# INTERNATIONAL STANDARD

# IEC 60684-3-212

Second edition
2005-11

## Flexible insulating sleeving –

## Part 3:
## Specifications for individual types of sleeving –
## Sheet 212: Heat-shrinkable polyolefin sleevings



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# FLEXIBLE INSULATING SLEEVING –

# Part 3: Specifications for individual types of sleeving – Sheet 212: Heat-shrinkable polyolefin sleevings

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International Standard IEC 60684-3-212 has been prepared by IEC technical committee 15: Standards on specifications for electrical Insulating materials.

This second edition cancels and replaces the first edition published in 1998, and constitutes a technical revision.

This edition includes the following significant changes with regards to the previous edition:

Replacement of the thermal endurance test method according to IEC 60216 with a long term ageing test, i.e. 3 000 h at the recommended maximum temperature found suitable for use, to provide safe thermal test data within a workable time scale.

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The text of this standard is based on the following documents:

| FDIS | Report on voting |
|---|---|
| 15/229/FDIS | 15/247/RVD |

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

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

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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 part 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 standard is one of the sheets comprising Part 3, as follows:

Sheet 212: Heat-shrinkable polyolefin sleevings.

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# FLEXIBLE INSULATING SLEEVING –

# Part 3: Specifications for individual types of sleeving – Sheet 212: Heat-shrinkable polyolefin sleevings

## 1 Scope

This standard gives the requirements for four types of heat-shrinkable polyolefin sleevings suitable for use at temperatures up to 135 °C.

Type A Flame retarded, shrink ratio 2:1

Type B Not flame retarded, shrink ratio 2:1

Type C Flame retarded, shrink ratio 3:1

Type D Not flame retarded shrink ratio 3:1

These sleevings are normally supplied with internal diameters up to 102 mm for shrink ratios of 2:1 and up to 39 mm for shrink ratios of 3:1 and in the following colours for types A and C: black, brown, red, yellow, green, blue, orange, violet, grey, white and green/yellow. Types B and D are transparent.

Sizes or colours other than those specifically listed in this standard may be available as custom items. These items are considered to comply with this standard if they comply with the property requirements listed in Tables 3, 4, 5 and 6 except for 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 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 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 60684-1:2003, *Flexible insulating sleeving – Part 1: Definitions and general requirements*

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

IEC 60684-2 Amendment 1: 2003, *Flexible insulating sleeving – Part 2: Methods of test*

IEC 60757:1983, *Code for designation of colours*

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

ISO 1817:1999, *Rubber, vulcanized – Determination of the effect of liquids*

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## 3 Designation

The sleeving shall be identified by the following designation:

| Description | IEC publication number | IEC part number | IEC sheet number | Type | Size (expanded/ recovered internal diameter, in mm) | Colour |
|---|---|---|---|---|---|---|
| ↓ | ↓ | ↓ | ↓ | ↓ | ↓ | ↓ |
| Sleeving | IEC 60684 | 3 | 212 | B | 12,7/6,4 | TT |

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

## 4 Conditions of test

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

## 5 Requirements

In addition to the general requirements given in IEC 60684-1, the sleeving shall comply with the requirements of Tables 1, 2, 3, 4, 5 and 6.

## 6 Sleeving conformance

Conformance with the requirements of this specification shall normally be based on the results from sizes and colours:

Type A: 12,7/6,4 mm, black

Type B: 12,7/6,4 mm, transparent

Type C: 12,0/4,0 mm, black

Type D: 12,0/4,0 mm, transparent

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

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**Table 1 – Dimensional and mass requirements for Types A and B**

| Size code | Internal diameter mm | | Recovered wall thickness mm | Mass per unit length max. g/m | |
|---|---|---|---|---|---|
| | Expanded min. | Recovered max. | | Type A | Type B |
| 1,2/0,6 | 1,2 | 0,6 | 0,45 ± 0,10 | 2,7 | 2,0 |
| 1,6/0,8 | 1,6 | 0,8 | 0,45 ± 0,10 | 3,2 | 2,3 |
| 2,4/1,2 | 2,4 | 1,2 | 0,50 ± 0,10 | 4,6 | 3,4 |
| 3,2/1,6 | 3,2 | 1,6 | 0,50 ± 0,10 | 5,6 | 4,1 |
| 4,8/2,4 | 4,8 | 2,4 | 0,50 ± 0,10 | 7,6 | 5,7 |
| 6,4/3,2 | 6,4 | 3,2 | 0,65 ± 0,15 | 13,6 | 10,0 |
| 9,5/4,8 | 9,5 | 4,8 | 0,65 ± 0,15 | 19,0 | 14,1 |
| 12,7/6,4 | 12,7 | 6,4 | 0,65 ± 0,15 | 24,4 | 18,1 |
| 19,0/9,5 | 19,0 | 9,5 | 0,75 ± 0,15 | 39,7 | 29,4 |
| 25,4/12,7 | 25,4 | 12,7 | 0,90 ± 0,15 | 61,2 | 45,3 |
| 38,0/19,0 | 38,0 | 19,0 | 1,00 ± 0,20 | 103 | 76,1 |
| 51,0/25,4 | 51,0 | 25,4 | 1,15 ± 0,25 | 159 | 118 |
| 76,0/38,0 | 76,0 | 38,0 | 1,25 ± 0,25 | 252 | 186 |
| 102,0/51,0 | 102,0 | 51,0 | 1,40 ± 0,25 | 369 | 273 |

**Table 2 – Dimensional and mass requirements for Types C and D**

| Size code | Internal diameter mm | | Recovered wall thickness mm | Mass per unit length max. g/m | |
|---|---|---|---|---|---|
| | Expanded min. | Recovered max. | | Type C | Type D |
| 1,5/0,5 | 1,5 | 0,5 | 0,45 ± 0,10 | 2,5 | 1,8 |
| 3,0/1,0 | 3,0 | 1,0 | 0,55 ± 0,10 | 4,6 | 3,4 |
| 6,0/2,0 | 6,0 | 2,0 | 0,65 ± 0,10 | 8,8 | 6,5 |
| 9,0/3,0 | 9,0 | 3,0 | 0,75 ± 0,15 | 14,9 | 11,0 |
| 12,0/4,0 | 12,0 | 4,0 | 0,75 ± 0,15 | 18,7 | 13,9 |
| 18,0/6,0 | 18,0 | 6,0 | 0,85 ± 0,20 | 31,4 | 23,2 |
| 24,0/8,0 | 24,0 | 8,0 | 1,00 ± 0,20 | 46,8 | 34,7 |
| 39,0/13,0 | 39,0 | 13,0 | 1,10 ± 0,20 | 82,1 | 60,8 |

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**Table 3 – Property requirements**

| Property | IEC 60684-2 Clause or subclause | Units | Max. or min. | Requirements | Remarks |
|---|---|---|---|---|---|
| Dimensions<br>– internal diameter<br>– wall thickness<br>– concentricity<br>• expanded<br>• recovered | 3<br>3.1.2<br>3.3.2<br>3.3.3 | <br>mm<br>mm<br>% | <br><br><br>Min. | <br>Tables 1 and 2<br>Tables 1 and 2<br><br>Type A and B 65<br>Type C and D 50<br>All types 85 | |
| Heat shock<br>Tensile strength<br>Elongation at break | 6<br>19.1 and 19.2<br>19.1 and 19.2 | <br>MPa<br>% | <br>Min.<br>Min. | <br>10<br>200 | Heat at 200 °C ± 5 K |
| Longitudinal change | 9 | % | Max. | + 5<br>– 10 | Heat the expanded sleeving at 200 °C ± 5 K for (5 ± 1) min |
| Bending at low temperature | 14 | – | – | No cracks shall be visible | Condition at – 55 °C ± 3 K. For strips, the mandrel shall be no more than 10 times the wall thickness. Full section sleeving is tested unfilled and the mandrel shall be no more than 10 times the outer diameter |
| Dimensional stability during storage | 16 | – | – | The dimensions shall be as specified in Tables 1 and 2 | |
| Tensile strength<br><br>Elongation at break | 19.1 and 19.2<br><br>19.1 and 19.2 | MPa<br><br>% | Min.<br><br>Min. | 10<br><br>250 | Use a jaw separation rate of 100 mm/min. Below 6,5 mm diameter test as sleeving, at 6,5 mm diameter and above test as dumb-bells |
| Secant modulus<br>at 2 % elongation | 19.4 | MPa<br>MPa | Min.<br>Max. | 50<br>175 | |
| Breakdown voltage | 21 | kV | Min. | Table 4 | |

*(continued)*

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**Table 3** *(continued)*

| Property | IEC 60684-2 Clause or subclause | Units | Max. or min. | Requirements | Remarks |
|---|---|---|---|---|---|
| Volume resistivity<br>– at room temperature<br>– after damp heat | 23<br>23.4.2<br>23.4.4 | <br>Ω m<br>Ω m | <br>Min.<br>Min. | <br>$10^{12}$<br>$10^{11}$ | |
| Flame propagation<br>Time of burning<br>Length burned | 26<br>Method C | <br>s<br>mm | <br>Max.<br>Max. | <br>30<br>75 | Types A and C only |
| Transparency | 28 | - | - | Printing shall be legible | Transparent sleeving only |
| Copper corrosion | 33 | % | Max. | None above the allowable 8 % | Heat for (16 ± 0,5) h at 175 °C ± 3 K |
| Colour fastness to light | 34 | | | The colour contrast between the exposed and unexposed parts of the specimens shall be equal to or less than that of the fastness standard. After this test transparent sleevings, Type B and D, shall meet the requirements for transparency | Fastness standard No. 5 |
| Resistance to selected fluids<br>Tensile strength<br>Elongation at break | 36<br>19.1 and 19.2<br>19.1 and 19.2 | <br>MPa<br>% | <br>Min.<br>Min. | <br>7<br>200 | Use the fluids and test temperatures specified in Table 5 |
| Mass per unit length | 38 | g/m | Max. | Table 1 and 2 | |
| Heat ageing<br>Tensile strength<br>Elongation at break | 39<br>19.1 and 19.2<br>19.1 and 19.2 | <br>MPa<br>% | <br>Min.<br>Min. | <br>10<br>150 | Heat at 150 °C ± 3 K |
| Water absorption | 40 | % | Max. | 0,5 | |
| Long term ageing<br>Elongation | 50<br>(Amendment 1)<br>19.1 and 19.2 | <br>% | <br>Min. | <br>125 | The ageing temperature shall be 135 °C ± 3 K |

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## 7 Breakdown voltage

The breakdown voltage shall be determined by any of the methods described in 21.2, 21.3 or 21.4 of IEC 60684-2. The central value shall comply with the minimum value in Table 4.

The rate of application of the voltage shall be 500 V/s.

**Table 4 – Requirements for breakdown voltage**

| **Nominal recovered wall thickness*** mm | **Breakdown voltage min.** kV |
|---|---|
| 0,45 | 9,0 |
| 0,50 | 10,0 |
| 0,55 | 10,5 |
| 0,65 | 12,0 |
| 0,75 | 13,5 |
| 0,85 | 15,0 |
| 0,90 | 16,0 |
| 1,00 | 17,5 |
| 1,10 | 18,5 |
| 1,15 | 19,0 |
| 1,25 | 20,0 |
| 1,40 | 22,0 |

* For non-standard wall thicknesses, the electric strength shall be at least that of the next smaller standard wall thickness. For wall thicknesses smaller than 0,45 mm, the electric strength shall be at least 20,0 kV/mm.

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**Table 5 – Resistance to selected fluids**

| Fluids | Type | Standard or symbol | Immersion temperature °C ± 2 K |
|---|---|---|---|
| Fuels | Gasoline | ISO 1817 Liquid B | 23 |
| | Kerosene | ISO 1817 Liquid F | 23 |
| Hydraulic fluids | Phosphate base | ISO 1817 Liquid 103 | 23 |
| | Silicone base | S-1714* | 23 |
| | Mineral base | H-520* | 23 |
| Oils | Synthetic base | ISO 1817 Liquid 101 | 23 |
| | Mineral base | ISO 1817 Oil no. 2 | 23 |
| | Mineral base | O-1176* | 23 |
| | Mineral base | O-142* | 23 |
| Cleaning fluids | Solvent | Isopropyl alcohol | 23 |
| | | Propanol 25 % White spirit 75 % | 23 |
| | | Methylethylketone | 23 |
| De-icing fluids | Runway de-icers | Inhibited potassium acetate in water, 50 % | 23 |
| | Aircraft de-icers | Ethylene glycol 80 %, water 20 % | 23 |
| * These are commercially available fluids which can be identified in aviation fluid guides. | | | |
| NOTE Other fluids and/or temperatures may be specified with specific needs. These additional fluids and/or temperatures should be applicable when incorporated into agreements between the supplier and the customer. | | | |

**Table 6 – Additional property requirements**

| Property | IEC 60684-2 Subclause | Units | Max. or min. | Requirements | Remarks |
|---|---|---|---|---|---|
| Fungus resistance<br>Tensile strength<br>Elongation at break | <br>19.1 and 19.2<br>19.1 and 19.2 | <br>MPa<br>% | <br>Min.<br>Min. | <br>10<br>250 | The test method shall be ISO 846, method B.<br>56 days exposure |
| Shelf life* | | | | The dimensions shall be as specified in Tables 1 or 2 | Condition the sleeving for 60 months at ambient temperature prior to testing; interim measurements shall to be made every 12 months |
| * Due to the duration of this test, lack of completion of this test shall not preclude certification of this sleeving. Additional evidence of compliance with this requirement in the interim shall be as agreed between the supplier and/or the approval authority and/or the customer. | | | | | |

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