BS EN 4681-001:2012

BSI Standards Publication

Aerospace series — Cables, electric, general purpose, with conductors in aluminium or copper-clad aluminium

Part 001: Technical Specification

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National foreword

This British Standard is the UK implementation of EN 4681-001:2012.

BSI as a member of CEN, is obliged to publish EN 4681-001:2012 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval as a European Standard.

In the opinion of the committee, the 600 V rms AC rating is not justified by the tests required by this standard, as different test conditions require the use of different voltages. For example, the arc track test which is mentioned in table 1 is carried out using either a 115 V or 230 V, according to BS EN 3475-603:2011, and so is the need for a corona test on cables used in non-pressurized zones on AC systems above 115 V phase to neutral.

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.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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

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Aerospace series - Cables, electric, general purpose, with conductors in aluminium or copper-clad aluminium - Part 001: Technical specification

Série aérospatiale - Câbles électriques, d'usage général, avec conducteurs en aluminium ou en aluminium chemisé cuivre - Partie 001: Spécification technique

Luft- und Raumfahrt - Elektrische Leitungen, zur allgemeinen Verwendung, mit Leitern aus Aluminium oder kupferbeschichtetem Aluminium - Teil 001: Technische Lieferbedingungen

This European Standard was approved by CEN on 25 February 2012.

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Foreword

This document (EN 4681-001:2012) 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.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2013, and conflicting national standards shall be withdrawn at the latest by April 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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1 Scope

This European Standard specifies the characteristics, test methods, qualification and acceptance conditions of single-core electric cables for general purpose with conductors in aluminium or copper-clad aluminium, intended for installation in aircraft electrical systems.

The insulation of these cables is designed to withstand a maximum service voltage of 600 V r.m.s. at a frequency not exceeding 2 000 Hz.

They are divided into types, the characteristics of which are given in the product standards. Unless otherwise specified in the product standard, the tests defined in this standard apply.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 3475-100 (all parts), *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 100: General*

EN 3719, *Aerospace series — Aluminium or aluminium alloy conductors for electrical cables — Product standard*

EN 3838, *Aerospace series — Requirements and tests on user-applied markings on aircraft electrical cables*

EN 4651, *Aerospace series — Copper-clad aluminium alloy conductors for electrical cables — Product standard* [1)]

EN 4681-002, *Aerospace series — Cables, electric, general purpose, with conductors in aluminium or copper-clad aluminium — Part 002: General*

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

ISO 2574, *Aircraft — Electrical cables — Identification marking*

TR 4648, *Aerospace series — Cable, electrical — Re-qualification following changes in design, material or manufacturing process* [2)]

TR 4684, *Aerospace series — Electrical Technology and component definition* [3)]

1) Published as ASD-STAN Prestandard at the date of publication of this standard (www.asd-stan.org).

2) Published as ASD-STAN Technical Report at the date of publication of this standard (www.asd-stan.org).

3) In study at the date of publication of this standard.

3 Terms, definitions and symbols

For the purposes of this standard, the terms, definitions and symbols given in EN 3475-100 or TR 4684 apply.

4 Materials and construction of cables

4.1 Conductors

They shall conform to EN 4651 or EN 3719 unless otherwise specified.

4.2 Finished cables

The insulation material shall present an uniform circular cross-section throughout the length of the cable.

Covering over the insulation shall be treated and applied in such a manner that the cables present a smooth appearance and are able to accept marking.

All materials used shall have no corrosive effect upon the conductors and shall not be susceptible to attack by mould or other micro-organisms.

5 Required characteristics

The characteristics of the cables, tested according to the methods described hereafter shall comply with the values given in the product standard.

6 Tests methods

See Table 1.

Table 1 — Tests: methods, application, requirements

§ No.	Tests						Requirements (and/or particulars)
	Description	**EN 3475-** (and/or particulars)	Qualification [a] (Clause 7.1).	Each delivery		Periodic every three years (7.2.4)	
				On all cables (7.2.1 and 7.2.2)	Prior to deliver (7.2.1 and 7.2.2)		
6	Test conditions	100	X	X	X	X	
6.1	Visual examination	201	3	X			Marking: according to Clause 8
6.2	Mass	202	3		X		Minimum length: 0,5 m
6.3	Dimensions (all) — outer diameter	203	3	 X	X		Conductor: according to concerned EN standard, unless otherwise specified. Product standard
6.4	Ohmic resistance per unit length	301	3		X		Product standard
6.5	Voltage proof test: — immersion test; — dry test; — or dry impulse test.	302 Alternative to dry test	 3	 X X			 2,5 KV r.m.s. 5 KV r.m.s. 8 KV peak voltage
6.6	Insulation resistance — at (20 ± 2) °C; — at (95 ± 2) °C.	303	3		 X	 X	For a length of 1 km: 1 500 MΩ minimum 15 MΩ minimum
6.7	Surface resistance	304	3				Minimum: 1 250 mΩ × mm
6.8	Overload resistance	305 T1 and T2: product standard	3			X	Applicable to cable of 0,6 mm² only
6.9	Continuity of conductors	306	1	X			
6.10	Corona extinction voltage	307	3		X		Applicability according to product standard
6.11	Accelerated ageing	401 Mandrel diameter and test load: Table 4	3			X	
6.12	Shrinkage and delamination	402 Temperature: product standard	3		X		Product standard
6.13	Delamination and blocking	403 Mandrel diameter: Table 4 Temperature: product standard	3		X		

Table 1 — Tests: methods, application, requirements *(continued)*

§ No.	Tests						Requirements (and/or particulars)
	Description	**EN 3475-** (and/or particulars)	Qualification [a] (Clause 7.1).	Each delivery		Periodic every three years (7.2.4)	
				On all cables (7.2.1 and 7.2.2)	Prior to deliver (7.2.1 and 7.2.2)		
6.14	Thermal shock	404 Temperature: product standard	3		X		Product standard
6.15	Bending at ambient temperature	405 Mandrel diameter: Table 4	3				
6.16	Cold bend test	406 Mandrel diameter and test load: Table 4	3			X	
6.17	Flammability	407	3			X	Product standard
6.18	Fire resistance	408					Not applicable
6.19	Air-excluded ageing	409 Temperature and time: product standard	3			X	
6.20	Thermal endurance	410	X				Product standard Applicable to cable of 0,6 mm² only
6.21	Resistance to fluids	411 Per fluid tested	1			X	Applicable to cable of 0,6 mm² only
6.22	Humidity resistance	412 If method B: temperature and time: product standard	3			X	Method A or B as requested in product standard
6.23	Wrap back test	413	3		X	X	Applicable to cables ≤ 5 mm²
6.24	Differential scanning calorimeter (DSC test)	414	3			X	Applicable for insulation systems containing PTFE
6.25	Rapid change of temperature	415					Not applicable
6.26	Thermal stability	416					Not applicable
6.27	Fire resistance of cables confined inside a harness	417					Not applicable
6.28	Thermal endurance for conductors	418	X				Product standard
6.29	Dynamic cut-through	501 (for insulation wall thickness ≤ 0,38 mm)	3			X	Product standard (arithmetic mean value of 8 (eight) tests per specimen) Applicable to cables ≤ 14 mm²

Table 1 — Tests: methods, application, requirements *(continued)*

§ No.	Tests						Requirements (and/or particulars)
	Description	**EN 3475-** (and/or particulars)	Qualification [a] (Clause 7.1).	Each delivery		Periodic every three years (7.2.4)	
				On all cables (7.2.1 and 7.2.2)	Prior to deliver (7.2.1 and 7.2.2)		
6.30	Notch propagation	502 Cut depth: product standard	3			X	
6.31	Scrape abrasion	503 Load: product standard	3			X	Requirements to be considered at 20 °C unless otherwise specified
6.32	Torsion	504 Test load: Table 4 T3 and T4: product standard	3			X	Applicable to cables ≤ 5 mm²
6.33	Tensile test on conductors and strands	505	3		X		According to concerned EN product standard, unless otherwise specified
6.34	Plating continuity	506	3		X		Applicable, unless otherwise specified
6.35	Adherence of plating	507	3		X		Applicable, unless otherwise specified
6.36	Plating thickness	508	3		X		According to concerned EN product standard, unless otherwise specified
6.37	Solderability	509	3		X		Product standard
6.38	Tensile strength and elongation of extruded insulation, sheath and jacket material	510	4		X		Product standard
6.39	Cable-to-cable abrasion	511 Mass: product standard	1			X	Product standard
6.40	Flexure endurance	512 Mandrel diameter and mass: product standard	3			X	Product standard
6.41	Deformation resistance (Installation with plastic cable ties)	513					Not applicable
6.42	Porosity of copper cladding on aluminium strands	514	3		X		Product standard
6.43	Crush resistance	515					Not applicable
6.44	Smoke density	601	3				Product standard

Table 1 — Tests: methods, application, requirements *(continued)*

§ No.	Tests						Requirements (and/or particulars)
	Description	EN 3475- (and/or particulars)	Qualification [a] (Clause 7.1).	Each delivery		Periodic every three years (7.2.4)	
				On all cables (7.2.1 and 7.2.2)	Prior to deliver (7.2.1 and 7.2.2)		
6.45	Toxicity	602	3				Product standard
6.46	Resistance to wet arc tracking	603	X				Product standard
6.47	Resistance to dry arc propagation	604	X				Product standard
6.48	Wet short circuit test	605	X				Product standard
6.49	Strippability and adherence of insulation to the conductor	701	3		X		Minimum adherence force according to Table 5.
6.50	Screen pushback capability	702					Not applicable
6.51	Permanence of manufacturer's marking	703	3		X		
6.52	Flexibility	704	2		X		Product standard
6.53	Permanence of user-applied marking	EN 3838	X			X	Product standard
	Contrast measurement	705 Laser parameters: 706	X		X		Product standard

[a] Number of specimens per cross-section for each test unless otherwise specified.

7 Quality assurance

7.1 Qualification

7.1.1 General requirements

See EN 9133.

7.1.2 Qualification conditions

The cables shall be submitted for qualification tests on drums, spools or in coils in sufficient lengths, wound evenly and uniformly.

Each drum, spool or coil shall have a label containing information given in 9.1.

7.1.3 Qualification tests

See Table 1.

7.1.4 Extension of qualification

The qualification granted may be applicable to adjacent cross-sections in accordance with Table 2.

Table 2 — Qualified cables and extension of qualification

Qualified cables		Cables covered by the same qualification	
Nominal cross-section mm^2	AWG [a]	Nominal cross-section mm^2	AWG [a]
0,25	24	0,25	24
0,6	20	0,4 to 1	22 to 18
2	14	1,2 to 5	16 to 10
9	8	9 to 22	8 to 4
42	1	28 to 107	3 to 0 000

[a] AWG = Closest American Wire Gage.

NOTE For cross sections 9 mm² to 107 mm², different reference cross-section may be selected after agreement with the Design Authority.

7.2 Acceptance tests

7.2.1 Required conditions

7.2.1.1 General

See Table 1.

The acceptance tests shall be carried out on cables delivered against a production batch to check that the cable characteristics are maintained.

7.2.1.2 Tests to be carried out on all cables

The cables which fail any of the tests specified in 7.2.2 shall be rejected.

7.2.1.3 Random sampling tests: retest

If any of the specimens fails one of the tests specified in 7.2.3, that test shall be repeated on another set of specimens of the same cross-section selected at random from the same batch. If one of these new specimens fails the test, the batch submitted for acceptance shall be rejected.

7.2.2 Production routine tests

The tests shall be carried out on all cables delivered.

See Table 1.

7.2.3 Tests prior to delivery

They shall be carried out by sampling on each production batch.

See Table 1.

7.2.4 Periodic tests

They shall be carried out by sampling at least every three (3) years.

See Table 1.

7.2.5 Tests to perform in case of change in design, materials, manufacturing process

See TR 4648.

8 Identification marking

Unless otherwise specified, the type, cross section and a reference for identification of country of origin, manufacturer, and the year of manufacture shall be indelibly marked on the cables, in accordance with ISO 2574, and EN 4681-002.

9 Packaging, labelling and delivery lengths

9.1 Packaging and labelling

Cables supplied on drum, spools or in coils shall be wound evenly and uniformly.

All cable ends shall be easily accessible and protected where necessary.

Each drum, spool or coil shall have a label indicating:

— manufacturer's name and designation;

— cable designation according to the EN product standard;

— batch number;

— date of manufacture (month, year);

— inspector's mark;

— total length and length of each piece of cable in metres from inside to outside.

9.2 Delivery lengths

They shall conform to Table 3 unless otherwise specified.

Table 3 — Delivery lengths

Nominal conductor cross-section mm^2	AWG [a]	Minimum acceptable continuous lengths	
		for at least 85 % of cables delivered m	for not more than 15 % of cables delivered m
0,25 to 1	24 to 18	150	30
1,2 to 3	16 to 12	100	20
5	10	70	20
9 to 107	8 to 0 000	As stated in the order	

[a] AWG = Closest American Wire Gage.

Table 4 — Mandrel diameter and test load

Conductor code	Nominal conductor cross-section mm^2	AWG [a]	Mandrel diameter mm	Test load N
002	0,25	24	12 times the maximum cable diameter	3,5
004	0,4	22		5
006	0,6	20		7,5
010	1,0	18		10
012	1,2	16		10
020	2,0	14		15
030	3,0	12		15
050	5,0	10		15
090	9	8	16 times the maximum cable diameter	45
140	14	6		45
220	22	4		45
340	34	2	22 times the maximum cable diameter	75
420	42	1		75
530	53	0		120
680	68	00		120
850	85	000		150
107	107	0 000		150

[a] AWG = Closest American Wire Gage.

Table 5 — Adherence of insulation to the conductor

Conductor code	Nominal conductor cross-section mm^2	AWG [a]	Adhesion force minimum N
002	0,25	24	2
004	0,4	22	2,5
006	0,6	20	4
010	1,0	18	6
012	1,2	16	8
020	2,0	14	8
030	3,0	12	10
050	5,0	10	10

[a] AWG = Closest American Wire Gage.

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