BS EN 60674-3-8:2011

BSI Standards Publication

Plastic films for electrical purposes

Part 3: Specifications for individual materials — Sheet 8: Balanced biaxially oriented polyethylene naphthalate (PEN) films used for electrical insulation

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National foreword

This British Standard is the UK implementation of EN 60674-3-8:2011. It is identical to IEC 60674-3-8:2011.

The UK participation in its preparation was entrusted to Technical Committee GEL/15, Solid electrical insulating materials.

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.

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Plastic films for electrical purposes - Part 3: Specifications for individual materials - Sheet 8: Balanced biaxially oriented polyethylene naphthalate (PEN) films used for electrical insulation

(IEC 60674-3-8:2011)

Films plastiques à usages électriques - Partie 3: Spécifications pour matériaux particuliers - Feuille 8: Films de polynaphtalate d'éthylène (PEN) à orientation bi-axiale équilibrée, utilisés dans l'isolation électrique
(CEI 60674-3-8:2011)

Isolierfolien für elektrotechnische Zwecke – Teil 3: Bestimmungen für einzelne Werkstoffe – Blatt 8: Isotrop biaxial orientierte Polyethylennaphthalat-(PEN)-Folien zur elektrischen Isolierung
(IEC 60674-3-8:2011)

CENELEC

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

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Foreword

The text of document 15/631/FDIS, future edition 1 of IEC 60674-3-8, prepared by IEC TC 15, Solid electrical insulating materials, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60674-3-8 on 2011-08-17.

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

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)	2012-05-17
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2014-08-17

Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 60674-3-8:2011 was approved by CENELEC as a European Standard without any modification.

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

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 60068-2-66	1994	Environmental testing - Part 2-66: Test methods - Test Cx: Damp heat, steady state (unsaturated pressurized vapour)	EN 60068-2-66	1994
IEC 60216-5 + corr. December	2008 2009	Electrical insulating materials - Thermal endurance properties - Part 5: Determination of relative thermal endurance index (RTE) of an insulating material	EN 60216-5	2008
IEC 60674-1	1980	Specification for plastic films for electrical purposes - Part 1: Definitions and general requirements	EN 60674-1	1998
IEC 60674-2 + corr. November	1988 1995	Specification for plastic films for electrical purposes - Part 2: Methods of test	EN 60674-2	1998
ISO 11357-3	1999	Plastics - Differential scanning calorimetry (DSC) - Part 3: Determination of temperature and enthalpy of melting and crystallization	-	-

CONTENTS

INTRODUCTION

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

The series consists of three parts:

Part 1: Definitions and general requirements (IEC 60674-1).

Part 2: Methods of test (IEC 60674-2).

Part 3: Specifications for individual materials (IEC 60674-3).

This standard contains one of the sheets comprising part 3, as follows:

Sheet 8: Balanced biaxially oriented polyethylene naphthalate (PEN) films used for electrical insulation.

PLASTIC FILMS FOR ELECTRICAL PURPOSES –

Part 3: Specifications for individual materials – Sheet 8: Balanced biaxially oriented polyethylene naphthalate (PEN) films used for electrical insulation

1 Scope

This International Standard gives the requirements for balanced biaxially oriented polyethylene naphthalate (PEN) films for use as electrical insulation.

Materials which conform to this specification meet established levels of performance. However, the selection of a material by a user for a specific application should be 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 references

The following referenced documents are indispensable for the application 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 60674-1:1980, *Specification for plastic films for electrical purposes – Part 1: Definitions and general requirements*

IEC 60674-2:1988, *Specification for plastic films for electrical purposes – Part 2: Methods of test*

IEC60068-2-66:1994, *Environmental testing – Part 2: Test methods – Test Cx: Damp heat, steady state (unsaturated pressurized vapour)*

IEC 60216-5:2008, *Electrical insulating materials – Thermal endurance properties – Part 5: Determination of relative thermal endurance index (RTE) of an insulating material*

ISO11357-3:1999, *Plastics – Differential scanning calorimetry (DSC) – Part 3:Determination of temperature and enthalpy of melting and crystallization*

3 Classification

The PEN film shall be of the following types:

Type 1a: General purpose, high hydrolytic stability grade.

Type 1b: General purpose, standard grade.

Type 2: Capacitor grade.

4 Designation

The plastic film shall be identified by the following designation:

Designation of the film - IEC 60674-3-8 - PEN - type - thickness in micrometres - width in millimetres - length in metres - colour.

Example:
Polyethylene naphthalate - IEC 60674-3-8 - PEN - type 1b - 100 - 20 - 200 – nc
(nc = natural colour; other colours according to IEC 60757).

5 General requirements

The material shall be made from polyethylene naphthalate; it shall be biaxially oriented with an approximately balanced orientation and shall conform to the requirements laid down in IEC 60674-1.

For certain applications additives to the base material may be present (e.g. pigments, dyes). Where such additives are included, they shall not affect the requirements for any of the properties listed for that type unless otherwise specified.

6 Dimensions

6.1 Thickness

The film thickness shall be measured by a gravimetric method in accordance with the requirements of Subclause 3.3 of IEC 60674-2.

NOTE There are no requirements for thickness in this standard but preferred thicknesses in µm are as follows:

1,2; 1,3; 1,5; 1,8; 1,9; 2; 2,1; 2,3; 3; 3,5; 4; 5; 6; 8; 9; 12; 16; 19; 20; 25; 38; 45; 50; 75; 89; 100; 125; 188; 200; 250.

The thickness tolerance shall comply with the requirements in Subclause 4.1 of IEC 60674-1 unless otherwise specified in the purchase contract.

6.2 Width

The film width shall be measured in accordance with the requirements of Clause 5 of IEC 60674-2.

Preferred widths cannot be given on account of the great variety of applications.

The tolerance on the width shall comply with the requirements of Subclause 4.2 of IEC 60674-1 except for slot closure applications where on a width of less than 25 mm a tolerance of $x\ ^{0,0}_{-0,3}$ mm is specified as an alternative.

7 Properties

7.1 Properties not dependent on thickness

Table 1 – Properties not dependent on thickness

Property	Requirements	Units	IEC 60674- 2 Test method Subclause	Type
Density - normal	1 350 ± 20	kg/m^3	4, Method D	1a,1b and 2
Melting- point	270 ± 5 [a]	°C	–	1a,1b and 2
Permittivity	2,6 ± 0,5	–	16.1 (23 °C, 1 kHz) [b]	1a,1b and 2
Dissipation factor	$<5 \times 10^{-3}$	–	16.1 (23 °C, 48 Hz – 62 Hz) [b]	1a,1b and 2
	$<9 \times 10^{-3}$	–	16.1 (23 °C, 1 kHz) [b]	1a and 1b
Volume resistivity	$>10^{16}$	Ω × m	15 [c]	1a and 1b
	$>10^{16}$			2
Surface resistivity	$>10^{14}$	Ω	14 [c]	1a and 1b
	$>10^{15}$			2

a DSC method according to ISO 11357-3.

b Use non-contacting electrodes or evaporated metal electrodes.

c Measurement conditions shall be 23 °C and 50 % r.h. after 24 h exposure. The test voltages are 100 V ± 10 V for thicknesses > 10 μm and 10 V for thicknesses < 10 μm.

7.2 Properties dependent on thickness

Table 2 – Properties dependent on thickness

Property	Requirements			Units	IEC 60674- 2 Test method Subclause	Type
	≤15 μm	>15 μm up to 100 μm	>100 μm up to 250 μm			
Tensile strength (either direction) Minimum value						
- Initial value	180 [a]	120	95	MPa	10 [b]	1a, 1b and 2
- After exposure to unsaturated damp heat for 96 h [c]	130 [a]	100	90			1a
	110 [a]	90	85			1b and 2
Elongation at break (either direction) Minimum value						
- Initial value	35 [a]	40	40	%	10 [b]	1a, 1b and 2
- After exposure to unsaturated damp heat for 96 h [c]	20 [a]	20	20			1a
	10 [a]	10	10			1b and 2
Dimensional change (shrinkage either direction)	1,3	1,0	0,8	%	23 (150 °C, 15 min)	1a, 1b and 2
	6,5	3,5	1,6		23 (200 °C, 10 min)	1a, 1b and 2
Electric strength	See Tables 3 and 4				18.1, a.c. [d]	1a, 1b and 2
					18.2, d.c.	2

[a] No requirement for film thicknesses below 5 μm.

[b] Rate of extension 100 mm/min, reference lines 100 mm apart.

[c] Exposure to unsaturated damp heat (unsaturated pressurized vapour), 120 °C, 85 % r.h. according to Clauses 3 to 9 in IEC 60068-2-66.

[d] Method to use 6 mm diameter electrodes. For materials of thicknesses 100 μm or less, tests shall be made in air using a rate of rise of voltage of 500 V/s. For materials thicker than 100 μm, tests shall be made in transformer oil in accordance with IEC60243-1.

Table 3 – Electric strength (a.c. test) for all types

Nominal thickness μm	Minimum electric strength V/μm		IEC 60674- 2 Test method Subclause
	23 °C	150 °C	
6 9 12 16 20 25 38 50 75 100 125 188 250	- - - 405 [a] 360 [a] 305 [a] 235 [a] 190 [a] 150 [a] 120 [a] 95 [b] 80 [b] 70 [b]	- - - 230 [c] 190 [c] 170 [c] 140 [c] 120 [c] 100 [c] 80 [c] 70 [c] 50 [c] 40 [c]	18.1 Using 6 mm diameter electrodes [a] in air. [b] in mineral transformer oil. [c] in silicone transformer oil.

Table 4 – Electric strength (d.c. test) type 2 only

Nominal thickness μm	Minimum breakdown voltage Central value V	Not more than two of the 21 results shall be below V	Not more than one of the 21 results shall be below V
4	1200	500	100 [a]
5	1200	500	200 [a]
6	1800	1200	1000 [a]
12	5900	3600	3000

[a] This value is only for information. The actual value shall be agreed between purchaser and manufacturer.

7.3 Other properties

7.3.1 Thermal endurance

Thermal endurance for types 1a and 1b films (≥25 μm) shall be measured according to IEC 60216-5.

RTE ≥ 160*

* End point criterion: 50 % retention of tensile strength.

Reference material: PPS (Polyphenylene Sulfide) film having approximately the same thickness as the subject material and an ATE in accordance with IEC 60216-5, Subclause 3.1.4.

Ageing temperatures of 180 °C, 200 °C and 220 °C are recommended.

There is no thermal endurance requirement for type 2 films.

7.3.2 Burning characteristics

No requirement.

8 Roll characteristics for all types

8.1 Roll diameter/film length

There are no requirements in this standard for roll diameters or film lengths on a roll. These should be subject to contract.

8.2 Windability/sag

8.2.1 General

The windability shall be measured in accordance with the requirements of Clause 6 of IEC 60674-2.

8.2.2 For films of width less than 150 mm

Method A shall be used.

8.2.3 For films of width 150 mm and above

Method B shall be used.

Table 5 – Windability

Property	Type 1	Type 2
Bias/camber	<10 mm	<10 mm
Sag (tension 5 MN/m^2)	<5 mm	<2 mm

The extension required to achieve bias/camber and sag limit shall be not more than 0,1 %. This requirement does not apply to thicknesses greater than 36 μm for which there are no requirements.

8.3 Joins

Where joins (splices) are permitted, their construction shall conform to the requirements given in Subclause 3.3 of IEC 60674-1. Breaks (unjoined pieces) shall also be indicated so as to be clearly visible when viewed from the end face of the roll.

The number of joins (splices) or breaks in each roll shall not exceed the values given in Table 6.

Table 6 – Maximum permissible number of joins or breaks per roll

Film thickness μm	Width ≤50 mm Outer diameter ≤250 mm	Width >50 mm Outer diameter ≤250 mm	Width >50 mm Outer diameter >250 mm – 400 mm
2; 3; 3,5; 4	6	4	6
5; 6	5	4	5
8	4	3	4
10	4	3	4
≥12	4	3	3
NOTE There is no requirement for films <2 μm.			

8.4 Roll width

The maximum difference between the film width measured according to Clause 5 of IEC 60674-2 and the roll width excluding the core (expressed in millimetres) shall be according to Table 7.

Table 7 – Film width

Nominal film width mm	Requirement Maximum difference mm
<150	0,5
150 to 300	1,0
≥300	2,0

8.5 Cores

The preferred core inner diameters are 76 mm and 152 mm.

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