing, resulting in a duration, between two consecutive impulses, exceeding 15 min, shall result in a retest of the complete series of 10 impulses at the polarity at which the interruption occurred. An already completed series of impulses at the opposite polarity does not have to be repeated.

As a means of conditioning the test object when using an approved measuring system, each series of 10 impulses may be preceded by one or more impulses of the same polarity at a level of approximately 50 %, 65 % and 80 % of the voltage and shape specified.

At least the first and tenth impulses at the voltage and shape specified shall be recorded, in each series.

The impulses at the lower level may be recorded.

The ambient temperature, the cable temperature and, where applicable, the gas or oil pressure shall be recorded.

When, for research purposes, lightning-impulse tests to levels above the withstand level are made, the procedure according to Annex A is recommended.

Annex A
(informative)

Tests above the withstand level

A.1 General

Annex A deals with the application of lightning-impulse test above the specified withstand level and the omission of power-frequency test.

When, for research purposes, lightning-impulse tests to levels above the withstand level are made, the procedure given below is recommended.

In this case, the power-frequency test at ambient temperature, specified in the relevant product standard or contractual agreements may be omitted, provided that there is no doubt that the test object has successfully passed the lightning-impulse withstand voltage test. If the last oscillogram does not show this clearly, further lightning-impulse voltages may be applied at withstand level to obtain a good oscillogram.

A.2 Procedure for tests above the withstand level

A.2.1 General sequence of lightning-impulse tests

With the temperature conditions as specified, lightning-impulses shall be applied in the following sequence:

1) 10 negative lightning-impulses at withstand voltage plus approximately 5 %;
2) 5 positive lightning-impulses, the first at 50 % of the value used for 1) and the remainder at progressively increasing values up to 85 % of the value used for 1);
3) 10 positive lightning-impulses at withstand voltage plus approximately 5 %;
4) 10 positive lightning-impulses at withstand voltage plus approximately 10 %;
5) 5 negative lightning-impulses, the first at 50 % of the value used for 4) and the remainder at progressively increasing values up to 85 % of the value used for 4);
6) 10 negative lightning-impulses at withstand voltage plus approximately 10 %.

A.2.2 Tests beyond withstand level

The sequence specified in A.2.1 shall be repeated, the test voltage being increased in steps of approximately 5 %. Thus, steps 7) to 9) will be at withstand voltage plus approximately 15 %; steps 10) to 12) at withstand voltage plus 20 %; and so on.

The test shall continue until the desired voltage is reached, or until breakdown occurs.

At least the first and tenth impulses of each series of 10 impulses shall be recorded in each series.

The impulses of each series of 5 impulses may be recorded.

A.2.3 Re-calibration of the generator

In case an approved measuring system is used, A.2.3 is not applicable.

In case an approved measuring system is not used, then, in general, no recalibration of the generator is necessary throughout this series of tests and the voltage can be determined by extrapolation from the original calibration. When, however, the margin between the test voltage and the maximum voltage used for the original calibration is considered too large for accurate results, a fresh calibration as described in Annex B may be necessary.

Annex B
(normative)

Calibration of impulse generator

B.1 General

Annex B is only applicable when an approved measuring system according to IEC 60060-2 is not used.

B.2 Calibration of impulse generator

Immediately before or during the period when the temperature of the cable is maintained at a constant value, preparatory to the application of the impulses, the generator shall be calibrated, with positive polarity, under the following conditions.

Both ends of the test assembly shall be connected to the impulse generator. A measuring sphere-gap and an oscillograph, with its associated voltage divider, shall be connected in parallel and remain so connected throughout the test.

For every setting of the sphere-gap, the charging voltage of the generator shall be so adjusted as to give 50 % flashover of the gap (see IEC 60060-1:2010, Annex A) and an oscillogram of the impulse voltage shall be taken. This procedure shall be carried out for at least three different settings of the sphere-gap. The settings shall be so selected that their 50 % flashover voltages are approximately 50 %, 65 % and 80 % of the test level specified.

A curve showing the charging voltage as a function of the sphere-gap flashover voltage shall be drawn for this positive polarity. This curve, which should be a straight line, shall be extrapolated to determine the charging voltage necessary to obtain the specified level with positive polarity.

The ratio of the voltage divider shall be so selected for this polarity as to take into account the maximum flashover voltages for the sphere-gap and the voltage oscillograms that have to be obtained. This value for the ratio of the voltage divider shall be used for all the oscillograms taken in the course of the series of tests with this polarity.

B.3 Application of the impulses at the level specified

With the sphere-gap setting increased so that no flashover occurs across the gap, and with the cable maintained at the required temperature, the test installation shall be subjected to a series of 10 positive impulses at the voltage specified. The time interval between two successive impulses shall be just sufficient to ensure that the impulse generator is charged at the correct voltage.

Immediately after the application of the 10 positive impulses, the generator shall be re-calibrated for negative polarity under the conditions specified in Clause B.2 and a series of 10 negative impulses of the same specified voltage shall then be applied to the test assembly.

Oscillograms shall be taken of at least the first and tenth impulses in each series. The oscillograms shall include a timing oscillation.

The ambient temperature, the cable temperature and, where applicable, the gas or oil pressure, shall be recorded during the test.

Annex C
(normative)

Test circuits for superimposed impulse voltage test

C.1 General

Figures C.1 and C.2 indicate possible configurations of the superimposed impulse voltage test circuits.

Circuits using a blocking capacitor will require a higher voltage to be applied from the impulse generator for a given output voltage at the test object than circuits using a spark gap (due to the voltage drop across the blocking capacitor).

NOTE 1 When using a spark gap circuit (set at the impulse generator) and when the DC and impulse polarities are opposite, the applied impulse voltage is similar to that impulse voltage when no DC voltage were present (measured in 8.3); it is not the difference between the DC level and impulse level of opposite polarity.

NOTE 2 If the DC and impulse voltages are of the same polarity, the careful adjustment of the spark gap avoids flashover under the DC voltage.

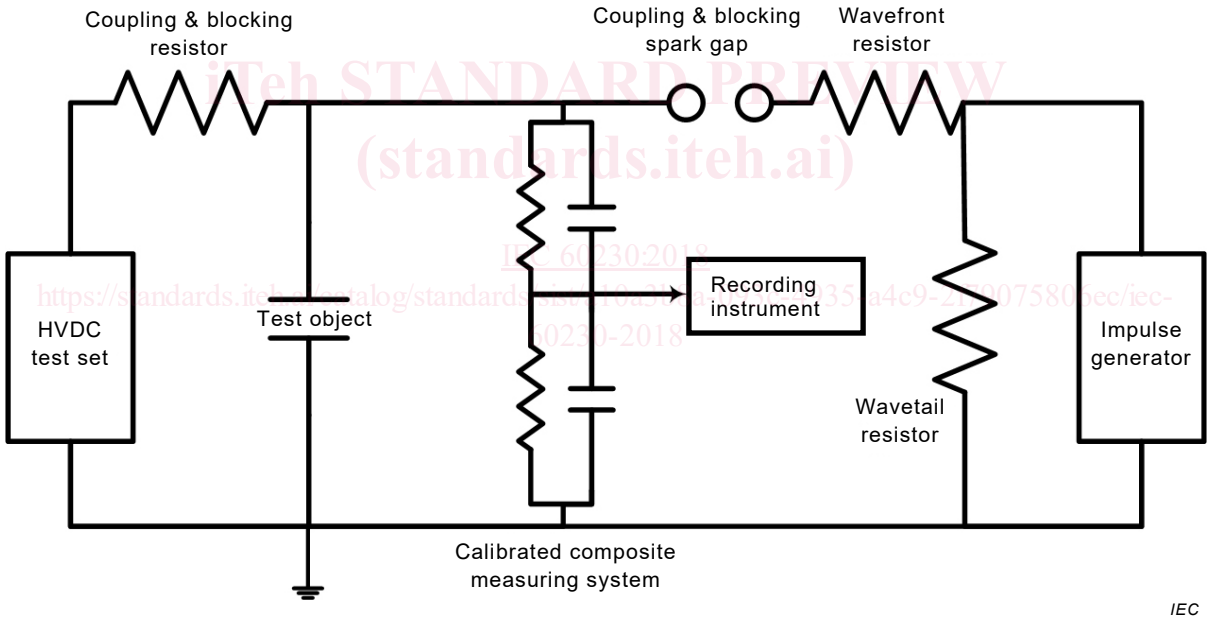

Figure C.1 – Spark gap setup using calibrated composite measuring system capable of measuring HVDC and impulse