

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Vulcanized fibre for electrical purposes –  
Part 2: Methods of test**

**(standards.iteh.ai)**

**Fibres vulcanisées à usages électriques –  
Partie 2: Méthodes d'essai**

<https://standards.iteh.ai/catalog/standards/sist/49efc77e-01b8-4185-88fe-0278e65287a6/iec-60667-2-2020>



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 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 l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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](http://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 It also gives information on projects, replaced and withdrawn publications.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](http://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](http://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](mailto:sales@iec.ch).

#### Electropedia - [www.electropedia.org](http://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 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

### 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](http://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](http://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](http://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](mailto:sales@iec.ch).

#### Electropedia - [www.electropedia.org](http://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.

#### Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE



**Vulcanized fibre for electrical purposes –  
Part 2: Methods of test**

**(standards.iteh.ai)**

**Fibres vulcanisées à usages électriques –  
Partie 2: Méthodes d'essai**

**(standards.iteh.ai)**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 29.035.10

ISBN 978-2-8322-8294-6

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD .....	3
INTRODUCTION .....	5
1 Scope .....	6
2 Normative reference .....	6
3 Terms and definitions .....	6
4 General notes on tests .....	7
4.1 Conditioning .....	7
4.2 Drying .....	7
4.3 Result .....	7
5 Thickness .....	7
6 Density .....	7
6.1 Apparent density .....	7
6.2 Density in liquid (specific gravity) .....	8
7 Tensile strength and elongation .....	8
8 Flexural strength .....	9
9 Water absorption .....	9
10 Electric strength up to and including 3 mm in thickness .....	9
11 Arc resistance .....	10
12 Chloride content .....	10
13 Ash content .....	10
14 Flexibility (bending) .....	10
15 Moisture content .....	11
16 Internal ply adhesion .....	11
17 Shrinkage .....	12
Figure 1 – Measuring principle for the determination of the flexibility .....	13
Figure 2 – Measuring device for the determination of the flexibility .....	13
Figure 3 – Ply adhesion testing jig .....	14
Table 1 – Conditioning time .....	7
Table 2 – Drying time .....	7

[standards.iteh.ai](https://standards.iteh.ai)  
 (standards.iteh.ai)

[IEC 60667-2:2020](#)

[standards.iteh.ai/catalog/standards/sist/49ef77e-01b8-4185-88fe-0278e65287a6/iec-60667-2-2020](https://standards.iteh.ai/catalog/standards/sist/49ef77e-01b8-4185-88fe-0278e65287a6/iec-60667-2-2020)

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**VULCANIZED FIBRE  
FOR ELECTRICAL PURPOSES –****Part 2: Methods of test****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 60667-2 has been prepared by IEC Technical Committee 15: Solid electrical insulating materials.

This second edition cancels and replaces the first edition published in 1982. This edition constitutes a technical revision.

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

- a) added Terms and definitions
- b) added General notes on tests
- c) added Thickness instead of dimension
- d) changed Apparent density from Density
- e) added Arc resistance
- f) deleted Sulphate content
- g) added method (Bending) for flexibility

- h) changed test method for internal ply adhesion
- i) added Shrinkage

The text of this International Standard is based on the following documents:

FDIS	Report on voting
15/911/FDIS	15/919/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 60667 series, published under the general title *Vulcanized fibre for electrical purposes*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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

**iTeh STANDARD PREVIEW**  
([standards.iteh.ai](http://standards.iteh.ai))

<https://standards.iteh.ai/catalog/standards/sist/49efc77e-01b8-4185-88fe-0278e65287a6/iec-60667-2-2020>

**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.**

## INTRODUCTION

This International Standard is one of a series which deals with vulcanized fibre sheets for electrical purposes.

The series consists of three parts:

Part 1: Definitions and general requirements (IEC 60667-1),

Part 2: Methods of test (IEC 60667-2),

Part 3: Specifications for individual materials (IEC 60667-3).

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[IEC 60667-2:2020](https://standards.iteh.ai/catalog/standards/sist/49efc77e-01b8-4185-88fe-0278e65287a6/iec-60667-2-2020)

<https://standards.iteh.ai/catalog/standards/sist/49efc77e-01b8-4185-88fe-0278e65287a6/iec-60667-2-2020>

# VULCANIZED FIBRE FOR ELECTRICAL PURPOSES –

## Part 2: Methods of test

### 1 Scope

This part of IEC 60667 gives methods of test for vulcanized fibre sheets for electrical purposes. Material made by combining with an adhesive several thicknesses of vulcanized fibre is not covered by this document.

Materials which conform to this specification meet established levels of performance. However, the selection of a material by a user for a specific application is based on the actual requirements necessary for adequate performance in that application and not based on this specification alone.

Safety warning: It is the responsibility of the user of the methods contained or referred to in this document to ensure that they are used in a safe manner.

### 2 Normative reference

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 60641-2:2004, *Pressboard and presspaper for electrical purposes – Part 2: Methods of tests*

IEC 60667-3 (all parts), *Specification for vulcanized fibre for electrical purposes – Part 3: Specifications for individual materials*

IEC 61621:1997, *Dry, solid insulating materials – Resistance test to high-voltage, low-current arc discharges*

ISO 178:2019, *Plastics – Determination of flexural properties*

ISO 287:2017, *Paper and board – Determination of moisture content of a lot – Oven-drying method*

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 specimen

rectangle of sheet cut to give dimensions from a roll or sheets drawn from selected units

### 3.2 test piece

quantity of sheet on which each single determination is carried out in accordance with the method of test

Note 1 to entry: It may be taken from a specimen; in some instances, it may be the specimen itself.

## 4 General notes on tests

### 4.1 Conditioning

Unless otherwise specified, the test specimens, after being cut, shall be conditioned in an atmosphere of  $23\text{ °C} \pm 2\text{ K}$ , and  $(50 \pm 5)\%$  RH and are tested in this atmosphere. The conditioning in relation to the thickness shall be as indicated in Table 1.

**Table 1 – Conditioning time**

Nominal thickness (mm)	≤ 0,5	> 0,5 to 1,0	> 1,0 to 2,0	> 2,0 to 3,0	> 3,0
Time (h)	≥ 48	≥ 72	≥ 96	≥ 120	≥ 240
Time (h) from the wet condition	≥ 48	≥ 96	≥ 120	≥ 240	≥ 480

(standards.iteh.ai)

### 4.2 Drying

The test pieces shall be dried in a ventilated oven at  $105\text{ °C} \pm 2\text{ K}$  as indicated in Table 2.

**Table 2 – Drying time**

Nominal thickness (mm)	≤ 0,5	> 0,5 to 1,5	> 1,5 to 5,0	> 5,0
Time (h)	6 to 24	24	48	72

### 4.3 Result

As a general rule, the central value is reported as the result. When agreed between parties, the mean value may be reported. This shall be noted in the test report.

## 5 Thickness

The thickness shall be determined as in IEC 60641-2.

Deviations from IEC 60641-2:

- 10 spots alongside the circumference of the test piece shall be measured and the mean value of them shall be obtained.

## 6 Density

### 6.1 Apparent density

The test shall be carried out on three conditioned test pieces; one determination is made on each of the three test pieces.

Use rectangular test pieces of an area not less than 100 cm<sup>2</sup> and determine the mass to an accuracy of 10<sup>-4</sup> × mass of the test piece.

Make two measurements of the length and two of the width of each test piece to an accuracy of 0,1 mm at points at least 12 mm from the corners.

Determine the thickness by making eight measurements as indicated in Clause 5 and calculate the mean value of the measurements.

Express the apparent density  $\rho$  (the mass to volume ratio) as g/cm<sup>3</sup>:

$$\rho = \frac{m}{s \times l \times w}$$

where

$m$  is the mass, in grams;

$s$  is the mean of the eight thickness measurements, in cm;

$l$  is the mean of the two length measurements, in cm;

$w$  is the mean of the two width measurements, in cm.

Report all three values. The central value shall be taken as the result.

## 6.2 Density in liquid (specific gravity)

Use rectangular test pieces of an area not less than 16 cm<sup>2</sup> with the original thickness of the material. Determine the mass of the test piece weighed to an accuracy of 10<sup>-4</sup> × mass of the test piece in air and in liquid of known density at the temperature of test.

The density in grams per cubic centimetre is calculated by the formula:

$$\rho = \frac{m_1 \times x}{m_1 - m_2}$$

where

$\rho$  is the density (g/cm<sup>3</sup>);

$m_1$  is the mass of test piece in air (g);

$m_2$  is the mass of test piece in liquid (g);

$x$  is the density of liquid (g/cm<sup>3</sup>).

NOTE Suitable liquids are: water, transformer oil, alcohol and other solvent.

## 7 Tensile strength and elongation

Tensile strength shall be measured according to the method described in IEC 60641-2.

Deviations from IEC 60641-2:

- five measurements shall be made on the test pieces 20 mm ± 2 mm by 180 mm cut from both directions of test specimens;
- the test length shall initially be 100 mm ± 0,5 mm;

- the load being applied at a rate of 60 mm/min and continued, the test piece breaks.

NOTE The width can be 12,5 mm ± 1 mm on the test pieces.

## 8 Flexural strength

The measurement of the flexural strength is only applicable for materials applied to a nominal thickness of 10 mm or more.

Flexural stress at rupture shall be determined as specified in ISO 178.

The test pieces shall be from the sheet to be tested with their major axes in the directions indicated at LN and WN in Figure 4 of ISO 178:2019; five test pieces in each direction. If the sheet to be tested is more than 20 mm thick, the thickness of the test pieces shall be reduced to 20 mm by machining both faces symmetrically.

## 9 Water absorption

Three test pieces shall be 50 mm ± 1 mm square of thickness of the sheet under test.

Dry three test pieces for 1 h in the oven controlled at 100 °C ± 2 K, and cool to ambient temperature in a desiccator.

The mass of the test pieces shall be measured to an accuracy of 1 mg.

Place the test pieces in a container containing distilled water, controlled at 23 °C ± 0,5 K.

After immersion, remove the test pieces from the water and remove all surface water with a clean, dry cloth or filter paper.

Re-weight the test pieces to the nearest 1 mg.

The water absorption in percentage is calculated by the following formula:

$$a = \frac{m_2 - m_1}{m_1} \times 100$$

where

$a$  is the water absorption (%);

$m_1$  is the mass of test piece in before immersion (g);

$m_2$  is the mass of test piece in after immersion (g).

## 10 Electric strength up to and including 3 mm in thickness

Electric strength shall be determined by the method specified in IEC 60641-2.

Deviations from IEC 60641-2:

- five measurements are made on the test pieces square of approximately 100 mm and of thickness of the sheet test;

- the electrodes shall consist of two metal cylinders with the edges rounded to give a radius of  $(3 \pm 0,2)$  mm. One electrode shall be  $(25 \pm 1)$  mm in diameter and approximately 25 mm high. The other electrode shall be  $(75 \pm 1)$  mm in diameter;
- the test pieces shall be dried in accordance with 4.2;
- measure and record the thickness of each test piece.

The electric strength in kilovolts per millimetre is calculated by the formula:

$$E = \frac{V}{t}$$

where

$E$  is the electric strength (kV/mm);

$V$  is the breakdown voltage (kV);

$t$  is the thickness of the test piece after drying (mm).

## 11 Arc resistance

Arc resistance at rupture shall be determined as specified in IEC 61621.

## 12 Chloride content

**ITeh STANDARD PREVIEW**  
(standards.iteh.ai)

Any recognized method of determining chloride ions in a water extract is permitted.

[IEC 60667-2:2020](https://standards.iteh.ai/catalog/standards/sist/49efc77e-01b8-4185-88fe-0278e65287a6/iec-60667-2-2020)

## 13 Ash content <https://standards.iteh.ai/catalog/standards/sist/49efc77e-01b8-4185-88fe-0278e65287a6/iec-60667-2-2020>

The amount of residue of material left after incineration of the material in the "as received" condition shall be determined according to the method described in IEC 60641-2. The mass of the test piece shall be 5 g. Three determinations shall be made.

## 14 Flexibility (bending)

The flexibility is determined using the measuring principle depicted in Figure 1.

A test piece is placed between the two jaws of the measuring device as shown in Figure 2. The jaws are closed until the test piece cracks or shows signs of rupture.

The flexibility tester is a small vise with jaws about 50 mm wide with small projections about 25 mm from the top edge of jaws against which the ends of specimens are placed. The movable jaw is equipped with a pointer and scale arrangement to indicate the decimal parts for each complete revolution of the vise handle. A dial gauge graduated in 0,01 mm units is placed in the back of the vise handle to indicate the jaw movement for a part of a complete revolution of the handle.

Measure the distance between the inner span of jaws by a dial gauge.

Three measurements of each direction are made on the test pieces approximately 25 mm by 50 mm cut from both directions of specimens.

Open the jaws of the bend tester to about 20 mm. Carefully insert a test piece  $(25 \pm 1)$  mm  $\times$   $(50 \pm 1)$  mm between the jaws in a slightly arched position brown side up. It may