

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Plastic films for electrical purposes –
Part 3: Specifications for individual materials – Sheet 1: Biaxially oriented
polypropylene (PP) films for capacitors**

**Films plastiques à usages électriques –
Partie 3: Spécifications pour matériaux particuliers – Feuille 1: Films de
polypropylène biorienté (PP) pour condensateurs**





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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PLASTIC FILMS FOR ELECTRICAL PURPOSES –

**Part 3: Specifications for individual materials –
Sheet 1: Biaxially oriented polypropylene (PP) films for capacitors**

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This consolidated version of IEC 60674-3-1 consists of the first edition (1998) [documents 15C/862/FDIS and 15C/952/RVD] and its amendment 1 (2011) [documents 15/596/CDV and 15/609/RVC]. It bears the edition number 1.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 60674-3-1 has been prepared by subcommittee 15C: Specifications, of IEC technical committee 15: Insulating materials.

The committee has decided that the contents of the base publication and its amendments 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

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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 1: Biaxially oriented (PP) polypropylene films for capacitors.

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PLASTIC FILMS FOR ELECTRICAL PURPOSES –

Part 3: Specifications for individual materials – Sheet 1: Biaxially oriented polypropylene (PP) films for capacitors

1 General

1.1 Scope

This sheet of IEC 60674-3 gives the requirements for biaxially oriented polypropylene film having a smooth or rough surface, corona treated when required for vacuum metallization. The films are for use as dielectric in capacitors.

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.

1.2 Normative references

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The following normative documents contain provisions which, through reference in this text, constitute provisions of this sheet of IEC 60674-3. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreement based on this sheet of IEC 60674-3 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below ¹⁾. Members of IEC and ISO maintain registers of currently valid International Standards.

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*

IEC 61074:1991, *Determination of heats and temperatures of melting and crystallization of electrically insulating materials by differential scanning calorimetry*

ISO 534:1988, *Paper and board – Determination of thickness and apparent bulk density or apparent sheet density*

ISO 11357-3, *Plastics – Differential scanning calorimetry (DSC) – Part 3: Determination of temperature and enthalpy of melting and crystallization*

1.3 Classification

The polypropylene film shall be of the following types:

Type 1: having smooth surfaces (space factor <5 %, see 5.9);

Type 1a: not corona treated;

¹⁾ In case of dispute, the referenced edition is applicable.

- Type 1b: one side pre-treated to facilitate the vacuum deposition of metal;
Type 1c: both sides pre-treated;
Type 2: having at least one rough surface (space factor ≥ 5 %, voir 5.9);
Type 2a: not corona treated;
Type 2b: one side pre-treated to facilitate the vacuum deposition of metal;
Type 2c: both sides pre-treated.
Type 3: having high electric strength for thin film (film thickness $\leq 3,5$ μm);
Type 3a: not corona treated;
Type 3b: one side pre-treated to facilitate the vacuum deposition of metal;
Type 3c: both sides pre-treated.

2 Designation

The plastic film shall be identified by the following designation:

Designation of the film - IEC 60674-3-1 - PP - type - thickness in micrometres - width in millimetres - length in metres.

EXAMPLE

Polypropylene film - IEC 60674-3-1 - PP - 1a - 6 - 100 - 3000.

3 General requirements

The materials shall be made essentially from isotactic type polypropylene homopolymer and shall conform to the requirements laid down in IEC 60674-1.

4 Dimensions

4.1 Thickness

The film thickness shall be measured in accordance with the requirements of 3.3 of IEC 60674-2. This is in general the gravimetric thickness, but for type 2 distinction shall be made between thickness determined by weighing (t_g = gravimetric thickness) and thickness measured by micrometer method (t_b = bulking thickness).

Gravimetric thickness shall be measured in accordance with the requirements of 3.3 of IEC 60674-2.

Bulking (micrometric) thickness shall be measured in accordance with ISO 534, except that the four test pieces are initially made up of 12 film layers, the layers being cut together using a suitable template (preferably 250 mm \times 200 mm, the 200 mm dimension being in the machine direction) from a blanket of film about 0,5 mm thick taken from the outer surface of the roll being sampled. Discard the first and last layer of each pack or test piece just prior to imposing the pack between the open pressure faces of the micrometer.

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

Type 1: 4,0; 5,0; 6,0; 7,0; 8,0; 10,0; 12,0; 15,0; 18,0; 20,0 and 25 μm .

Type 2: 7,4; 9,0; 10,1; 11,0; 12,0; 12,7; 13,6; 14,4; 15,2; 16,2 and 17,8 μm .

Type 3: 2,5; 2,8; 3,0 and 3,5 μm .

The thickness tolerance shall comply with the requirements of IEC 60674-1 unless otherwise specified.

4.2 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 and different requirements throughout the capacitor industry.

The tolerance on the width shall comply with the requirements of 4.2 of IEC 60674-1.

4.3 Length/diameter

There are no requirements in this standard for length or diameters of rolls. These should be subject to purchase contract.

5 Properties

5.1 Physical properties

See table 1.

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Table 1 – Physical properties

Property	Test method	Unit	Requirement	Remarks
Density	IEC 60674-2, clause 4, method D	Mg/m ³	0,91 ± 0,01	This method is only suitable for film thickness >12 µm. The recommended mixture is methanol/ethylene glycol
Melting point	IEC 61074 ISO 11357-3	°C	165 to 175	DSC method
Tensile strength (either direction)	IEC 60674-2, clause 10	MPa	Minimum Type 1: 120 Type 2: 90	Specimen width (15 ± 3) mm, rate of extension (100 ± 2) mm/min, reference lines with the initial grip separation (100 ± 2) mm apart
Elongation at break (either direction)		%	Minimum Type 1: 40 Type 2: 30 Type 3: 30	
Surface resistivity	IEC 60674-2, clause 14 ¹⁾	Ω	≥10 ¹⁴	
Volume resistivity	IEC 60674-2, clause 15 ¹⁾	Ωm	>10 ¹⁵	The test voltages are (100 ± 10) V for thicknesses >10 µm and (10 ± 1) V for thicknesses ≤10 µm
Dissipation factor at 23 °C and 48 Hz – 62 Hz: 1 kHz:	IEC 60674-2, subclause 16.1 or 16.2		≤3 × 10 ⁻⁴ ≤3 × 10 ⁻⁴	Use non-contacting electrodes or evaporated metal electrodes (subclause 16.1)
Permittivity	IEC 60674-2, subclause 16.1		2,2 ± 0,1	Use non-contacting electrodes or evaporated metal electrodes (subclause 16.1)
Dimensional change for shrinkage: – Machine direction – Transverse direction	IEC 60674-2, clause 23	%		Shrinkage shall be agreed between buyer and seller
NOTE Although the potential effects of certain properties such as crystallinity, orientation and isotactic/ atactic content on the performance of the film are recognized, no recommendations regarding the determination of these parameters have been made, particularly as no suitable test methods are available in IEC 60674-2.				
¹⁾ Measurement conditions: (23 ± 2) °C and (50 ± 5) % relative humidity after at least 24 h exposure.				

5.2 Electric strength (d.c. test)

Electric strength shall be measured according to 18.2 of IEC 60674-2. The central value shall be not less than the value given in table 2. The winding tension shall 2,5 N/mm² ± 0,5 N/mm².

Table 2 – Electric strength (d.c. test) for types 1, 2 and 3

Nominal film thickness μm	Electric strength (central value) V/μm	Not more than 1 of 21 results shall be below V/μm
4	120	40
5	150	60
6	190	80
7 and 7,4	230	100
8	250	120
9	270	145
10 and 10,1	290	165
11	300	175
12	310	185
12,7	315	195
>12,7 to 25	320	200

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Nominal film thickness μm	Type	Electric strength (central value) V/μm		Not more than 1 of 21 results shall be below V/μm	
		23 °C	105 °C	23 °C	105 °C
2,5	3	250	125	150	75
2,8		250	125	150	75
3,0		250	125	150	75
3,5		250	125	150	75
4	1 and 2	120	-	40	-
5		150	-	60	-
6		190	-	80	-
7 and 7,4		230	-	100	-
8		250	-	120	-
9		270	-	145	-
10 and 10,1		290	-	165	-
11		300	-	175	-
12		310	-	185	-
12,7		315	-	195	-
>12,7 to 25	320	-	200	-	

5.3 Electrical weak spots

Electrical weak spots shall be measured according to 19.3 of IEC 60674-2 with a test voltage of 150 V/μm based on the nominal thickness of the film.