BS EN 2234:2012

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# Aerospace series — Cable, electrical, fire resistant — Technical specification

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

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# EN 2234

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# Aerospace series - Cable, electrical, fire resistant - Technical specification

Série aérospatiale - Câbles électriques résistant au feu - Spécification technique

Luft- und Raumfahrt - Elektrische Leitungen, feuerbeständig - Technische Lieferbedingungen

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# Contents

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# Forword

This document (EN 2234:2012) 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.

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# 1 Scope

This European Standard specifies the required characteristics and test procedures for fire resistant or fire-proof electrical cables for use in aircraft electrical systems. These cables should also maintain a specific surface resistance when they are subjected to a flame of 1 100 °C after 5 minutes (fire resistant) or 15 minutes (fire-proof) exposure.

They should be rated at an a.c. voltage of 600 V r.m.s., a frequency of maximum 2 000 Hz and a long term temperature of up to 260 °C (ambient temperature plus temperature rise in conductor).

# 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, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 100: General*

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

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

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

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

IEC 60028:1925, *International standard of resistance for copper*

# 3 Terms, Definitions and Symbols

For the purposes of this document, the terms, definitions and symbols given in ISO 8815 and EN 3475-100 apply.

# 4 Materials and construction

## 4.1 Conductors

### 4.1.1 Materials

The individual strands used for the conductors shall be cylindrical and shall be:

— of nickel clad copper alloy for nominal cross section of 0,4 $mm^2$;

— of nickel clad copper for nominal sections ≥ 0,6 $mm^2$.

The copper shall meet the requirements of IEC 60028 and the copper alloy the requirements of this European Standard.

The nickel shall not represent less than 27 % of the total mass of the individual strand.

Individual strands shall show the following minimum breaking strength:

— 280 $N/mm^2$ for nickel clad copper;

— 315 $N/mm^2$ for nickel clad copper alloy.

#### 4.1.2 Lay length

Up to 9 $mm^2$ cross section inclusive (code 090), concentric or unilay conductors are used. The lay for the stranded conductor, checked over the outside layer of a test piece 1 m long, shall be between 8 times and 16 times the maximum diameter of this conductor.

For sectional areas between 14 $mm^2$ and 68 $mm^2$ (codes 140 to 680), the conductor comprises concentric or bunched conductors twisted together. The lay of the strands for the basic concentric or bunched conductors shall not exceed 30 times the diameter of the concentric or bunched conductor in question.

The lay for concentric (or bunched) conductors, measured over the outer layer of the conductor, shall be between 8 times and 16 times the maximum conductor diameter.

In all cases the lay of the outer layer shall be left-hand.

#### 4.1.3 Joints

The conductors shall be free from any joints. Each strand comprising the conductors 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 3 m, measured between different strands.

#### 4.1.4 Compaction

Compaction of the causing deformation of the strands or damage to the plating is not permitted.

### 4.2 Construction

Finished cables

The insulation shall be of a material, which takes on the circular shape of the conductor throughout its length. It shall closely cover the conductor without adhering to it, so that it reduces the corona effect and the risk of blistering and heat corrosion due to voids and gaseous discharges.

The insulation shall be neither too tight nor too loose, so as to provide satisfactory mechanical characteristics and be easily removable using commercially available tools. (See 6.45)

The protective sheath shall be of a material, which takes on the round shape of the insulated conductor lying under it. It shall provide adequate protection from mechanical damage and contamination by liquids, as specified in the product standard. The outer surface shall be smooth and suitable for identification marking.

The protective sheath shall not have a corrosive effect on the screen and shall be resistant to fungus and other.

## 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 method

See Table 1.

**Table 1 — Tests: methods, application, requirements**

| § No. | Tests | | | | | | Requirements (and/or particulars) |
|---|---|---|---|---|---|---|---|
| | **Description** | **EN 3475-** (and/or particulars) | Qualification 1) (Clause 7).[a] | Each delivery | | Periodic every three years (7.2.4) | |
| | | | | On all cables (7.2.1 and 7.2.2) | Prior to deliver | | |
| 6 | Test conditions | 100 | X | X | X | X | |
| 6.1 | Visual examination | 201 | 3 | X | | | Product standard |
| 6.2 | Mass | 202<br>minimum length 0,5 m | 3 | | X | | Product standard |
| 6.3 | Dimensions | 203 | 3 | X | X | X | Product standard |
| 6.4 | Ohmic resistance per unit length | 301 | 3 | | X | | Product standard |
| 6.5 | Voltage proof test:<br>— immersion test;<br>— dry test;<br>— or dry impulse test. | 302<br><br><br><br>Alternative to dry test | <br>3 | <br><br>X<br>X | <br>X | | <br>2,5 Kv r.m.s.<br>5 Kv r.m.s.<br>8 Kv peak voltage |
| 6.6 | Insulation resistance<br>— at (20 ± 2) °C;<br>— at (95 ± 2) °C. | 303 | 3 | | <br>X | <br><br>X | For 1 km length<br>500 MΩ<br>1 MΩ |
| 6.7 | Surface resistance | 304 | 3 | | | | Minimum: 1 250 mΩ.mm |
| 6.8 | Overload resistance | 305<br>T1 and T2: product standard | 3 | | | X | Applicable to code 006 only |
| 6.9 | Continuity of conductors | 306 | X | X | | | Applicable |
| 6.10 | Accelerated ageing | 401<br>Mandrel diameter and test load: Table 4 | 3 | | | X | |
| 6.11 | Shrinkage and delamination | 402 [b]<br>Temperature: product standard | 3 | | X | | Product standard |

*(continued)*

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

| § No. | Tests | | | | | | Requirements (and/or particulars) |
|---|---|---|---|---|---|---|---|
| | **Description** | **EN 3475-** (and/or particulars) | **Qualification** (Clause 7.1).[a] | **Each delivery** | | **Periodic every three years** (7.2.4) | |
| | | | | **On all cables** (7.2.1 and 7.2.2) | **Prior to deliver** | | |
| 6.12 | Delamination and blocking | 403<br>Mandrel diameter: Table 4<br>Temperature: product standard | 3 | | X | | Product standard |
| 6.13 | Thermal shock | 404<br>Temperature: product standard | 3 | | | X | Product standard |
| 6.14 | Bending at ambient temperature | 405<br>Mandrel diameter: Table 4 | 3 | | | X | |
| 6.15 | Cold bend test | 406<br>Mandrel diameter and test load: Table 4<br>Temperature: product standard | 3 | | | X | Product standard |
| 6.16 | Flammability | 407 | 3 | | | X | Product standard |
| 6.17 | Fire resistance | 408<br>Per fluid tested | 1 | | X | | Without fluid immersion for tests prior to delivery. |
| 6.18 | Air-excluded ageing | 409<br>Temperature and time: product standard | 3 | | | X | |
| 6.19 | Thermal endurance | 410<br>Temperature and time: product standard | X | | | | Product standard<br>Applicable to code 006 only.<br>4 × 10 samples |
| 6.20 | Resistance to fluids | 411<br>Per fluid tested | 1 | | | X | |
| 6.21 | Humidity resistance | 412<br>Method A or B as requested in product standard | 3 | | | X | |
| 6.22 | Wrap back test | 413 | 3 | | X | | Applicable to cables ≤ 5 $mm^2$ |
| 6.23 | Differential scanning calorimeter (DSC test) | 414 | 3 | | | X | |
| 6.24 | Rapid change of temperature | 415 | | | | | Not applicable |
| 6.25 | Thermal stability | 416 | | | | | Not applicable |

*(continued)*

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

| § No. | Tests | | | | | | Requirements (and/or particulars) |
|---|---|---|---|---|---|---|---|
| | **Description** | **EN 3475-** (and/or particulars) | **Qualification** (Clause 7.1).[a] | **Each delivery** | | **Periodic every three years** (7.2.4) | |
| | | | | **On all cables** (7.2.1 and 7.2.2) | **Prior to deliver** | | |
| 6.27 | Dynamic cut-through | 501<br>Temperature: product standard | 3 | | | X | Product standard |
| 6.28 | Notch propagation | 502<br>Cut depth: product standard | 3 | | | X | |
| 6.29 | Scrape abrasion | 503<br>Load : product standard | 3 | | | X | Requirement to be considered at 20 °C unless otherwise specified |
| 6.30 | Torsion | 504<br>Test load: Table 4<br>T3 and T4: product standard | 3 | | | X | Applicable to ≤ 5 $mm^2$ |
| 6.31 | Tensile test on conductors and strands | 505 | 3 | | X | | See 4.1 of this standard. |
| 632 | Plating continuity | 506 | 3 | | X | | |
| 6.33 | Adherence of plating | 507 | 3 | | X | | |
| 634 | Plating thickness | 508 | 3 | | X | | |
| 6.35 | Solderability | 509 | 3 | | X | | Product standard |
| 6.36 | Tensile strength and elongation of extruded insulation, sheath and jacket materials | 510 | 4 | | X | | Product standard |
| 6.37 | Cable-to-cable abrasion | 511 | 1 | | | X | Product standard |
| 6.38 | Flexure endurance | 512 | 3 | | | X | Product standard |
| 6.39 | Deformation resistance (Installation with plastic cable ties) | 513 | | | | | Not applicable |
| 6.40 | Smoke density | 601 | X | | | X | Product standard |
| 6.41 | Toxicity | 602 | X | | | X | Product standard |
| 6.42 | Resistance to wet arc tracking and electric arc propagation | 603 | X | | | X | Product standard |
| 6.43 | Resistance to dry arc tracking and electric arc propagation | 604 | X | | | X | Product standard |
| 6.44 | Wet short circuit test | 605 | X | | | X | Product standard |
| 6.45 | Strippability and adherence of insulation to the conductor | 701 | 3 | | X | | Product standard |

*(continued)*

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

| § No. | Tests | | | | | | Requirements (and/or particulars) |
|---|---|---|---|---|---|---|---|
| | **Description** | **EN 3475-** (and/or particulars) | **Qualification** (Clause 7.1). [a] | **Each delivery** | | **Periodic every three years** (7.2.4) | |
| | | | | **On all cables** (7.2.1 and 7.2.2) | **Prior to deliver** | | |
| 6.46 | Screen pushback capability | 702 | NOT APPLICABLE | | | | |
| 6.47 | Permanence of manufacturer's marking | 703 | 3 | | X | | Product standard |
| 6.48 | Flexibility | 704 | 2 | | X | | Product standard |
| 6.49 | Contrast measurement | 705 and EN 3838 | X | | X | | Product standard |
| 6.50 | Laser markability | 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 and Table 3.

**Table 2 — Qualified cables and extension to qualification – Single core**

| Qualified cables | | Cables covered by the same qualification | |
|---|---|---|---|
| Nominal cross-section $mm^2$ | AWG [a] | Nominal cross section $mm^2$ | AWG [a] |
| 0,4 | 22 | 0,4 | 22 |
| 0,6 | 20 | 0,6 to 1 | 20 to 18 |
| 2 | 14 | 1,2 to 5 | 16 to 10 |
| 9 | 8 | 9 to 34 | 8 to 2 |
| 53 | 0 | 42 to 68 | 1 to 00 |
| [a] Closest American Wire Gage. | | | |

For cross-sections 9 $mm^2$ to 68 $mm^2$, different reference cross-section may be selected after agreement with the design authority.

**Table 3 — Qualified cables and extension to qualification – Multicore unshielded**

| Number of conductors | Qualified cables | | | Cables covered by the same qualification | |
|---|---|---|---|---|---|
| | Nominal cross-section $mm^2$ | AWG [a] | Number of conductors | Nominal cross-section $mm^2$ | AWG [a] |
| 2 | 0,6 | 20 | 2 and 3 | 0,4 - 0,6 - 1 - 1,2 - 2 | 22 - 20 - 18 - 16 - 14 |
| [a] Closest American Wire Gage. | | | | | |

## 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 an order 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 specimen fails one of the test 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 delivery batch.

#### 7.2.4 Periodic tests

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

See Table 1.

## 8 Identification marking

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

## 9 Packaging, labelling, and delivery lengths

### 9.1 Packaging and labelling

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

All cables 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;

— batch number;

— date of manufacture;

— inspector mark;

— total length and length of each piece of cable in meters from inside to out side.

### 9.2 Delivery lengths

They shall conform to Table 4 and Table 5 unless otherwise specified.

**Table 4**

| **Nominal cross-section for cables** 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 |
| 0,4 to 1 | 22 to 18 | 150 | 30 |
| 1,2 to 3 | 16 to 12 | 100 | 20 |
| 5 to 14 | 10 to 6 | 50 | 15 |
| 22 to 68 | 4 to 00 | 30 | 10 |

[a] Closest American Wire Gage.

**Table 5**

| **Conductor code** | **Nominal cross-section of conductor** mm$^2$ | **AWG** [a] | **Maximum mandrel diameters** mm | **Loads** N | **Bond strength** min. N |
|---|---|---|---|---|---|
| 004 | 0,4 | 22 | 30 | 10 | 5,5 |
| 006 | 0,6 | 20 | 30 | 10 | 9,0 |
| 010 | 1 | 18 | 40 | 10 | 15,0 |
| 012 | 1,2 | 16 | 40 | 15 | 19,0 |
| 020 | 2 | 14 | 40 | 15 | 22,0 |
| 030 | 3 | 12 | 50 | 15 | 22,0 |
| 050 | 5 | 10 | 60 | 25 | 22,0 |
| 090 | 9 | 8 | 75 | 25 | — |
| 140 | 14 | 6 | 85 | 45 | — |
| 220 | 22 | 4 | 100 | 45 | — |
| 340 | 34 | 2 | 120 | 70 | — |
| 420 | 42 | 1 | 130 | 70 | — |
| 530 | 53 | 0 | 140 | 90 | — |
| 680 | 68 | 00 | 160 | 110 | — |

[a] Closest American Wire Gage

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