

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Plastic films for electrical purposes –
Part 3: Specifications for individual materials – Sheet 3: Polycarbonate (PC)
films used for electrical insulation**

**Films plastiques à usages électriques –
Partie 3: Spécifications pour matériaux particuliers – Feuille 3: Films de
polycarbonate (PC) utilisés dans l'isolation électrique**



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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.035.20

ISBN 978-2-8322-7401-9

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PLASTIC FILMS FOR ELECTRICAL PURPOSES –**Part 3: Specifications for individual materials –
Sheet 3: Polycarbonate (PC) films used for electrical insulation**

FOREWORD

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IEC 60674-3-3 has been prepared by IEC technical committee 15: Solid electrical insulating materials. It is an International Standard.

This second edition cancels and replaces the first edition published in 1992. This edition constitutes a technical revision.

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

- a) the title of the standard has been changed to unify the name within the IEC 60674 series;
- b) update of the normative references.

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

Draft	Report on voting
15/979/CDV	15/1004/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60674 series, published under the general title *Plastic films 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 date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

This document 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 60674-1);

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

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

This document contains one of the sheets comprising Part 3, as follows:

Sheet 3: Polycarbonate (PC) films used for electrical insulation

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PLASTIC FILMS FOR ELECTRICAL PURPOSES –

Part 3: Specifications for individual materials – Sheet 3: Polycarbonate (PC) films used for electrical insulation

1 Scope

This sheet of IEC 60674-3 gives the requirements for polycarbonate films used for 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 can 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 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 60674-3-3:2023

IEC 60674-1:1980, *Specification for plastic films for electrical purposes – Part 1: Definitions and general requirements*

60674-3-3-2023

IEC 60674-2:2016, *Specification for plastic films for electrical purposes – Part 2: Methods of test*

IEC 60757, *Code for designation of colours*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

4 Classification

The polycarbonate film shall be of the following types:

- Type 1: General purpose amorphous, unstretched;
- Type 2: General purpose amorphous, stretched;
- Type 3: For use as the dielectric of capacitors, partially crystalline and stretched.

These three types are available in regular and in flame-retardant types.

5 Designation

The plastic film shall be identified by the following designation:

IEC Publication number	Film name abbreviation	Type	Thickness (μm)	Width (μm)	Length (m)	Colour	Flame-retardant or regular
IEC 60674-3-3	- PC	- Type 1	- 100	- 20	- 200	- nc	- f

Any colour abbreviation shall comply with IEC 60757, where applicable. Non-standard colours shall be written out in full.

EXAMPLE 1 nc = natural colour.

The last letter of the designation shall indicate whether it is flame-retardant or regular.

EXAMPLE 2 f = flame-retardant; r = regular.

6 General requirements

The material shall be made from bisphenol-A-polycarbonate.

Flame-retardant grades shall be made from a blend of bisphenol-A-polycarbonate and brominated bisphenol-A-polycarbonate.

The material shall be a flexible, self-supporting film. All types shall conform to the general requirements laid down in IEC 60674-1.

For certain applications, additives to the base material can be present (e.g. thermal or UV stabilisers, dyes, or pigments for identification purposes).

Where such additives are used, they shall not affect the requirements for any of the properties listed for that type, unless otherwise specified.

7 Dimensions

7.1 Thickness

The film thickness shall be measured by a gravimetric method in accordance with the requirements of 4.3.2 of IEC 60674-2:2016.

There are no requirements for thickness in this document, but preferred thicknesses are as follows:

2 μm ; 3 μm ; 4 μm ; 5 μm ; 6 μm ; 7 μm ; 8 μm ; 10 μm ; 12 μm ; 15 μm ; 20 μm ; 25 μm ; 30 μm ; 40 μm ; 50 μm ; 60 μm ; 75 μm ; 80 μm ; 100 μm ; 120 μm ; 125 μm ; 150 μm ; 180 μm ; 200 μm ; 250 μm ; 380 μm ; 500 μm and 760 μm .

The thicknesses described in Table 1 are commonly available.

Table 1 – Type and thickness range

Type	Thickness range for all types µm
1	20 to 760
2	20 to 100
3	2 to 60

The thickness tolerance shall comply with the requirements in 4.1 of IEC 60674-1:1980, unless otherwise specified in the purchase contract.

7.2 Width

The film width shall be measured in accordance with the requirements of Clause 6 of IEC 60674-2:2016.

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

The tolerance on the width shall comply with the requirements in 4.2 of IEC 60674-1:1980.

7.3 Film length/roll diameter

There are no requirements in this document for film lengths or diameters of rolls. These should be subject to purchase contract.

8 Properties

8.1 Properties not dependent on thickness

See Table 2.

Table 2 – Properties not dependent on thickness for all types

Property	Type	Unit	Requirement	Test method	Remarks		
Density - regular	1 and 2 3	kg/m ³	1 200 ± 20 1 210 ± 20	ISO 1183-2:2019	This method is only suitable for film thickness > 12 µm.		
Density - flame-retardant	1, 2 and 3	kg/m ³	a)				
Melting point	3	°C	Under consideration	ISO 11357-3:2018	DSC method		
Relative permittivity 23 °C, 48 Hz to 62 Hz 23 °C, 1 kHz	1, 2 and 3	–	3,0 ± 0,1 3,0 ± 0,1	IEC 60674-2:2016, 18.2 ^{b)}	Use evaporated metal electrodes or non-contacting electrodes (18.2.4 of IEC 60674-2:2016 or 18.2.5 of IEC 60674-2:2016).		
Dissipation factor 23 °C, 48 Hz to 62 Hz 23 °C, 1 kHz			1 and 2			< 0,002 0 < 0,002 2	
23 °C, 48 Hz to 62 Hz 23 °C, 1 kHz	3	–	< 0,001 2 < 0,001 5	IEC 60674-2:2016, 18.3	Wound capacitor method		
Volume resistivity	1 2 and 3	Ω·m	≥ 1 × 10 ¹⁴ ≥ 1 × 10 ¹⁵	IEC 60674-2:2016, Clause 17	The test voltages are 100 V for thicknesses > 10 µm and 10 V for thicknesses ≤ 10 µm.		
Surface resistivity	1, 2 and 3	Ω	≥ 1 × 10 ¹⁵	IEC 60674-2:2016, Clause 16			
Electrolytic corrosion Visual test Tensile strength test Corrosion liability factor	1, 2 and 3	–	Not corrosive	IEC 60426:2007			
		%	≤ 3				
Dimensional change for shrinkage Machine direction Transverse direction Machine direction Transverse direction Machine direction Transverse direction	1 2 3	%	< 3 < 3 > 25 < 3 < 14 < 3	IEC 60674-2:2016, Clause 25	160 °C, 30 min		
Dimensional change under tension with rising temperature	1 and 2 3		°C			> 145 > 220	IEC 60674-2:2016, Clause 26
Dimensional change under pressure with rising temperature	1 and 2 3		°C			> 175 > 180	IEC 60674-2:2016, Clause 27
<p>a) The nominal density shall be as specified in the purchase contract. Typical values for nominal densities are in the range of 1 260 kg/m³ to 1 440 kg/m³. The actual density shall not differ from the nominal density by more than ±20 kg/m³.</p> <p>b) Measurement conditions: (23 ± 2) °C and (50 ± 5) % relative humidity after at least 24 h exposure.</p>							

8.2 Properties dependent on thickness

See Table 3.

Table 3 – Properties dependent on thickness for all types

Property	Type	Unit	Requirement			IEC 60674-2:2016 Test method Clause
			Nominal thickness µm			
			< 5	≥ 5, < 100	≥ 100	
Tensile strength Machine direction Transverse direction	1	MPa	–	≥ 80 ≥ 80	≥ 60 ≥ 60	12 ^{a)}
	2		–	≥ 130 ≥ 80	–	
	3		No requirement	≥ 180 ≥ 60	–	
Elongation at break Machine direction Transverse direction	1	%	–	≥ 100 ≥ 100	≥ 80 ≥ 80	12 ^{a)}
	2		–	≥ 40 ≥ 100	–	
	3		No requirement	≥ 40 ≥ 100	–	

^{a)} Rate of extension 100 mm/min, reference lines 100 mm apart.

8.3 Electric strength (AC test) [IEC 60674-3-3:2023](https://standards.iteh.ai/catalog/standards/sist/31e4ffb1-d70a-446a-971d-d7e3ca0ce304/iec-60674-3-3-2023)

See Table 4. <https://standards.iteh.ai/catalog/standards/sist/31e4ffb1-d70a-446a-971d-d7e3ca0ce304/iec-60674-3-3-2023>

Table 4 – Electric strength (AC test) for all types

Nominal thickness µm	Minimum electric strength V/µm	IEC 60674-2:2016 Test method Subclause
6	260	20.1
15	260	Using 6 mm diameter electrodes in air
20	250	
30	250	
40	190	
60	160	20.1
100	100	Using 6 mm diameter electrodes in transformer oil
150	80	
200	70	
250	60	
380	60	
760	60	

8.4 Electric strength (DC test) for type 3 only

See Table 5.