BS EN 60243-3:2014

BSI Standards Publication

# Electric strength of insulating materials — Test methods

## Part 3: Additional requirements for 1,2/50 µs impulse tests

bsi.

...making excellence a habit.™

## National foreword

This British Standard is the UK implementation of EN 60243-3:2014. It is identical to IEC 60243-3:2013. It supersedes BS EN 60243-3:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/112, Evaluation and qualification of electrical insulating materials and systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.


Published by BSI Standards Limited 2014

ISBN 978 0 580 83185 0
ICS 17.220.99; 29.035.01

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2014.

### Amendments/corrigenda issued since publication

| Date | Text affected |
|---|---|

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 60243-3

February 2014

ICS 17.220.99; 29.035.01

Supersedes EN 60243-3:2001

English version

# Electric strength of insulating materials - Test methods - Part 3: Additional requirements for 1,2/50 µs impulse tests

(IEC 60243-3:2013)

Rigidité diélectrique des matériaux isolants - Méthodes d'essai - Partie 3: Exigences complémentaires pour les essais aux ondes de choc 1,2/50 µs (CEI 60243-3:2013)

Elektrische Durchschlagfestigkeit von isolierenden Werkstoffen - Prüfverfahren - Teil 3: Zusätzliche Festlegungen für 1,2/50 µs Stoßspannungsprüfungen (IEC 60243-3:2013)



CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

**CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels**



Ref. No. EN 60243-3:2014 E

## Foreword

The text of document 112/246/CDV, future edition 3 of IEC 60243-3, prepared by IEC/TC 112 "Evaluation and qualification of electrical insulation materials and systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60243-3:2014.

The following dates are fixed:

| | | |
|---|---|---|
| • latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2014-09-30 |
| • latest date by which the national standards conflicting with the document have to be withdrawn | (dow) | 2016-12-31 |

This document supersedes EN 60243-3:2001.

This standard shall be read in conjunction with EN 60243-1.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

## Endorsement notice

The text of the International Standard IEC 60243-3:2013 was approved by CENELEC as a European Standard without any modification.

# Annex ZA
(normative)

## Normative references to international publications with their corresponding European publications

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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

| Publication | Year | Title | EN/HD | Year |
|---|---|---|---|---|
| IEC 60243-1 | 2013 | Electric strength of insulating materials - Test methods - Part 1: Tests at power frequencies | EN 60243-1 | 2013 |

CONTENTS

# ELECTRIC STRENGTH OF INSULATING MATERIALS – TEST METHODS –

## Part 3: Additional requirements for 1,2/50 μs impulse tests

## 1 Scope

This part of IEC 60243 gives requirements additional to those in IEC 60243-1 for the determination of the electric strength of solid insulating materials under 1,2/50 μs impulse voltage stress.

## 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.

IEC 60243-1:2013, *Electric strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60243-1, together with the following, apply.

**3.1**
**full impulse-voltage wave**
aperiodic transient voltage that rises rapidly to a maximum value, then falls less rapidly to zero (see Figure 1)

**3.2**
**peak value (of an impulse-voltage wave)**
$U_P$
maximum value of voltage

**3.3**
**virtual peak value (of an impulse-voltage wave)**
$U_1$
value derived from a recording of an impulse-voltage wave on which high-frequency oscillations, or overshoot of a limited magnitude, may be present

**3.4**
**virtual origin (of an impulse-voltage wave)**
$O_1$
point of intersection $O_1$ with the line of zero voltage of a line drawn through the points of 0,3 and 0,9 times the virtual peak value on the front of an impulse-voltage wave (see Figure 1)

**3.5**
**virtual front time (of an impulse-voltage wave)**
$t_1$
equal to 1,67 times the interval $t_f$ between the instants when the voltage is 0,3 and 0,9 times the peak value ($t_f$, Figure 1)

**3.6**
**virtual time to half-value**
$t_2$
time interval $t_2$ between the virtual origin $O_1$ and the instant on the tail when the voltage has decreased to half the peak value

**3.7**
**impulse breakdown voltage**
nominal peak voltage that the wave causing breakdown would have reached if breakdown had not occurred

**3.8**
**withstand voltage**
highest nominal peak voltage of a set of three impulses which did not cause breakdown

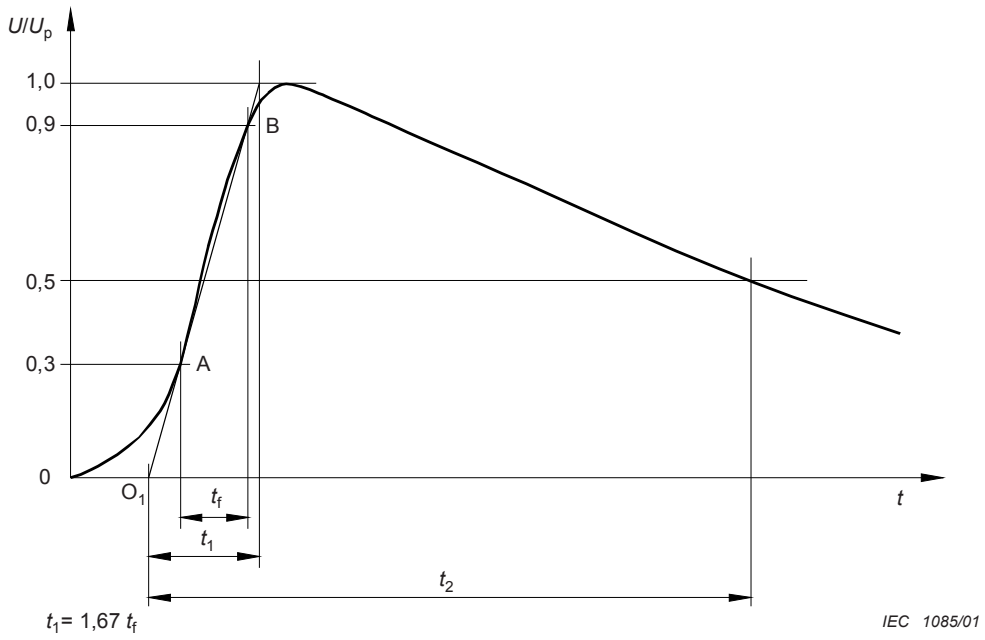


**Figure 1 – Full impulse-voltage wave**

## 4 Significance of the test

In addition to the information of Clause 4 of IEC 60243-1:2013, the following points are of importance in connection with impulse-voltage tests.

High-voltage equipment may be subjected to transient voltage stresses resulting from such causes as nearby lightning strokes. This is particularly true of apparatus such as transformers and switchgears used in electrical power transmission and distribution systems. The ability of insulating materials to withstand these transient voltages is important in establishing the reliability of apparatus insulated with these materials.

Transient voltages caused by lightning may be of either positive or negative polarity. In a symmetrical field between identical electrodes, the polarity has no effect on the electric

strength. However, with dissimilar electrodes, there may be a pronounced polarity effect. When asymmetrical electrodes are used for testing materials with which the tester has no previous experience or knowledge, it is recommended that comparative tests be made with both directions of polarity.

The standard wave shape is a 1,2/50 μs wave, reaching peak voltage in approximately 1,2 μs, and decaying to 50 % of peak value in approximately 50 μs after the beginning of the wave. This wave is intended to simulate a lightning stroke that may strike a system without breakdown.

NOTE If the object being tested has appreciable inductive characteristics, it may be difficult or impossible to attain the specified wave shape with less than 5 % oscillations, as prescribed in 8.2. However, the procedures given in this standard are expected ordinarily to be applied to configurations of test specimens and electrodes which are primarily capacitive. Testing of more complex configurations, such as between coils of completed apparatus or models of such apparatus, should be performed in accordance with the specifications for that apparatus.

Because of the short time involved, dielectric heating, other thermal effects and the influence of injected space-charges may be reduced during impulse testing of most materials. Thus, impulse tests usually give higher values than the peak voltage of short-term ac tests. From comparisons of the impulse electric strength with the values drawn from longer time tests, inferences may be drawn as to the modes of failure under the various tests for a given material.

## 5 Electrodes and test specimens

Clause 5 of IEC 60243-1:2013 is applicable.

## 6 Conditioning before tests

Clause 6 of IEC 60243-1:2013 is applicable.

## 7 Surrounding medium

Clause 7 of IEC 60243-1:2013 is applicable.

## 8 Electrical apparatus

### 8.1 Voltage source

The test voltage applied to the electrodes shall be provided by an impulse generator having the following characteristics.

A choice of either positive or negative polarity shall be provided, one of the connections to the electrodes being earthed.

Controls within the generator shall be capable of adjusting the shape of the wave applied to the test specimen under test to have a virtual front time $t_1$ of (1,2 ± 0,36) μs, and virtual time to half-value $t_2$ of (50 ± 10) μs (see Figure 1).

The voltage capability and energy-storage capacity of the generator shall be sufficient to apply impulse waves of the proper shape to any test specimens to be tested, up to the breakdown voltage or specified proof voltage of the material.

The peak value of the voltage is taken as the virtual peak value, provided that the conditions of 8.2 are satisfied.

### 8.2 Voltage measurement

Provisions shall be made for recording the voltage wave as applied to the test specimen, and for measuring the virtual peak voltage, the virtual front time and the virtual time to half-value within ±5 % of the true values.

If the voltage wave has oscillations with a magnitude of no more than 5 % of the peak value, and a frequency of at least 0,5 MHz, a mean curve may be drawn, the maximum amplitude of which is the virtual peak value. If the oscillations are of greater magnitude, or of lower frequency, the voltage wave is not acceptable for a standard test.

## 9 Procedure

Clause 9 of IEC 60243-1:2013 is applicable. However, the application of the voltage shall be as shown in Clause 10.

## 10 Application of voltage

### 10.1 Breakdown test

Breakdown tests shall be in accordance with Clause 11 of IEC 60243-1:2013.

The voltage impulses shall be applied in an increasing series of sets of three waves of equal peak voltages. The peak voltage of the initial set should be approximately 70 % of the expected breakdown voltage.

Increase the peak voltage of successive sets by 5 % to 10 % of the peak value of the first set. Table 1 of IEC 60243-1:2013 is applicable.

Allow sufficient time between successive impulses for the generator to become completely charged. Normally, a time of three times the charging time constant for the generator is sufficient.

Sufficient time shall also be allowed between successive impulses to allow dissipation of any injected space-charge. For many materials, the charging time of the generator will cover this eventuality. For materials having a longer space-charge retention time, the necessary time shall be specified in the material specification sheet. If this information is not known, but a long space-charge retention period is suspected, then additional tests should be run with longer intervals between impulses, to determine if a significant difference in breakdown values is obtained.

A valid test on a test specimen is one in which impulse waves are applied at at least two voltage levels without breakdown, before breakdown occurs at the third or a subsequent level.

The electric strength shall be based on the virtual peak voltage of the last set of three waves which was applied without breakdown. The breakdown voltage is the nominal voltage of the next set of waves causing breakdown.

When using asymmetrical electrode systems, preliminary tests shall be conducted to determine the polarity which yields the lower breakdown voltage. If significant differences are obtained, the polarity giving the lower test results should be used.

### 10.2 Proof tests

One set of three impulses of specified proof voltage (virtual value) shall be applied to the test specimen in accordance with Clause 11 of IEC 60243-1:2013. When necessary for calibration

purposes, up to three impulses with peak voltages not exceeding 80 % of the proof voltage may be applied prior to the application of the proof voltage waves.

## 11 Criterion of breakdown

Clause 11 of IEC 60243-1:2013 is applicable.

## 12 Number of tests

Clause 12 of IEC 60243-1:2013 is applicable.

## 13 Report

Unless otherwise specified, the report shall include the following:

a) a complete identification of the material tested, a description of the test specimens and the method of their preparation;

b) the polarity of the impulse waves;

c) the median (central value) of the electric strengths in kV/mm and/or of the breakdown voltages in kV (not that used for proof testing);

d) the thickness of each test specimen (see 5.4 of IEC 60243-1:2013);

e) the surrounding medium during the test and its properties;

f) the electrode system with polarity of electrodes when they are dissimilar;

g) the individual values of electric strength in kV/mm and/or breakdown voltage in kV (not that used for proof testing);

h) the temperature, pressure and humidity during tests in air or other gas, or the temperature of the surrounding medium when this is a liquid;

i) the conditioning treatment before test;

j) the initial nominal peak-voltage level for each test specimen;

k) an indication of the type and position (for example, at the electrode edge) of breakdown on the test specimen, and which impulse of the last set of three impulses resulted in breakdown for each test specimen;

l) the position on the voltage wave (wave-front, peak, or wave-tail) of breakdown for each test specimen.

_____

*This page deliberately left blank*

*This page deliberately left blank*

# British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

## About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

## Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

## Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

## Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

**PLUS** is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

**BSI Group Headquarters**

389 Chiswick High Road London W4 4AL UK

## Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

## Copyright



## Useful Contacts:

**Customer Services**
**Tel:** +44 845 086 9001
**Email (orders):** orders@bsigroup.com
**Email (enquiries):** cservices@bsigroup.com

**Subscriptions**
**Tel:** +44 845 086 9001
**Email:** subscriptions@bsigroup.com

**Knowledge Centre**
**Tel:** +44 20 8996 7004
**Email:** knowledgecentre@bsigroup.com

**Copyright & Licensing**
**Tel:** +44 20 8996 7070
**Email:** copyright@bsigroup.com

bsi.

...making excellence a habit.™