

INTERNATIONAL STANDARD



**Flexible insulating sleeving –
Part 3: Specifications for individual types of sleeving –
Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving**



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INTERNATIONAL STANDARD



**Flexible insulating sleeving –
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Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FLEXIBLE INSULATING SLEEVING –

Part 3: Specifications for individual types of sleeving – Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

FOREWORD

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International Standard IEC 60684-3-216 has been prepared by IEC technical committee 15: Solid electrical insulating materials.

This second edition cancels and replaces the first edition published in 2001, Amendment 1:2005 and Amendment 2:2013. This edition constitutes a technical revision.

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

- a) the temperature at which the sleeving is shrunk in a forced-air circulation oven for (5 ± 1) min has been increased from $(150 \pm 5) ^\circ\text{C}$ to $(200 \pm 5) ^\circ\text{C}$.

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

FDIS	Report on voting
15/888/FDIS	15/902/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

A list of all parts in the IEC 60684 series, published under the general title *Flexible insulating sleeving*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

This International Standard is one of a series which deals with flexible insulating sleeving for electrical purposes.

The series consists of three parts:

Part 1: Definitions and general requirements (IEC 60684-1);

Part 2: Methods of test (IEC 60684-2);

Part 3: Specifications for individual types of sleeving (IEC 60684-3).

This document comprises one of the sheets of Part 3 **as follows:**

Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

FLEXIBLE INSULATING SLEEVING –

Part 3: Specifications for individual types of sleeving – Sheet 216: Heat-shrinkable, flame-retarded, limited-fire-hazard sleeving

1 Scope

This ~~sheet~~ part of IEC 60684-3 gives the requirements for four types of heat-shrinkable, flame-retarded, limited-fire-hazard sleeving with a thermal endurance rating of 105 °C as shown below.

Class A:	thin wall	shrink ratio 2:1	internal diameter up to 102,0 mm
Class B:	medium wall	shrink ratio 2:1	internal diameter up to 60,0 mm
Class C:	thick wall	shrink ratio 2:1	internal diameter up to 51,0 mm
Class D:	medium wall	shrink ratio 3:1	internal diameter up to 40,0 mm

These sleeveings are normally supplied in the following colours: black, red, green, blue, white, yellow and green/yellow.

Sizes or colours other than those listed in this document ~~may be~~ are available as custom items. These items ~~shall be~~ are considered to comply with this document if they comply with the property requirements listed in Tables 5, 6, 7 and 8, excluding dimensions and mass.

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~~ will be based on the actual requirements necessary for adequate performance in that application and not based on this specification alone.

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 60684-1: ~~1980~~2003, ~~Specification for~~ Flexible insulating sleeving – Part 1: Definitions and general requirements

IEC 60684-2: ~~1997~~2011, Flexible insulating sleeving – Part 2: Methods of test

IEC 60757:1983, Code for designation of colours

ISO 846: ~~1997~~2019, Plastics – Evaluation of the action of microorganisms

ISO 1817: ~~1999~~2015, Rubber, vulcanized or thermoplastic – Determination of the effect of liquids ~~(available in English only)~~

3 Terms and definitions

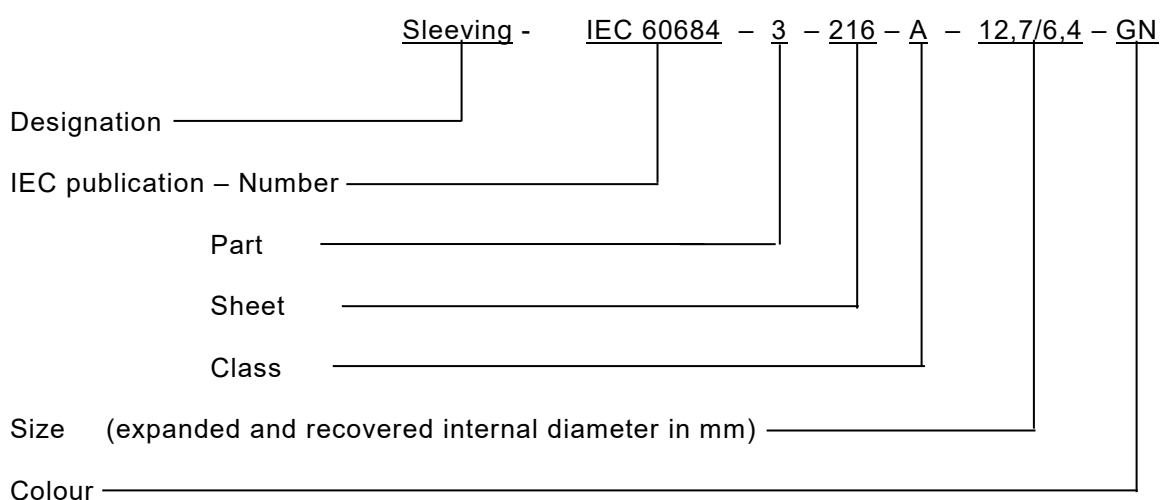
No terms and definitions are listed in this document.

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

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

4 Designation

This sleeving shall be identified by the following designation:



Any abbreviation of colour shall comply with IEC 60757. Where no abbreviation is given, the colour shall be written in full.

5 Conditions of test

Unless otherwise specified, the sleeving shall be shrunk in a forced-air circulation oven for (5 ± 1) min at ~~(150~~ 200 ± 5) °C, prior to testing.

6 Requirements

In addition to the general requirements given in IEC 60684-1, the sleeving shall comply with the requirements in Tables 1 through 8.

7 Sleeving conformance

Conformance to the requirements of this specification shall normally be based on the results ~~from~~ for black colour of the following sizes:

- Class A: 12,7 mm/6,4 mm
- Class B: 12,0 mm/6,0 mm
- Class C: 12,7 mm/6,4 mm
- Class D: 18,0 mm/6,0 mm

~~of black colour.~~ The colour fastness to light shall be determined for all colours.

Table 1 – Dimensional and mass requirements – Class A

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,2/1,6	3,2	1,6	$0,50 \pm 0,10$	6,0
4,8/2,4	4,8	2,4	$0,50 \pm 0,10$	8,2
6,4/3,2	6,4	3,2	$0,65 \pm 0,15$	13,5
9,5/4,8	9,5	4,8	$0,65 \pm 0,15$	19,5
12,7/6,4	12,7	6,4	$0,65 \pm 0,15$	25,0
19,0/9,5	19,0	9,5	$0,75 \pm 0,15$	43,0
25,4/12,7	25,4	12,7	$0,90 \pm 0,15$	67,0
38,0/19,0	38,0	19,0	$1,00 \pm 0,20$	112
51,0/25,4	51,0	25,4	$1,15 \pm 0,25$	175
76,0/38,0	76,0	38,0	$1,25 \pm 0,25$	281
102,0/51,0	102,0	51,0	$1,40 \pm 0,25$	404

Table 2 – Dimensional and mass requirements – Class B

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,0/1,5	3,0	1,5	$0,70 \pm 0,10$	8,5
5,0/2,5	5,0	2,5	$0,75 \pm 0,15$	13,5
8,0/4,0	8,0	4,0	$0,80 \pm 0,15$	21,0
12,0/6,0	12,0	6,0	$0,90 \pm 0,15$	33,0
18,0/9,0	18,0	9,0	$1,00 \pm 0,20$	54,0
24,0/12,0	24,0	12,0	$1,10 \pm 0,20$	77,0
40,0/20,0	40,0	20,0	$1,30 \pm 0,25$	146
60,0/30,0	60,0	30,0	$1,50 \pm 0,30$	250

Table 3 – Dimensional and mass requirements – Class C

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,2/1,6	3,2	1,6	$0,75 \pm 0,15$	9,9
4,8/2,4	4,8	2,4	$0,85 \pm 0,20$	15,8
6,4/3,2	6,4	3,2	$0,90 \pm 0,20$	21,0
9,5/4,8	9,5	4,8	$1,00 \pm 0,20$	32,0
12,7/6,4	12,7	6,4	$1,20 \pm 0,30$	53,6
19,0/9,5	19,0	9,5	$1,45 \pm 0,35$	91,6
25,4/12,7	25,4	12,7	$1,80 \pm 0,45$	155
38,0/19,0	38,0	19,0	$2,40 \pm 0,50$	294
51,0/25,4	51,0	25,4	$2,80 \pm 0,50$	435

Table 4 – Dimensional and mass requirements – Class D

Size code	Internal diameter mm		Recovered wall thickness mm	Mass per unit length g/m Max.
	Expanded Min.	Recovered Max.		
3,0/1,0	3,0	1,0	$0,60 \pm 0,10$	5,5
6,0/2,0	6,0	2,0	$0,70 \pm 0,10$	10,5
9,0/3,0	9,0	3,0	$0,80 \pm 0,15$	17,0
12,0/4,0	12,0	4,0	$0,85 \pm 0,15$	23,0
18,0/6,0	18,0	6,0	$1,00 \pm 0,20$	39,0
24,0/8,0	24,0	8,0	$1,20 \pm 0,20$	61,0
40,0/13,0	40,0	13,0	$1,25 \pm 0,20$	98,5

Table 5 – Property requirements (1 of 3)

Property	IEC 60684-2 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensions	3				
— internal diameter	3.1.2	mm	Min.	Tables 1 to 4	
— wall thickness	3.3.2	mm		Tables 1 to 4	
— concentricity	3.3.3	%			
— • expanded				65	
— • recovered				85	
Heat shock	6				
— tensile strength	19.1 and 19.2	MPa	Min.	6	Heat the expanded sleeving at $(150 \pm 5) ^\circ\text{C}$ for (5 ± 1) min
— elongation at break	19.1 and 19.2	%	Min.	100	
Longitudinal change	9	%	Max.	-10 $+5$	The test is done on expanded sleeving
Bending at low temperature	14	—	—	No cracking shall be visible	Test at $-30 ^\circ\text{C}$ after conditioning at that temperature for 4 h. For strips, the mandrel shall be between 20 and 22 times the wall thickness. Full section sleeving is tested unfilled and the mandrel shall be between 20 and 22 times the outer diameter

Property	IEC 60684-2 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensional stability during storage	16	—	—	The dimensions shall be as specified in tables 1 to 4	
Tensile strength	19.1 and 19.2	MPa	Min.	7	Use a jaw separation rate of 100 mm/min. For internal diameters <6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Elongation at break	19.1 and 19.2	%	Min.	200	
Secant modulus at 2 % elongation	19.4	MPa	Min.	40	
		MPa	Max.	130	
Breakdown voltage	21	kV	Min.	Table 6	
Volume resistivity	23				
— at room temperature	23.4.2	Ωm	Min.	10^{11}	
— after damp heat	23.4.4	Ωm	Min.	10^{10}	
Flame propagation	26 Method C				
— Time of burning		s	Max.	30	
— Length burned		mm	Max.	75	
Oxygen index	27				
— at ambient temperature	27.1	%	Min.	29	
— at elevated temperature	27.2	°C	Min.	250	
Copper corrosion	33	%	Max.	8	Heat the specimens for $(16 \pm 0,5)$ h at (150 ± 3) °C
Colour fastness to light	34			The colour contrast between the exposed and unexposed parts of the specimen shall be equal to or less than that of the fastness standard	Fastness standard 5

Property	IEC 60684-2 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Resistance to selected fluids	36				Use the fluids and test temperatures specified in table 7
— Tensile strength	19.1 and 19.2	MPa	Min.	4	
— Elongation at break	19.1 and 19.2	%	Min.	100	
Thermal endurance Temperature index	37		Min.	105	The test to establish failure shall be elongation to break; the end point shall be 50 % absolute elongation at break
Mass per unit length	38	g/m	Max.	Tables 1 to 4	
Heat ageing	39				Heat at $(135 \pm 3) ^\circ\text{C}$.
— Tensile strength	19.1 and 19.2	MPa	Min.	5	
— Elongation at break	19.1 and 19.2	%	Min.	150	
Water absorption	40	%	Max.	1,0	
Smoke index	43	—	Max.	20	
Toxicity index	44	—	Max.	5	
Halogen content	45				Expressed as chlorine
	45.1	%	Max.	0,2	
	45.2	%	Max.	0,1	
Acid gas generation	46				
	46.2	pH	Min.	3,5	
		pH	Max.	10,5	
		$\mu\text{S/mm}$	Max.	10,0	

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensions	3				
– internal diameter	3.1.2	mm		Tables 1 to 4	
– wall thickness	3.3.2	mm		Tables 1 to 4	
– concentricity	3.3.3	%	Min.		
• expanded				65	
• recovered				85	
Heat shock	6				
– tensile strength	19.2 and 19.3	MPa	Min.	6	Heat the expanded sleeving at $(150 \pm 5) ^\circ\text{C}$ for (5 ± 1) min
– elongation at break	19.2 and 19.3	%	Min.	100	Use a jaw separation rate of 100 mm/min. For internal diameters $< 6,5$ mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Longitudinal change	9	%	Max.	–10 +5	The test is done on expanded sleeving
Bending at low temperature	14	–	–	No cracking shall be visible	Test at $-30 ^\circ\text{C}$ after conditioning at that temperature for 4 h. For strips, the mandrel shall be between 20 times and 22 times the wall thickness. Full section sleeving is tested unfilled and the mandrel shall be between 20 times and 22 times the outer diameter

Table 5 (2 of 3)

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Dimensional stability on storage	16	–	–	The dimensions shall be as specified in Tables 1 to 4	
Tensile strength	19.2 and 19.3	MPa	Min.	7	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Elongation at break	19.2 and 19.3	%	Min.	200	
Secant modulus at 2 % elongation	19.5	MPa MPa	Min. Max.	40 130	
Breakdown voltage	21.2	kV	Min.	Table 6	
Volume resistivity	23				
– at room temperature	23.5.2	Ωm	Min.	10^{10}	
– after damp heat	23.5.4	Ωm	Min.	10^9	
Flame propagation	26 Method C				
– Time of burning		s	Max.	30	
– Length burned		mm	Max.	75	
Oxygen index	27				
– at ambient temperature	27.1	%	Min.	29	
– at elevated temperature	27.2	°C	Min.	250	
Copper corrosion	33	%	Max.	8	Heat the specimens for $(16 \pm 0,5)$ h at (150 ± 3) °C
Colour fastness to light	34			The colour contrast between the exposed and unexposed parts of the specimen shall be equal to or less than that of the fastness standard	Fastness standard 5

Table 5 (3 of 3)

Property	IEC 60684-2:2011 clause or subclause	Units	Max. or Min.	Requirements	Remarks
Resistance to selected fluids	36				Use the fluids and test temperatures specified in Table 7
– Tensile strength	19.2 and 19.3	MPa	Min.	4	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
– Elongation at break	19.2 and 19.3	%	Min.	100	
Long term heat ageing	50 -	%	Min.	100	Ageing temperature shall be 105 °C ± 3 K
Elongation at break	19.2 and 19.3				Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
Mass per unit length	38	g/m	Max.	Tables 1 to 4	
Heat ageing	39				Heat at (135 ± 3) °C.
– Tensile strength	19.2 and 19.32	MPa	Min.	5	Use a jaw separation rate of 100 mm/min. For internal diameters < 6,5 mm, use sleeving samples for testing. On 6,5 mm and larger diameter sleeving, use dumb-bell samples cut from the sleeving
– Elongation at break	19.2 and 19.3	%	Min.	150	
Water absorption	40	%	Max.	1,0	
Smoke index	43	–	Max.	20	
Toxicity index	44	–	Max.	5	
Halogen content	45				Expressed as chlorine
	45.1	%	Max.	0,2	
	45.2	%	Max.	0,1	
Acid gas generation	46				
	46.2	pH	Min.	3,5	
		pH	Max.	10,5	
		µS/mm	Max.	10,0	

The breakdown voltage shall be determined by any of the methods described in 21.2, 21.3 or 21.4 of IEC 60684-2:2011. The central value shall comply with the minimum value in Table 6.