BS EN 4674-001:2017

BSI Standards Publication

Aerospace series — Electrical cables, installation — Self-wrapping shielding (EMI) protective sleeve

Part 001: Technical specification

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National foreword

This British Standard is the UK implementation of EN 4674-001:2017. It supersedes BS EN 4674-001:2015 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ACE/6, Aerospace avionic electrical and fibre optic technology.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Published by BSI Standards Limited 2017

ISBN 978 0 580 96015 4

ICS 49.060

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2017.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 4674-001

March 2017

ICS 49.060

Supersedes EN 4674-001:2015

English Version

Aerospace series - Electrical cables, installation - Self-wrapping shielding (EMI) protective sleeve - Part 001: Technical specification

Série aérospatiale - Câbles électriques, installation - Gaine de protection blindée (EMI) auto-fermable - Partie 001 : Spécification technique

Luft- und Raumfahrt - Elektrische Leitungen, Installation - Selbstschließender abschirmender (EMI) Schutzschlauch - Teil 001: Technische Lieferbedingungen

This European Standard was approved by CEN on 2 January 2017.

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Contents

Page

European foreword

This document (EN 4674-001:2017) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

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1 Scope

This European Standard specifies the general characteristics, qualification and acceptance requirements for self-wrapping shielding (EMI) protective sleeve designed for EMI shielding of cable and cable bundles for aerospace applications.

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.

EN 2267-010, *Aerospace series — Cables, electrical, for general purpose — Operating temperatures between – 55 °C and 260 °C — Part 010: DR family, single UV laser printable — Product standard*

EN 2591-214, *Aerospace series — Elements of electrical and optical connection — Test methods — Part 214: Lightning strike, current and voltage pulse*

EN 2591-307, *Aerospace series — Elements of electrical and optical connection — Test methods — Part 307: Salt mist*

EN 2825, *Aerospace series — Burning behaviour of non metallic materials under the influence of radiating heat and flames — Determination of smoke density*

EN 2826, *Aerospace series — Burning behaviour of non metallic materials under the influence of radiating heat and flames — Determination of gas components in the smoke*

EN 3197, *Aerospace series — Design and installation of aircraft electrical and optical interconnection systems*

EN 3475, *Aerospace series — Cables, electrical, aircraft use — Test methods* [1)]

EN 3844-1, *Aerospace series — Flammability of non metallic materials — Part 1: Small burner test, vertical — Determination of the vertical flame propagation*

EN 4674-002, *Aerospace series — Electrical cables, installation — Self-wrapping shielding (EMI) protective sleeve — Part 002: General and list of product standard*

EN 4674-003, *Aerospace series — Electrical cables, installation —Self-wrapping shielding (EMI) protective sleeve — Part 003: Open sleeve — Inside pressurized area — EMI protection 5 kA — Temperature range – 65 °C to 200 °C — Product standard*

EN 4674-004, *Aerospace series — Electrical cables, installation — Self-wrapping shielding (EMI) protective sleeve — Part 004: Open sleeve — Outside pressurized area — EMI protection 10 kA — Temperature range – 65 °C to 200 °C — Product standard*

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1) All its parts quoted in this European Standard.

EN 6059, *Aerospace series — Electrical cables, installation — Protection sleeves — Test methods* [1)]

EN 9133, *Aerospace series — Quality management systems — Qualification procedure for aerospace standard parts*

ISO 8815, *Aircraft — Electrical cables and cables harnesses — Vocabulary*

IEC 62153-4-3, *Metallic communication cable test methods — Part 4-3: Electromagnetic compatibility (EMC) — Surface transfer impedance — Triaxial method* [2)]

ASTM B33, *Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes* [3)]

ASTM B298, *Standard Specification for Silver-Coated Soft or Annealed Copper Wire* [3)]

ASTM B355, *Standard Specification for Nickel-Coated Soft or Annealed Copper Wire* [3)]

ASTM D4894, *Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials* [3)]

TR 4684, *Aerospace series — Electrical technology and component definition* [4)]

3 Terms, definitions and symbols

For the purposes of this document, the terms, definitions and symbols given in ISO 8815 or TR 4684 apply.

4 Description

This technical specification covers tubular self-wrappable sleeving, used as EMI protection of different levels. It can be used in pressurized or non-pressurized areas. Easy installation and removal are expected.

These sleeves are built with:

— a particular number of longitudinal wires or group of wires (warps) made of plated copper;
— the wires or group of wires are assembled by weaving mono- and/or multi-filament strands which have aerospace grade mechanical and thermal characteristics;
— optional, transversal-filling strands made of plated copper can be added to provide electrical continuity between longitudinal warps;
— the internal part can be covered by a tape maintained close to the EMI screen, in order to improve the protection of the cables and cable bundle inside.

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2) Published by: IEC International Electrotechnical Commission. http://www.iec.ch/

3) Published by: ASTM National (US) American Society for Testing and Materials. http://www.astm.org/

4) In preparation at the date of publication of this standard.

A sleeve overlap is needed.

See Figures 1 and 2 for illustration.

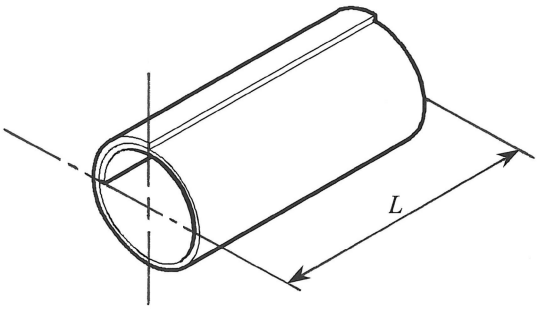
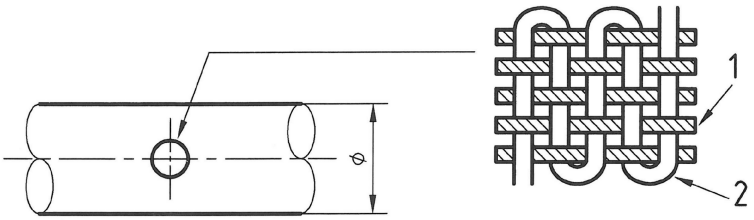


Figure 1



Key

1 warp
2 weft

Figure 2

5 Design

5.1 General requirements

These protection sleeves are intended to meet the following requirements as specified in detail in Clause 7:

— EMI protection of cables and cable bundles,
— non-aggressive to the protected cables and cable bundles,
— resistance to hostile environments, such as temperature and fluid exposure,
— minimum mass,
— mechanical flexibility,
— the minimum bend radius applicable shall be equal to the specified minimum bend radius for cables and cable bundles, as specified in EN 3197 or in the product standard,
— the flammability, smoke emission and toxicity of all parts shall meet the requirements mentioned in the product standard.

5.2 Screen requirements

5.2.1 Materials

Strands used for this European Standard shall be cylindrical and made with high conductivity annealed electrolytic copper (see ASTM B355, ASTM B298, ASTM B33).

On ASTM B355 finished product:

— the elongation prior to rupture, for each class 4 and class 10 copper strand, shall be at least 15 %;
— the elongation prior to rupture, for each class 27 copper strand, shall be at least 8 %;
— the tensile strength, for each copper strand, shall be at least 220 MPa.

5.2.2 Metal plating

The individual strands may be:

— provided with a uniform plating of tin (code B) or silver (code C), or nickel (code D).

Plating thicknesses shall be at least 1,0 µm for silver and at least 1,3 µm for nickel.

When tin plating is authorized, the thickness shall be sufficient to comply with the tests specified in EN 3475-506 and EN 3475-507.

Particular plating thickness will be necessary to provide high resistance to corrosion.

For example, a high resistance to corrosion can be obtained with the use of nickel coated copper strands where the nickel shall not represent less than 27 % of the total mass of the individual strand (also called class 27 or class C27). In this case, the tensile strength for each strand shall be at least 280 MPa. Refer to ASTM B355.

5.2.3 Construction of warps

All wires or group of wires used to build a particular size shall be of the same cross-section, and if inserted as groups of wires using the same number and diameter of strands.

Strands forming an individual group of wires shall not be twisted together and shall run longitudinally as parallel to each other as possible in order to minimize linear resistance, to limit crossover for electrical connection dispersion during installation purpose.

When necessary to ensure a good EMI protection, particular care shall be brought to the necessary electrical link between all warps of a size.

Per sleeve size, the total cross-section shall be sufficient to satisfy the required transfer impedance in the full range of frequencies.

5.2.4 Joints

Unless specific validation of the process used, the warps making the final assembly shall be free from any total joints. Each strand comprising the warps may, however, include soldered or brazed joints. For strands with a diameter of 0,25 mm or greater, butt joints shall be used.

The distance between two joints in individual strands shall exceed 1 m, measured between different strands.

5.3 Fibre requirements

5.3.1 Materials

Mono- or multi-filament fibres used for this European Standard:

— shall be flame resistant and shall not support combustion;
— shall be moisture resistant and shall not support fungus growth;
— shall not be adversely affected by weathering, fluids and propellants absorption;
— shall not be affected by normal manipulations, temperature and ambient conditions encountered during service life operations.

Materials that outgas only a minimum amount of noxious gases shall be selected.

Colour shall be as given in EN 4674-002.

5.3.2 Construction

Mono- or multi-filament fibres, used to hold together all wires or group of wires, shall be of a uniform shape and constitution, with a smooth surface and free from knots or other defects that might affect the service life.

5.4 Protective tape requirements

5.4.1 Materials

Taking into account insulation materials used for the current generation of wires and cables, unless otherwise specified in product standard, it is recommended to use a mechanical protection of sufficient thickness, according to ASTM D4894, type IV, grade 2 specification.

5.4.2 Construction

The protective tape shall be maintained adjacent to the EMI screen using an appropriate process, such as for example:

— an adhesive,
— the sewing process,
— the weave used to hold the group of wires together.

The maintaining process shall be easily removable, to ensure 360° electrical bonding on end-fittings (i.e. backshells, half-shells).

5.5 Installation requirements

5.5.1 Twisting of the sleeve

A twisting of two 360° turns per meter is mandatory for the installation, in order to avoid the opening of the sleeve or the exit of any cable (e.g. in bend radius).

The product must fulfil all the requirements after the two 360° turns per metre.

5.5.2 Temperature range

Each product standard shall define the applicable temperature range.

5.5.3 Identification

A tracer line shall be included to indicate the minimum overlap, defining the maximum admissible bundle diameter for which the sleeve can operate.

To identify each concerned product, coloured tracer line identification shall be included on the external edge.

The tracer line indicating the minimum overlap shall have the same colour as the tracer line on the external edge.

To identify each sleeve size, unless otherwise specified in product standard no specific tracer shall be specified.

Tracer line materials shall be compatible with sleeve temperature range during all the service life.

Colours for both tracer lines shall be as given in EN 4674-002 or according to product standard.

5.5.4 Implementation on bundles

The help of a simple associated tool is permissible to move apart the two edges. When used, this tool shall not damage the sleeve, its edges or the protective tape (if any), and shall not damage the cables inside the sleeve.

5.5.5 Connecting devices

For the long term, efficiency of the EMI protection provided by such sleeve will be maintained only if connecting devices installed are duly qualified in the concerned environment.

For this, we need to take into account dimensional stability of the sleeve in the full range of thermal and vibratory environments.

If necessary, the product standard can specify particularly recommended connecting devices.

6 Definition drawings and mass

Exact description, specific requirements, general dimensions and mass of these sleeves are given in each concerned product standard.

7 Test methods

7.1 Qualification tests

7.1.1 General

For each product standard, qualification tests shall be as given in Table 1 and Table 2.

7.1.2 Standard tests

See Table 1.

Table 1 — Standard test methods for qualification *(1 of 3)*

Test method	Designation of the test	Details
EN 6059-201	Visual inspection	Applicable – All test specimens (see product standard).
EN 6059-202	Dimensions and mass	Applicable – All test specimens (see product standard).
EN 6059-203	Coverage	Not applicable
EN 6059-301	Sun light exposure	Applicable – Test must be performed on each type of raw-material (tapes, fibres, tracer line) and three samples (medium size) of finished product (duration according to product standard).
EN 6059-302	High temperature exposure	Applicable – Three samples per size.
EN 6059-303	Resistance to fluids	Applicable – Test must be performed on each type of raw-material (tapes, fibres, tracer line) and three samples (medium size) of finished product.
EN 3844-1B	Flammability	Applicable – Three samples of a medium size. Unless otherwise specified in product standard: Extinguishing time 15 s max.
EN 6059-305	Fluid absorption	Not applicable
EN 6059-306	Mould growth	Applicable – Three samples of a medium size. There shall be no damage that would affect service use and no mould growth or darkening of any textile part visible to the naked eye.
EN 6059-308	Rapid change of temperature	Applicable – Test three different sizes: smallest, medium and largest (three samples per size)
EN 6059-309	Fire resistance of protected bundle	Not applicable
EN 6059-401	Expansion range	Not applicable
EN 6059-402	Bending properties	Applicable – Three samples of the smallest size. Specimens installed on aerospace cable, such as EN 2267-010, twisted two turns per metre tied every 100 mm, loaded with 10 N must not show any evidence of deformation, swelling, cracking or more than 10 % of rupture of metallic filament after 200 cycles.
EN 6059-403	Scrape abrasion	Not applicable
EN 6059-404	Tensile strength	Not applicable
EN 6059-405	Dynamic cut-through	Applicable – Three samples of the smallest size. Load as specified in the product standard.
EN 6059-406	Vibration	Applicable – Test three different sizes: smallest, medium and largest (three samples per size). There shall be no evidence of wear or defect visible on the cable insulation. Some defects could be acceptable on sleeve strands if the electrical tests are passed.

Table 1 — Standard test methods for qualification *(2 of 3)*

Test method	Designation of the test	Details	
EN 6059-501	Voltage proof test	Not applicable	
EN 6059-502	Resistance to electrical arcs	Not applicable	
EN 6059-503	Temperature rise due to rated current injected on the sleeve	Applicable – Three samples of the smallest size. Unless otherwise specified in product standard I_n = 10 A and $\Delta T \leq 5$ °C I_1 = 400 A for 500 ms and $T_1 \leq T_a + 10$ °C	
EN 6059-601	Open and close	Applicable – On three samples of the smallest and medium sizes. Unless otherwise specified in product standard. 100 cycles.	
EN 2825	Smoke density	Applicable – Test three samples of a medium size. The test duration shall be 4 min. The maximum specific optical smoke density (average) shall not exceed: D_s = 200 (flaming mode). D_s = 150 (non flaming mode).	
EN 2826	Toxicity	Applicable – Test three samples of a medium size. The test duration shall be 4 min.	
		Gas component	**Limit of concentration** (ppm) (duration 4 min)
		Hydrogen fluoride HF	100
		Hydrogen chloride HCI	150
		Hydrogen cyanide HCN	150
		Sulphur dioxide SO_2/H_2S	100
		Nitrous gases NO/NO_2	100
		Carbon monoxide CO	1 000
EN 3475-301	Ohmic resistance per unit length	Applicable – Three samples per size (see product standard). The measurement shall be representative of a sleeve installed on 1 m length bundle, with two 360° turns per metre.	
EN 3475-505 for metallic strands EN 6059-404 for non-metallic strands	Tensile test on conductors and strands	Applicable for raw material, during purchasing process.	
EN 3475-506	Plating continuity	Applicable for raw material, during purchasing process (test report issued by raw material manufacturer can be provided).	
EN 3475-507	Adherence of plating	Applicable for raw material, during purchasing process (test report issued by raw material manufacturer can be provided).	
EN 3475-508	Plating thickness	Applicable for raw material, during purchasing process (test report issued by raw material manufacturer can be provided).	

Table 1 — Standard test methods for qualification *(3 of 3)*

Test method	Designation of the test	Details
EN 3475-509	Solderability	Applicable during purchasing process for codes B, C.
EN 3475-807 IEC 62153-4-3	Transfer impedance	Applicable – Three samples per size (see product standard). Sleeve shall be installed on samples with two 360° turns per metre.
EN 2591-214	Lightning strike, current and voltage pulse	Applicable – Three samples of the smallest size. Sleeve shall be installed on samples with two 360° turns per metre. Waveform, current pulse amplitude and requirements shall be as specified in the product standard.
EN 2591-307	Salt mist	Applicable – Test three different sizes: smallest, medium and largest (three samples per size). Duration of the test shall be as specified in the product standard. Before and at the end of the test, samples shall be straightened for measurements of the linear resistance. The measurement after the test shall be compliant with the product specification; Furthermore, when examined with the naked eye, there shall be no cracking, flaking or peeling of the plating, or pitting or exposed metal under the plating surface. There shall be no adherent or distinctly visible green spots when examined with the naked eye. Any defect occurring less than 15 mm from each end shall be disregarded. Sample definition shall be in accordance with 7.1.3.

7.1.3 Endurance cycles

Unless otherwise specified in the concerned technical product standard, at least one size of protection sleeve per sleeve thickness or construction type (if different from one size to another) shall be assessed.

If possible, for each thickness or construction type, the test must be performed on a sample that has the minimum authorized thickness or the minimum authorized weight.

Table 2 — Test methods for endurance *(1 of 2)*

Designation of the test	Test method
Group 0 Visual examination	EN 6059-201
Dimensions and mass	EN 6059-202
Ohmic resistance per unit length	EN 3475-301
Transfer impedance	EN 3475-807 IEC 62153-4-3

Table 2 — Test methods for endurance *(2 of 2)*

Designation of the test	Test method
Group 1	
Rapid change of temperature	EN 6059-308
Vibration	EN 6059-406
Bending properties	EN 6059-402
Salt mist	EN 2591-307
Visual examination	EN 6059-201
Ohmic resistance per unit length	EN 3475-301
Transfer impedance	EN 3475-807 IEC 62153-4-3
Group 2	
Vibration	EN 6059-406
Temperature rise due to rated current	EN 6059-503
Lightning test	EN 2591-214
Visual examination	EN 6059-201
Ohmic resistance per unit length	EN 3475-301
Transfer impedance	EN 3475-807 IEC 62153-4-3

7.2 Maintenance qualification tests

The maintenance qualification tests shall be carried out every 36 months for products in production or when production is restarted in the event of a stoppage of greater than 36 months after qualification.

The maintenance qualification tests shall be performed on specimens taken at random in accordance with EN 9133, and shall be as given in Table 3.

Table 3 — Maintenance qualification tests

Test method	Designation of the test	Details
EN 6059-201	Visual inspection	See 5.2 and product standard.
EN 6059-202	Dimensions and mass	See 5.2, 5.3, 5.4 and product standard.
EN 3844-1B	Flammability	Applicable – Three samples of a medium size. Unless otherwise specified in product standard: Extinguishing time 15 s max.
EN 3475-301	Ohmic resistance per unit length	Applicable – Three samples per size (see product standard). The measurement shall be representative of a sleeve installed on 1 m length bundle, with the two 360° turns per metre.
EN 3475-807 IEC 62153-4-3	Transfer impedance	Applicable – Three samples per size (see product standard). Sleeve shall be installed on samples with the two 360° turns per metre.
EN 3475-505 for metallic strands EN 6059-404 for non-metallic strands	Tensile test on conductors and strands	Applicable during raw material purchasing process.
EN 3475-506	Plating continuity	Applicable during raw material purchasing process (test report issued by raw material manufacturer can be provided).
EN 3475-507	Adherence of plating	Applicable during raw material purchasing process (test report issued by raw material manufacturer can be provided).
EN 3475-508	Plating thickness	Applicable during raw material purchasing process (test report issued by raw material manufacturer can be provided).

7.3 Production routine tests

Production routine tests shall be applied to specimens taken at random from every batch and shall be as given in Table 4.

Table 4 — Production routine tests

Test method	Designation of the test	Details
EN 6059-201	Visual inspection	See 5.2 and product standard.
EN 6059-202	Dimensions and mass	See 5.2, 5.3, 5.4 and product standard.
EN 3475-301	Ohmic resistance per unit length	See product standard.
EN 3475-508	Plating thickness (Applicable during raw material purchasing process)	See product standard (test report issued by raw material manufacturer can be provided).

8 Quality assurance

See EN 9133.

9 Example for designation in product standards

See EN 4674-002.

10 Delivery conditions

Unless otherwise specified in the order, the protection sleeve delivery lengths shall be in accordance with Table 5.

Table 5 — Delivery lengths

Product standard	Minimum acceptable continuous delivered sleeve lengths	
	At least 65% of delivered sleeves shall be in continuous lengths of not less than	No sleeve shall be less than
EN 4674-003	30 m	5 m
EN 4674-004		

Qualification tests shall take into account these parameters if used in production.

11 Packaging

See EN 4674-002.

12 Marking

See EN 4674-002.

13 Storage

See EN 4674-002.

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