

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Electric and optical fibre cables – Test methods for non-metallic materials –
Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven**

**Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux
non-métalliques –**

**Partie 401: Essais divers – Méthodes de vieillissement thermique –
Vieillissement en étuve à air**

[IEC 60811-401:2012](#)

<https://standards.iteh.ai/catalog/standards/iec/3e992989-4b8c-4b77-a969-6b9f17705d7d/iec-60811-401-2012>





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2017 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
Fax: +41 22 919 03 00
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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

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 also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions 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

65 000 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.

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: csc@iec.ch.

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.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

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 aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions 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

65 000 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.

Service Clients - webstore.iec.ch/csc

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



IEC 60811-401

Edition 1.1 2017-07
CONSOLIDATED VERSION

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Electric and optical fibre cables – Test methods for non-metallic materials –
Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven**

**Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux
non-métalliques –**

**Partie 401: Essais divers – Méthodes de vieillissement thermique –
Vieillissement en étuve à air**

[IEC 60811-401:2012](https://standards.iteh.ai/catalog/standards/iec/3e992989-4b8c-4b77-a969-6b9f17705d7d/iec-60811-401-2012)

<https://standards.iteh.ai/catalog/standards/iec/3e992989-4b8c-4b77-a969-6b9f17705d7d/iec-60811-401-2012>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.035.01; 29.060.20

ISBN 978-2-8322-4652-8

**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.**

REDLINE VERSION

VERSION REDLINE



**Electric and optical fibre cables – Test methods for non-metallic materials –
Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven**

**Câbles électriques et à fibres optiques – Méthodes d'essai pour les matériaux
non-métalliques –**

**Partie 401: Essais divers – Méthodes de vieillissement thermique –
Vieillissement en étuve à air** [IEC 60811-401:2012](https://standards.iteh.ai/catalog/standards/iec/3e992989-4b8c-4b77-a969-6b9f17705d7d/iec-60811-401-2012)

<https://standards.iteh.ai/catalog/standards/iec/3e992989-4b8c-4b77-a969-6b9f17705d7d/iec-60811-401-2012>

CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Test method	6
4.1 General.....	6
4.2 Influence of the ageing treatment on the mechanical characteristics.....	7
4.2.1 Apparatus.....	7
4.2.2 Sample and test pieces preparation.....	7
4.2.3 Ageing procedure	7
4.2.4 Measurements.....	8
4.2.5 Expression of results	8
4.2.6 Requirements	9
4.2.7 Test report.....	9
4.3 Bending test on test pieces of core.....	9
4.3.1 Apparatus.....	9
4.3.2 Sample and test pieces preparation.....	9
4.3.3 Procedure.....	9
4.3.4 Requirement.....	10
4.3.5 Test report.....	10
Annex A (normative) Methods of measuring air flow in ovens.....	11
Annex B (normative) Test pieces preparation in presence of copper or metal coated copper conductor	15
Annex C (normative) Sample and test pieces preparation for ageing of complete cable	18
Bibliography.....	19
Figure A.1 – Flowmeter for air-flow control in air ovens for method 2	13
Figure A.2 – Calibration diagram of the capillary tube of the flowmeter for air-flow control in air ovens for method 2	14
Figure B.1 – Specially prepared test pieces	17
Figure B.2 – Dumb-bell test pieces preparation after ageing	17
Table 1 – Number of turns for bending test	10
Table B.1 – Summary of ageing tests for insulated conductors in case of difficulties in preparing test pieces due to conductor insulation or separator adhesion during ageing.....	15

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRIC AND OPTICAL FIBRE CABLES – TEST METHODS FOR NON-METALLIC MATERIALS –

Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven

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 60811-401 edition 1.1 contains the first edition (2012-03) [documents 20/1285/FDIS and 20/1334/RVD] and its amendment 1 (2017-07) [documents 20/1733/FDIS and 20/1738/RVD].

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 60811-401 has been prepared by IEC technical committee 20: Electric cables.

There are no specific technical changes with respect to the previous edition, but see the Foreword to IEC 60811-100:2012.

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

This part of IEC 60811 shall be used in conjunction with IEC 60811-100.

A list of all the parts in the IEC 60811 series, published under the general title *Electric and optical fibre cables – Test methods for non-metallic materials*, can be found on the IEC website.

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 "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.

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

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

The IEC 60811 series specifies the test methods to be used for testing non-metallic materials of all types of cables. These test methods are intended to be referenced in standards for cable construction and for cable materials.

NOTE 1 Non-metallic materials are typically used for insulating, sheathing, bedding, filling or taping within cables.

NOTE 2 These test methods are accepted as basic and fundamental and have been developed and used over many years principally for the materials in all energy cables. They have also been widely accepted and used for other cables, in particular optical fibre cables, communication and control cables and cables for ships and offshore applications.

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

[IEC 60811-401:2012](#)

<https://standards.iteh.ai/catalog/standards/iec/3e992989-4b8c-4b77-a969-6b9f17705d7d/iec-60811-401-2012>

ELECTRIC AND OPTICAL FIBRE CABLES – TEST METHODS FOR NON-METALLIC MATERIALS –

Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven

1 Scope

This Part 401 of IEC 60811 specifies the procedure for ageing in an air oven, which typically applies to crosslinked and thermoplastic compounds used for insulating and sheathing materials.

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 60228, *Conductors of insulated cables*

IEC 60811-100:2012, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 100: General*

IEC 60811-409, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 409: Miscellaneous tests – Loss of mass test for thermoplastic insulations and sheaths*

<https://www.it-ebooks.info> IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC 60811-504, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 504: Mechanical tests – Bending tests at low temperature for insulation and sheaths*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60811-100 apply.

4 Test method

4.1 General

This part of IEC 60811 shall be used in conjunction with IEC 60811-100.

~~Unless otherwise specified, tests shall be carried out at room temperature.~~

An ageing treatment in an air oven may be required by the relevant cable standard:

- a) for prepared test pieces of insulating or sheathing material only (see 4.2.3.2);
- b) for prepared test pieces of cores (conductor and insulation) (see 4.2.3.2 and 4.2.3.3 if necessary);

- c) for test pieces of completed cable (see 4.2.3.4);
- d) for the loss of mass test (see IEC 60811-409).

The ageing test a) or b) and the loss of mass test d) may be combined and carried out on the same test pieces when the aging time and aging temperature are the same.

In general, mechanical characteristics are measured after treatment, but in some cases, the conductor and the separator, if any, cannot be removed without damaging the insulation and a bending test is realized on the circular conductor up to and including 16 mm². Ageing followed by the bending test is considered the acceptance procedure in case of dispute.

4.2 Influence of the ageing treatment on the mechanical characteristics

4.2.1 Apparatus

The ageing treatment is realized in an oven with natural air flow or air flow by pressure. The air shall enter the oven in such a way that it flows over the surface of the test pieces and leaves near the top of the oven. The oven shall have not less than 8 and not more than 20 complete air changes per hour at the specified ageing temperature. Two test methods for measuring air flow through an oven are given in Annex A.

Unless otherwise specified in the relevant cable specification, a rotating fan inside the oven is allowed when testing rubber compounds. For all other compounds a fan shall not be used inside the oven, and in cases of dispute, rubber compounds shall also be tested in an oven which is designed to operate without a fan rotating inside it.

4.2.2 Sample and test pieces preparation

The sample of the cable, or sheath removed from the cable, or samples of core, cut into pieces which are sufficiently long, shall be taken, preferably from positions close to that from which the samples for the tensile tests without ageing are taken in accordance with IEC 60811-501.

Test pieces, dumb-bell or tubular, are prepared according to IEC 60811-501.

Test pieces can consist of samples of core, cut into pieces which are sufficiently long. If, after ageing, the conductor and the separator, if any, cannot be removed without damaging the insulation, preparation of test pieces shall be carried out according to Annex B (Clause B.2). For circular conductors up to and including 16 mm² and having plain or metal coated wires and also when a separator around the conductor is included, a bending test is carried out on the aged test pieces.

4.2.3 Ageing procedure

4.2.3.1 General

This test shall be carried out not less than 16 h after the extrusion or cross-linking, if any, of the insulating or sheathing compounds. It can be done on tubular or dumb-bell test pieces prepared according to IEC 60811-501 or insulated cores as described in the present standard.

4.2.3.2 Ageing procedure for test pieces prepared according to IEC 60811-501 and Clause B.1 and B.2.2 and Annex C of this standard

This procedure shall be used for

- test pieces of insulating material without conductor and of sheathing material, according to IEC 60811-501,
- test pieces of cores with the original conductor (see Clause B.1),
- tubular test pieces with a reduced conductor (see B.2.2),

– complete cable (see Annex C).

Compounds of obviously different compositions shall not be tested at the same time in the same oven.

Five test pieces, as specified in IEC 60811-501 shall be suspended vertically and substantially in the middle of the oven so that each test piece is at least 20 mm from any other test pieces.

The test pieces shall not occupy more than 2 % of the volume of the oven.

The test pieces shall be kept in the oven at the temperature and for the time specified for the material in the relevant standard for the type of cable.

As soon as the ageing period is completed, the test pieces shall be removed from the oven and left at ~~ambient~~ room temperature, avoiding direct sunlight, for at least 16 h.

4.2.3.3 Ageing procedure for test pieces prepared from conductors above 16 mm²

The following procedure shall be used when the conductor and the separator, if any, cannot be removed without damaging the insulation after ageing.

The test pieces prepared as described in B.2.3.1 shall be placed substantially in the middle of the oven so that each test piece is at least 20 mm from any other test pieces. They shall be supported at both ends and the insulation shall not contact any object other than the binding wire. The test pieces shall not occupy more than 2 % of the volume of the oven, and they shall be kept in the oven at the temperature and for the time specified in the relevant standard for the type of cable.

As soon as the ageing period is completed, the test pieces shall be removed from the oven, left at ~~ambient~~ room temperature avoiding direct sunlight, for at least 16 h, dumb-bell are prepared as described in B.2.3.2.

4.2.3.4 Ageing procedure for pieces of complete cable

The three test pieces of cable as described in Clause C.1 shall be suspended vertically and substantially in the middle of the oven at least 20 mm away from any other piece and shall not occupy more than 2 % of the volume of the oven.

The test pieces of cable shall be kept in the oven at the temperature and for the time specified in the relevant standard for the type of cable.

As soon as the specified heating period is completed, the test pieces of cable shall be removed from the oven and left at ~~ambient~~ room temperature, avoiding direct sunlight, for at least 16 h.

4.2.4 Measurements

Determination of the mechanical properties on aged dumb-bell and/or tubular test pieces obtained directly after ageing or prepared after ageing, according to the case (see B.2.3 or Clause C.2) shall then be carried out in accordance of IEC 60811-501.

4.2.5 Expression of results

Calculate the tensile strength and the elongation at break, according to the definitions given in IEC 60811-501.

If required by the standard for the material in the relevant standard for the type of cable, the values found for the aged test pieces shall be calculated, in terms of variation compared to the untreated test pieces according to the following formulae:

$$V_T = \frac{T_E - T_U}{T_U} \times 100 \quad (1)$$

$$V_E = \frac{E_E - E_U}{E_U} \times 100 \quad (2)$$

where

- V_T variation of the tensile strength in per cent;
- T_E tensile strength of aged test piece;
- T_U tensile strength of untreated test piece;
- V_E variation of the elongation at break in per cent;
- E_E elongation at break of aged test piece in per cent;
- E_U elongation at break of untreated test piece in per cent.

NOTE The untreated specimen is kept at room temperature.

4.2.6 Requirements

The value and the variation between the median value obtained of the test pieces aged and the median value of the values obtained for the untreated test pieces (see IEC 60811-501) expressed as a percentage of the latter shall not exceed the percentage specified in the standard for the material in the relevant standard for the type of cable.

4.2.7 Test report

The test report shall be in accordance with that given in IEC 60811-100.

4.3 Bending test on test pieces of core

4.3.1 Apparatus

Ageing is carried out in an oven as described in 4.2.1.

The bending test apparatus is described in IEC 60811-504.

4.3.2 Sample and test pieces preparation

Two samples of suitable length shall be taken from each core to be tested preferably from positions close to that from which the samples for the tensile tests without ageing are taken (see IEC 60811-504).

4.3.3 Procedure

Test pieces are aged according to the procedure described in 4.2.3.3.

As soon as the ageing period is completed, the test pieces shall be removed from the oven and left at room temperature, avoiding direct sunlight, for at least 16 h.

Each test piece shall then be bent at ~~ambient~~ room temperature around a mandrel so as to form a close helix.

The bending procedure shall be carried out uniformly at a rate of one turn in about 5 s.

The bending tests may be carried out with the apparatus described in IEC 60811-504.

The diameter of the mandrel shall be f times the diameter of the core. The values of f and also the number of turns are specified as follows.

Table 1 – Number of turns for bending test

Cross-sectional area of conductor mm ²	Factor f	Number of turns
Up to and including 2,5	1 ±0,1	7
4 and 6	2 ±0,1	6
10 and 16	4 ±0,1	5

4.3.4 Requirement

At the end of the bending procedure the test pieces shall be examined while still on the mandrel. The insulation of both test pieces shall not show any crack when examined with normal or corrected vision without magnification. Any cracks in the first or the last turn on the mandrel shall be disregarded.

4.3.5 Test report

The test report shall be in accordance with that given in IEC 60811-100.

iTeh Standards

(<https://standards.iteh.ai>)

Document Preview

[IEC 60811-401:2012](#)

<https://standards.iteh.ai/catalog/standards/iec/3e992989-4b8c-4b77-a969-6b9f17705d7d/iec-60811-401-2012>