

# Specification for plastic films for electrical purposes —

## Part 2: Methods of test

The European Standard EN 60674-2:1998, with the incorporation of amendment A1:2001, has the status of a British Standard

ICS 29.035.20

# Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Cable and Insulation Standards Policy Committee (CIL/-) to Technical Committee CIL/15, upon which the following bodies were represented:

- Adhesive Tape Manufacturers' Association
- British Ceramic Research Limited
- British Industrial Ceramic Manufacturers' Association
- British Paper and Board Industry Federation
- Department of Trade and Industry, National Measurement Accreditation Service
- ERA Technology Limited
- Electrical and Electronic Insulation Association (BEAMA Ltd.)
- Electricity Supply Industry in England and Wales
- Ministry of Defence
- Rotating Electrical Machines Association (BEAMA Ltd.)
- Telecommunication Engineering and Manufacturing Association
- Transmission and Distribution Association (BEAMA Ltd.)

The following bodies were also represented in the drafting of the standard, through sub-committees and panels:

- British (AC) Capacitor Manufacturers' Association (BEAMA Ltd.)
- British Plastics Federation
- EBEA (the Electronics and Business Equipment Association)
- Packaging and Industrial Films Association

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## Amendments issued since publication

| Amd. No. | Date           | Comments                                                       |
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| 9101     | July 1996      | Indicated by a sideline in the margin                          |
| 10106    | October 1998   | Implements the European Standard                               |
| 13661    | 22 August 2002 | Replacement of Clause 16 and addition of Figure 7 and Figure 8 |
|          |                |                                                                |

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## National foreword

This part of this British Standard is the English language version of EN 60674-2:1998, including amendment A1:2001. It is identical with IEC Publication 60674-2:1988, *Specification for plastic films for electrical purposes — Part 2: Methods of test*, together with its Corrigendum November 1995 and amendment 1:2001, published by the International Electrotechnical Commission (IEC).

### Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index” or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

The Technical Committee has reviewed the provisions of IEC 60343:1970 and ISO/DIS 6824, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. Related British Standards to IEC 60243:1967 and IEC 60454-2:1974 are BS 2918:1957 and BS 3924:1978, respectively. Related British Standards to IEC 60250:1969 are BS 2067:1953 and BS 4542:1970. Related British Standards to ISO 1183:1987 are BS 2782-6:Method 620A:1980 and BS 3715:1964. A related British Standard to ISO 1184:1983 is BS 2782-3:Method 326:1977.

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### Summary of pages

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English version

## Specification for plastic films for electrical purposes — Part 2: Methods of test

(includes amendment A1:2001)  
(IEC 60674-2:1988 + corrigendum 1995 + A1:2001)

Spécification pour les films en matière plastique à  
usages électriques —  
Partie 2: Méthodes d'essai  
(inclut l'amendement A1:2001)  
(CEI 60674-2:1988 + corrigendum 1995 + A1:2001)

Bestimmung für Isolierfolien für elektrotechnische  
Zwecke —  
Teil 2: Prüfverfahren  
(enthält Änderung A1:2001)  
(IEC 60674-2:1988 + corrigendum 1995 + A1:2001)

This European Standard was approved by CENELEC on 1998-04-01. Amendment A1 was approved by CENELEC on 2001-12-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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## CENELEC

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

**Central Secretariat: rue de Stassart 35, B-1050 Brussels**

## Foreword

The text of the International Standard IEC 60674-2:1988 and its corrigendum November 1995, prepared by SC 15C, Specifications, of IEC TC 15, Insulating materials, was submitted to the formal vote and was approved by CENELEC as EN 60674-2 on 1998-04-01 without any modification.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-12-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1998-12-01

Annexes designated “normative” are part of the body of the standard. In this standard, Annex ZA is normative. Annex ZA has been added by CENELEC.

## Foreword to amendment A1

The text of document 15C/1263/FDIS, future amendment 1 to IEC 60674-2:1988, prepared by SC 15C, Specifications, of IEC TC 15, Insulating materials, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60674-2:1998 on 2001-12-01.

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## Introduction

This standard is one of a series which deals with plastic films for electrical purposes.

The series will consist of three parts:

- *Part 1: Definitions and general requirements* (IEC Publication 60674-1);
- *Part 2: Methods of test*;
- *Part 3: Specifications for individual materials* (IEC Publication 60674-3).

## 1 Scope

This standard is applicable to plastic films used for electrical purposes. This Part 2 gives methods of test.

## 2 General notes on tests

**2.1** Discard at least the first three layers of film from the roll to be tested before removing test specimens.

**2.2** Sample rolls shall be exposed for at least 24 h to the standard atmosphere  $23 \pm 2$  °C and  $50 \pm 5$  % r.h. before test specimens are removed for test. Unless otherwise specified, all individual test specimens shall be conditioned for 1 h and tested in the same standard atmosphere.

## 3 Thickness

Thickness shall be measured by any one or more of the methods given below as required by the future IEC Publication 60674-3.

### 3.1 Determination of thickness by mechanical scanning

#### 3.1.1 Principle

The method is based on ISO Standard 4593 using a precision micrometer to measure the thickness of a single sheet test specimen.

#### 3.1.2 Test specimens and measuring points

Cut three strips about 100 mm wide across the width of the sample. The test strips shall not contain creases or other defects.

Determine the thickness of the test strips in accordance with the requirements of ISO Standard 4593 using a micrometer having plane or radiused measuring surfaces.

Measurements shall be made at nine points at approximately equally spaced intervals along the length of the test strips. In the case of samples less than 300 mm wide make the measurements every 50 mm along the length of the test strips. In the case of untrimmed rolls, readings shall not be taken within 50 mm of the edges.

#### 3.1.3 Result

The thickness is the central value of all the measurements, the highest and lowest values on each strip being reported.

### 3.2 Determination of gravimetric thickness of a sample

Principle: calculation of the thickness of a sample from measurements of mass, area and density in accordance with Section 1 of ISO Standard 4591.

### 3.3 Determination of average gravimetric thickness of a roll

Principle: calculation of the average thickness from measurements of the length, average width and net mass of the roll and the density of the film in accordance with Section 2 of ISO Standard 4591.

### 3.4 Crosswise thickness profile and lengthwise variation in thickness (Under consideration.)

## 4 Density

To be determined in accordance with ISO Recommendation 1183. The particular method will be specified in IEC Publication 60674-3.

## 5 Width

To be determined in accordance with ISO Standard 4592, except that a 5 m sample length is used. Determine the width five times along the length at equal intervals after the film has relaxed for one hour. Record each width measured and report the central value as the width of the roll.

## 6 Windability (bias/camber and sag)

### 6.1 Principle

An assessment is made of the distortion of the film as supplied in the roll.

Two forms of distortion may be apparent in the film which can impair its subsequent winding characteristics. These distortions are:

- 1) the film may exhibit bias or camber and therefore its edges may not be straight (see Figure 1);
- 2) the film may sag below its general level in areas where it has been stretched (see Figure 2 and Figure 3).

### 6.2 Introduction

Two methods are given. Method A is appropriate for narrow (i.e. less than 150 mm) films where distortion is apparent mainly as bias/camber and also for the measurement of sag for very thick films where the tension required for extension by Method B is excessive.

Method B is appropriate for wider (i.e. greater than 150 mm) films where distortion is apparent, mainly as sag.

### 6.3 Method A

#### 6.3.1 Principle

To assess bias/camber, a length of film is unwound and laid on a flat surface and the deviation of each of its edges from a straight line is measured (see Figure 1).

To assess sag, a length of film is unwound and laid orthogonally over two parallel bars under defined conditions and the deviation from a uniform catenary is measured (see Figure 2). It may sometimes be convenient to make this measurement using the rollers of a winding machine, but in cases of dispute the dimensions and distances shall be as given below.

#### 6.3.2 Measurement of bias/camber

##### 6.3.2.1 Apparatus

A flat, horizontal table of any suitable material having a satin finish (not polished) of sufficient width to accommodate the maximum width of film to be tested and of length  $1\,500 \pm 15$  mm with ends parallel to within  $0.1^\circ$  (or 1.8 mm per 1 metre of table width). Alternatively, the table may be longer than the above length but must then have two reference lines clearly marked on its surface  $1\,500 \pm 15$  mm apart and parallel to the same accuracy.

- A soft brush suitable for smoothing the film specimen on the table surface.
- A long (in excess of 1 525 mm) steel straight-edge.
- A 150 mm steel rule with 1 mm graduations.

##### 6.3.2.2 Test specimens

The first three layers of film from the roll are discarded. For each specimen a fresh length of approximately 2 m is taken, being drawn from the roll with the lightest tension necessary to unwind it slowly (at about 300 mm/s).

##### 6.3.2.3 Procedure

The specimen length of film is placed lengthwise over the table as shown in Figure 1. Starting from one end, the soft brush is used to lightly press the film into intimate contact with the table surface, expelling any trapped air as far as possible.

The steel straight-edge is then placed along one edge of the film so that any deviation of the film edge from a straight line can be readily observed. The straight-edge is adjusted to coincide with the film edge at the two table ends (or at the reference marks if these are used) and the distance between these points shall be  $1\,500 \pm 15$  mm. The distance between the straight edge and the film edge is measured to the nearest 1 mm at approximately mid-span by means of the steel rule.

The deviation of the second film edge is then measured using the same procedure.

The sum of the distances in millimetres of the two edges of the film from the steel straight-edge at the mid-span is the bias/camber value for that test specimen.

The above procedure is repeated for two further test specimens.

#### **6.3.2.4 Results**

The bias/camber is the central value of the three determinations, the other two values being reported.

### **6.3.3 Measurement of sag**

#### **6.3.3.1 Apparatus**

A rigid framework supporting two parallel, freely rotatable metal rollers, each roller  $100 \pm 10$  mm in diameter and of sufficient length to accommodate the maximum width of film to be tested. The axes of the rollers shall be in the same horizontal plane and set mutually parallel to within  $0.1^\circ$  (i.e. within 1.8 mm per 1 m length of roller) with a separation of  $1\,500 \pm 15$  mm. The roller surfaces shall be accurately cylindrical to within 0.1 mm with any suitable satin finish (not polished) (see Figure 2). The framework shall be fitted with a device for mounting the roll of film being tested immediately below one of the rollers. The mounting shall be such that the axis of the film roll is parallel to the superior roller to within  $1^\circ$  and the film may be drawn off the roll against an adjustable unwind tension. At the opposite end of the framework a weighted or sprung clamp is fixed to the film web hanging freely from the second roller. The weight or spring loading and its position on the film may be adjusted so as to give a substantially uniform tension across the web as specified in IEC Publication 60674-3.

A device for measuring along a line midway between the rollers the distance of the film below the plane of those rollers (see Figure 3). The device may comprise simply a long (in excess of 1,525 mm) steel straight-edge and a 150 mm steel rule with 1 mm graduations, or more complex devices may be employed whereby the film position is noted automatically or semi-automatically.

#### **6.3.3.2 Test specimens**

The first three layers of film from the roll are discarded. For each specimen a fresh length of approximately 2 m is drawn from the roll with the lightest tension necessary to unwind it slowly (at about 300 mm/s).

#### **6.3.3.3 Procedure**

The specimen length of film is placed over the apparatus rollers, the free end of the film is clamped in the tensioning device, the tension adjusted to the value given for the film in IEC Publication 60674-3 and the lateral position of the film as it passes over the second roller adjusted so that the film web lies approximately horizontal at mid-span.

Using the steel straight-edge and graduated steel ruler or other suitable device the film is checked across the film width at mid-span and any edge sag or sag lanes noted. The maximum depth of any sag lane below the general film surface surrounding it is measured to the nearest 1 mm (see Figure 3) and reported as the sag value for that test.

The above procedure is repeated for two further test specimens.

#### **6.3.3.4 Result**

The sag value is the central value of the three determinations, the other two values being reported.

## 6.4 Method B

### 6.4.1 Principle

The total amount of sag and bias/camber is assessed by one measurement. A length of film is unwound and laid orthogonally over two parallel bars under defined conditions. The film is strained until free of visible sag and bias/camber and the extension necessary to achieve this is measured. It may sometimes be convenient to make this measurement using the rollers of a winding machine but in cases of dispute the dimensions and distances shall be as given below.

### 6.4.2 Apparatus

A rigid framework supporting two parallel, freely-rotatable metal rollers, each roller  $100 \pm 10$  mm in diameter and of sufficient length to accommodate the maximum width of film to be tested. The axes of the rollers shall be in the same horizontal plane and set mutually parallel to within  $0.1^\circ$  (i.e. within 1.8 mm per 1 m length of roller) with a separation of  $1\,500 \pm 15$  mm. The roller surfaces shall be accurately cylindrical to within  $\pm 0.1$  mm with any suitable satin finish (not polished). The framework shall be fitted with a device for mounting the roll of film being tested immediately below one of the rollers. The mounting shall be such that:

- a) the axis of the film roll is parallel to the superior roller to within  $2^\circ$ ;
- b) the lateral position of the film may be adjusted as desired; and
- c) the film may be drawn off the roll against an adjustable unwind tension.

At the opposite end of the framework a weighted or sprung clamp is fixed to the film web hanging freely from the second roller. The weight or spring loading of the clamp and its position on the film may be varied to give an adjustable tension substantially uniform across the web.

- A steel straight-edge (in excess of 1 525 mm).
- A flexible steel rule 2 m or more in length with 1 mm graduations.
- Suitable self-adhesive labels.

### 6.4.3 Test specimens

The first three layers of film from the roll are discarded and a fresh length of approximately 2 m is drawn from the roll with the lightest tension necessary to unwind it slowly (at about 300 mm/s).

### 6.4.4 Procedure

The specimen length of film is placed over the apparatus rollers. With light hand tension applied to the web, the free end of the film is moved so that the film web between the rollers is as flat as possible and the free end is then clamped in the tensioning device. The tension is adjusted to  $1.0 \pm 0.2$  mN/m<sup>2</sup> (based on the nominal thickness and width of the film).

Two reference marks (between 1.0 m and 1.1 m apart) are applied to the film on a line exhibiting minimal sag and which is approximately parallel to the edges of the film. These marks may conveniently be specific edges of two self-adhesive labels applied to the film surface.

The distance between the marks is measured to within  $\pm 0.5$  mm using the flexible steel tape.

The tension applied to the film is increased until:

- a) the film is visually smooth;
- b) each film edge is straight to within 0.5 mm at mid-span when compared with the straight-edge; and
- c) the sag at any point does not exceed 7.5 mm when compared with the straight-edge.

The distance between the reference marks at this tension is measured using the steel tape and the extension of the film is expressed as a percentage of the original mark separation.

The above procedure is repeated for two further test specimens.

### 6.4.5 Result

The total sag and bias/camber is the central value of the three determinations, the other two values being reported.

## 7 Surface roughness

Under consideration.

## 8 Coefficient of friction

To be determined in accordance with IEC Publication 60648.

### *Principle*

This method covers determination of starting and sliding friction of plastic film and sheeting when sliding over itself or other substances under specified conditions. The procedure permits the use of a stationary sled with a moving plane or a moving sled with a stationary plane. Both procedures yield the surface coefficient of friction for a given test specimen.

## 9 Wetting tension (polyolefine films)

### 9.1 Test principle and introductory remarks

The determination of the wetting tension is based on the phenomenon that drops of a series of an organic liquid mixture with gradually increasing surface tension, when they have reached a specific concentration, have the ability to wet the film surface. Since the wetting tension of a film in contact with a drop of the respective liquid mixture in the presence of air is a function of the surface energies of both the air-film and the film-liquid interfaces, any trace of surface-active impurities in the liquid reagents or on the film may affect the results. It is, therefore, important that the film surface to be tested should not be touched or rubbed, that all equipment be clean and that reagent purity be carefully controlled.

### 9.2 Apparatus

- Cotton-tipped wooden applicators approximately 150 mm long.
- Two burets, 50 ml.
- Bottles, 100 ml with caps and labels      { cleaned with chrome sulphuric acid and  
rinsed with distilled water.

### 9.3 Reagents

Prepare mixtures of reagent-grade formamide ( $\text{HCONH}_2$ ) and reagent-grade ethylene-glycol-monoethyl-ether ( $\text{CH}_3\text{CH}_2 - \text{O} - \text{CH}_2\text{CH}_2 - \text{OH}$ ) in the proportions shown in the following Table I for the integral values of wetting tension in the range over which measurements are to be made.

If desired, add to each of the mixtures mentioned in Table I a very small amount of dye of high tinctorial value. The dye used should be of such colour as to make drops clearly visible on the surface of the polyolefin film. Furthermore, the dye must be of such chemical composition that it will not measurably affect the wetting tension of the liquid mixtures.

NOTE 1 It is recommended that the surface tension of the liquid mixtures be checked weekly. Any wetting tension method usually applied in the laboratory is suitable.

NOTE 2 Although the shown liquid mixtures are relatively stable, exposure to temperatures above 30 °C and humidity above 70 % r.h. should be avoided.

NOTE 3 Both ethylene-glycol-monoethyl-ether and formamide are toxic and should be handled with due precaution. Since formamide is particularly dangerous when in direct contact with the eyes, safety goggles should be worn when making up the liquid mixtures. National safety regulations should be observed.