INTERNATIONAL STANDARD

ISO 2635

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Aircraft — Conductors for general purpose aircraft electrical cables and aerospace applications — Dimensions and characteristics

Aéronefs — Conducteurs pour câbles électriques pour usage général aéronautique et pour applications aérospatiales — Dimensions et caractéristiques

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 2635 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 1, *Aerospace electrical requirements*.

This second edition cancels and replaces the first edition (ISO 2635:1979), which has been technically revised.

Introduction

The need for International Standardization in the Aerospace industry cannot be overemphasized. Multinational projects abound in the construction industry and all major airlines use equipment produced in different continents. The mixture of specifications and standards combine to increase the chances of maintenance errors, no more so than in the interconnection system. Power plant manufacturers in France may use conductors and terminations manufactured in Europe mating at the firewall with terminations and conductors manufactured in North America. This can result in different contacts, crimp tools and settings, and insulating stripping tools being required to work on mating connectors. The same would apply to many types of equipment.

The requirement for close or “clipped” tolerance, lightweight conductors can provide the opportunity to address many of these problems by overcoming the long-standing issue of AWG versus metric sizes.

This revision of ISO 2635 introduces a list of lightweight conductors for airframe cables. This list supplements the existing list of standard metric conductors which has not received worldwide acceptance. The list is derived from NEMA standard WC 67 which includes the constructions in previous and existing specifications ISO 2635:1979, EN 2083, prEN 4434, BS 3G 231 and MIL-W-29606. It has also been compared with those used by airframe constructors. The conductor codes in Table 1 are taken from WC 67.

The constructions presented are those which are considered to be standards within the existing rules governing aircraft cables, e.g. 19 strands minimum, copper alloy for size 24 and smaller. However, it does take advantage of the lightest weight for each size. The resultant standard is therefore a mixture of conductors with metric and imperial origins which gives the greatest advantage to constructors and users for the future.

This International Standard:

— obeys existing rules regarding conductors for aircraft;

— gives the lightest weight for each size/rating presently used;

— standardizes the conductor cross sectional area throughout the world aerospace industry;

— enables the standardization of terminations and the crimp tools used to produce the joints;

— reduces the number of insulation stripping tools required to service aircraft;

— enables the world industry to concentrate its efforts on improving interconnection technology knowing that a world market exists;

— enables regulatory authorities (CAA, FAA, JAA, etc.) to make rules regarding the interconnection system which applies internationally.

All these will, by reducing complexity, reduce servicing errors and contribute to aircraft safety.

Aircraft — Conductors for general purpose aircraft electrical cables and aerospace applications — Dimensions and characteristics

1 Scope

This International Standard specifies the dimensions, electrical characteristics and mechanical characteristics of multi-strand conductors for general-purpose aircraft electrical cables and aerospace applications. It applies to stranded conductors over the nominal cross-sectional area range 0,12 mm^2 to 107 mm^2 inclusive.

It is not applicable to conductors for fire-resistant cables or for thermocouple extension cables. Conductors for fire-resistant cables are specified in ISO 1967 and for thermocouple extension cables are specified in ISO 8056-1.

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.

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8815 and the following apply.

3.1
conductor code
numeric or alphanumeric code which designates conductor size and properties

3.2
worldwide wire gauge
WWG
identification system, similar to the American wire gauge (AWG) system from which it has been derived, for an international designation of wire cable sizes

4 Required characteristics

4.1 General

The dimensions, electrical resistance, mechanical properties and mass of the conductors shall conform to the values given in Table 1 or Table 2. Table 2 should be used for new designs.

4.2 Materials

4.2.1 Conductors of nominal cross-sectional area 0,25 mm^2 to 0,12 mm^2 shall be produced from high-strength copper alloy, and conductors of nominal cross-sectional areas greater than 0,25 mm^2 shall be produced in copper of electrotechnical quality (i.e. ETP grade copper).

4.2.2 Conductors shall be manufactured from unused materials that have been exposed only to processes essential to their manufacture and application.

4.2.3 Size 24 and smaller conductors shall be made from high strength copper alloy. The larger sizes shall be electrotechnical grade copper.

NOTE No ISO standards are available which specify aircraft grade copper and copper alloys.

4.2.4 The plating materials shall conform to the appropriate requirements of Clause 6.

4.2.5 These conductors in copper and copper alloy may be unplated (code letter A), tinned (code letter B), silver-plated (code letter C) or nickel-plated (code letter D) in accordance with the requirements of, and to the thickness required by, the individual specification for which the conductors are being used. The thickness of the silver-plating (code letter C) shall be at least 1,0 µm and the thickness of the nickel-plating, (code letter D), at least 1,25 µm.

5 Construction

5.1 Table 1 gives the number of strands to be used for each cross-section of conductor and gives the nominal conductor sizes over the range of nominal cross-sections from 0,15 mm^2 to 107 mm^2. Table 2 gives the required characteristics for a range of lightweight conductors, as described in the introduction to this International Standard, over the range of nominal cross-sections from 0,12 mm^2 to 107 mm^2 (WWG28 to WWG0000).

5.2 Strands shall be clean, bright and free from surface irregularities.

5.3 Conductors shall comprise the number and diameter of strands given in Table 1 or Table 2. Conductors shall be either concentric lay or rope lay.

5.4 There shall be no kinks, joints or other irregularities in the complete conductor.

5.5 Joints in single strands shall be brazed or hard soldered. There shall not be more than one such joint in any 50 m of single strand. Joints in single strands shall not be within 300 mm of any other joint in the same layer.

6 Tests and requirements

6.1 Tensile strength and elongation

6.1.1 Method

Use a tensile tester capable of 1 % accuracy, with jaw separation rates of 200 mm/min to 300 mm/min (copper) and 40 mm/min to 60 mm/min (copper alloy). Test the whole conductor. The initial jaw separation shall be 245 mm to 255 mm.

6.1.2 Requirement

Tensile strength and elongation at break of the conductor prior to insulation shall be as given in Table 1 or Table 2, based on an average of three tests.

6.2 Mass per unit length

Weigh at least 1 m of conductor. The mass per unit length for each size shall be as given in Table 1 or Table 2.

6.3 Resistance

6.3.1 Method

Measure the electrical resistance of the conductor (in ohms) and correct to 20 °C using the following formula:

— for annealed copper: $R_T = R_{20}\,[1 + 0{,}003\,931(T - 20)]$, or

— for copper alloy: $R_T = R_{20}\,[1 + 0{,}003\,500(T - 20)]$

where

T is the temperature, in degrees Celsius, of the conductor under test;

R_T is the resistance of sample at temperature T;

R_{20} is the resistance at 20 °C.

6.3.2 Requirement

The values calculated shall not exceed those given in Table 1 or Table 2.

6.4 Strand-plating continuity

6.4.1 Method

Take three strands no less than 150 mm in length from a conductor previously straightened by hand. Degrease the strands without causing damage then wipe, using a clean dry cloth. Ensure that any strands cleaned in this manner are not touched by hand. Immerse the strands for 30 s in a solution of sodium polysulfide of density 1,142 g/cm^3 at 20 °C, then wash carefully in distilled water. In addition immerse silver- and nickel-coated strands for 15 s in a hydrochloric acid solution of density 1,088 g/cm^3 at 20 °C and wash carefully in distilled water. Examine the strands under a magnification of × 30.

6.4.2 Requirement

No adherent or distinct black spots shall be observed. Any blackening occurring less than 15 mm from each end shall be disregarded.

6.5 Strand-plating adherence

6.5.1 Method

Take three strands not less than 150 mm in length from a conductor previously straightened by hand. Wind each strand around itself, using half the specimen length as a mandrel so as to form 10 adjacent turns. Examine the strands under a magnification of × 100.

6.5.2 Requirement

The plating shall not exhibit any detachment or cracks.

6.6 Strand-plating thickness

When measured by any approved method the thickness of silver shall be 1,0 µm minimum and nickel plating shall be 1,25 µm minimum.

7 Packaging and labelling

7.1 Conductors conforming to this International Standard shall be uniformly wound on reels, bobbins or in coils and shall be protected against damage and the ingress of moisture.

7.2 Each reel, bobbin or coil shall have firmly attached to it a label bearing the following details:

Name of conductor

Identification block

ISO 2635 C 012 or W28

Number of this International Standard
Code letter for plating
Code number for nominal cross-section

Table 1 — Conductor, electric cable, in copper and copper alloy

Conductor code	Nominal cross-sectional area	Approximate wire gauge with reference to AWG	Number of strands in conductor	Nominal strand size	Conductor diameter		Electrical resistance at 20 °C max.		Mechanical properties		
									Elongation	Mass per unit length	Ultimate breaking load
	mm^2			mm	min. mm	max. mm	Types A and C Ω/km	Types B and D Ω/km	min. %	max. kg/km	min. N
001 [a]	0,15	26	19	0,10	0,46	0,53	149	160	6	1,60	46
002 [a]	0,25	24	19	0,12	0,55	0,62	106	114	6	2,18	67
004	0,4	22	19	0,15	0,72	0,80	55,3	60,0	10	3,43	71
006	0,6	20	19	0,20	0,94	1,04	31,0	33,2	10	5,95	127
010	1	18	19	0,25	1,18	1,29	19,6	21,1	10	9,16	198
012	1,2	16	19	0,30	1,39	1,53	13,6	14,5	10	13,2	285
020	2	14	37	0,25	1,68	1,82	10,2	10,9	10	18,0	385
030	3	12	37	0,32	2,12	2,28	6,40	6,80	10	28,5	645
050	5	10	37	0,40	2,69	2,88	4,00	4,20	10	46,0	1 000
090	9	8	117	—	—	4,40	2,30	2,40	10	86,1	—
140	14	6	127	—	—	5,50	1,50	1,55	10	133	—
220	22	4	182	—	—	6,80	0,910	0,940	10	214	—
340	34	2	201	—	—	8,60	0,585	0,620	10	333	—
420	42	1	245	—	—	9,50	0,480	0,500	10	402	—
530	53	0	322	—	—	10,7	0,375	0,390	10	526	—
680	68	00	416	—	—	12,1	0,295	0,305	10	685	—
850	85	000	513	—	—	13,6	0,233	0,240	10	849	—
107	107	0000	660	—	—	15,2	0,183	0,190	10	1 090	

[a] High-strength copper alloy.

Table 2 — Conductor, electric cable, lightweight, in copper and copper alloy

Conductor code (worldwide wire gauge, WWG)	Nominal cross-sectional area	Rope construction	Number of strands in conductor	Nominal strand size ∅	Missing strands	Diameter[b] (tight tolerance) mm		Resistance (Ω/km) max.			Mechanical properties		
											Elonga-tion	Mass per unit length	Ultimate breaking load
	mm^2			mm	max.	min.	max.	Plating code A and C	Plating code D	Plating code B	min. %	max. kg/km	min. N
W28 [a]	0,12		19	0,09	0	0,41	0,44	164	176	N/A	6	1,30	36
W26 [a]	0,15		19	0,10	0	0,45	0,49	149	160	N/A	6	1,40	46
W24 [a]	0,25		19	0,12	0	0,55	0,59	106	114	N/A	6	2,00	67
W22	0,4		19	0,15	0	0,70	0,75	56,4	60	60	10	3,13	71
W20	0,6		19	0,2	0	0,94	1,04	31,3	33,2	33,2	10	5,55	127
W18	1		19	0,25	0	1,16	1,25	19,6	21,1	21,1	10	8,90	198
W16	1,2		19	0,29	0	1,31	1,41	14,9	15,6	15,8	10	11,80	285
W14	2		37	0,25	0	1,68	1,75	10,2	10,9	10,9	10	17,20	385
W12	3		37	0,32	0	2,12	2,27	6,40	6,80	6,80	10	27,50	600
W10	5		37	0,40	0	2,69	2,80	4,0	4,2	4,2	10	45,80	1 000
W8	9		127	0,30	0	4,00	4,20	2,16	2,3	2,3	10	87,0	
W6	14	27 × 7	189	0,30	0	5,03	5,40	1,44	1,58	1,58	10	126	
W4	22	19 × 7	133	0,45	0	6,35	6,81	0,866	0,902	0,919	10	214	
W2	34	37 × 19	703	0,25	2	8,20	8,60	0,556	0,613	0,613	10	342	
W1	42	19 × 43	817	0,25	2	9,14	9,65	0,482	0,498	0,489	10	410	
W0	53	19 × 55	1 045	0,25	3	10,00	10,80	0,354	0,371	0,381	10	525	
W00	68	19 × 70	1 330	0,25	3	11,20	12,06	0,279	0,292	0,299	10	666	
W000	85	37 × 45	1 665	0,25	4	12,70	13,70	0,223	0,233	0,233	10	836	
W0000	107	37 × 57	2 109	0,25	5	14,40	15,36	0,177	0,184	0,184	10	1059	

[a] High-strength copper alloy.

[b] These values are provided for information as the practical measurement of conductor diameter presents difficulties. The dimensions of the conductor are determined by maximum mass and resistance values.