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Aircraft — Electrical connectors — Design requirements

Aéronefs — Connecteurs électriques — Caractéristiques

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 1949 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles.*

This second edition cancels and replaces the first edition (ISO 1949 : 1973), of which it constitutes a technical revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Contents

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Aircraft — Electrical connectors — Design requirements

0 Introduction

This International Standard has been prepared to provide a statement of the design features, performance requirements and test methods shown to be desirable for aircraft electrical connectors suitable for airframe use.

For a specific range of connectors to be considered as being in conformity with this International Standard, it is necessary to prepare a "detail specification" for the range. The detail specification should include the information listed in annex A.

The tests referred to in this International Standard are specified in ISO 2100.

1 Scope and field of application

1.1 This International Standard lays down the general performance requirements and standardization principles for aircraft connectors. It is intended to cover types of connectors designed to use crimped, soldered and welded contacts accommodating aircraft cables. It does not define a particular type of connector dimensionally.

1.2 This International Standard outlines the basic design, mechanical and electrical requirements for the connectors and the basic environmental conditions of operation.

WARNING — As far as explosion proofness is concerned, the engaged connectors complying with this International Standard are not defined as explosion proof. They do constitute an explosion hazard and shall NOT be disengaged while carrying current.

2 References

ISO 1966, *Crimped joints for aircraft electric cables.*

ISO 2100, *Aircraft — Electrical connectors — Tests.* [1)]

ISO/TR 2685, *Aircraft — Environmental conditions and test procedures for airborne equipment — Resistance to fire in designated fire zones.*

IEC Publication 50(581), *International Electrotechnical Vocabulary — Chapter 581: Electromechanical components for electronic equipment.*

IEC Publication 130-1, *Connectors for frequencies below* 3 MHz *— Part 1: General requirements and measuring methods.*

3 Definitions

For the purposes of this International Standard, the following definitions apply. [See also IEC Publication 50(581).]

3.1 conductor barrel: That part of the contact which is designed to accommodate the conductor.

3.2 insulation barrel; insulation bucket: That part of the contact which is designed to accommodate the conductor insulation.

3.3 bunch rating: The current rating (derating) applied to specific numbers of cables when formed into looms, i.e. bunched together.

3.4 cable clamp: A part of a connector or an accessory attached to the connector body to support the cable or wire to provide strain relief and absorb mechanical stress which would otherwise be transmitted to the termination.

3.5 cable outlet: A part of a connector or an accessory consisting of straight or angled rigid housing for attachment to the connector body. It may incorporate provision for a cable clamp or seal for terminating screens and provide shielding to electrical interference.

3.6 connector: A device which facilitates the connection and disconnection of electrical circuits for access or transport.

1) Cross-references to ISO 2100 apply to the second edition published in 1987.

3.7 fixed connector; receptacle: A connector for attachment to a chassis, panel, wall, bulkhead or to a piece of apparatus, and having male or female contacts.

3.8 free connector; plug connector: A connector for attachment to the free end of a wire or a cable, and having male or female contacts.

3.9 free coupler connector: A connector that mates with a free connector in a cable-to-cable application.

3.10 connector interface: The two surfaces of the contact side of a pair of connectors which face each other when the connectors are mated.

3.11 contact holding force: That force which is required to retain a male contact gauge of specified mass and size in a female contact.

3.12 male contact; pin: A contact having an engaging end which makes contact by insertion into a female contact.

3.13 contact retention force: The axial force in either direction which a contact can withstand without being permanently displaced from its position within the insulator.

3.14 female contact; socket: A contact having an engaging end which will accept entry of male contact.

3.15 coupling: The mechanical device used to mate and retain a pair of connectors in engagement with each other.

3.16 crimped contact: A contact with the conductor barrel designed to be physically compressed (deformed) around the conductor to make electrical and mechanical contact.

3.17 dimensional checks: Checks designed to establish that all parts of the specimens are in conformity with the detail drawings.

3.18 generic type: Type having the same general characteristics.

3.19 connector insert: An insulating element designed to support and position contacts in a connector.

3.20 insert retention: Ability of the insert to withstand specified axial load in either direction without being dislodged from its normal position within the shell.

3.21 key: A projection which engages with a keyway, to provide guidance and alignment.

3.22 keyway: The slot or groove in which a key engages.

3.23 mated pair[1]: A combination, when mated, of two connectors designed to be coupled.

3.24 orientation: The angular position of an insert within a circular shell, constituting the whole or part of a connector polarization system.

Identification of the orientation is from a specified datum point on the interface to a specified datum on the shell, such as a major key or keyway.

3.25 polarization: The provision of features (e.g. keys and keyways) on mating connectors to prevent incorrect mating.

3.26 restricted entry: Female contact or insert contact cavity design, which prevents the insertion of an oversize male contact or test probe.

3.27 scoop: The action of touching contacts with the front edge of the mating shell during the search for correct engagement of connectors.

3.28 shell: The outside case of a connector into which the insert and contacts are assembled.

3.29 type approval[1]: Decision by the proper authority (the customer himself or his nominee) that the manufacturer can be considered able to produce components in reasonable quantities meeting the relevant specification.

3.30 type tests[1]: All the tests to be carried out on a number of specimens representative of the type of component of one manufacturer, with the object of determining whether the manufacturer can be considered able to produce components meeting the relevant specification.

3.31 interchangeable: A component is interchangeable when it meets the original performance specifications and is intermountable. In the case of connectors, interchangeability applies only to connector mated sets, since individual connectors are not necessarily intermateable.

3.32 intermateable: Two connectors are intermateable when they are capable of being connected electrically and mechanically but without regard to their performance and intermountability.

3.33 intermountable: Two components are intermountable when their mechanical mounting parameters are identical without regard to intermateability or interchangeability.

1) As defined in IEC Publication 130-1.

Section one : Design requirements

4 General

4.1 Materials and finishes

Materials and finishes shall be laid down in the control drawings; however, where these are not so specified they shall be selected so as to satisfy the performance requirements of the detail specification. Dissimilar metals shall not be used in intimate contact unless protection is afforded to prevent electrolytic corrosion.

4.2 Performance

The connectors and their accessories (not including contact insertion/removal and unwired contact removal tools) shall attain the performance detailed in this International Standard when subjected to any one or any natural combination of the environmental conditions specified in clause 5.

5 Environmental conditions

5.1 Temperature range

Connectors shall be classified as follows, according to the maximum working temperature for which they are suitable:

Class 1: −40 to +105 °C

Class 2: −55 to +125 °C

Class 3: −65 to +200 °C

Class 4: −65 to +260 °C

Class 5: −65 to +350 °C

NOTE — See designation examples given in the note to 5.3.

The upper temperature is the maximum internal hot spot temperature resulting from any combination of electrical load and ambient temperature. Electrical connectors shall be capable of continuous operation within the declared temperature range. Any limitations shall be declared in the detail specification.

5.2 Altitude

Connectors shall be suitable for use at altitudes up to 24 000 m.

5.3 Sealing classifications

The sealing classifications for connectors are as follows:

Class N

An environmentally sealed connector, which, although meeting the requirements for immersion at low air pressure and climatic tests (see ISO 2100) laid down in this International Standard, may have a leakage rate exceeding 1 cm^3/h at a differential pressure of 1 atm[1].

Class S

Connector sealed (unmated) to a leakage rate of 1 cm^3/h at a differential pressure of 1 atm[1].

Class H

Connector (fixed connector or bulkhead types only) hermetically sealed to a leakage rate of 1×10^{-7} cm^3/s at a differential pressure of 1 atm[1].

Class K

A fireproof connector meeting the requirements for a class N connector and those laid down for the resistance to fire (fireproofness) test specified in ISO 2100, test No. 21 (see also ISO/TR 2685).

Class U

Unsealed connector.

NOTE — Temperature, sealing and fireproofness are the only classifications imposed by this International Standard. The following designation examples are given for clarification purposes.

Designation examples:

Class 3H

A fixed connector which is hermetically sealed to operate within the temperature range from −65 to +200 °C.

Class 3N

A normally sealed connector to operate within the temperature range from −65 to +200 °C.

Class 3K

A normally sealed connector to operate within the temperature range from −65 to +200 °C and which meets the resistance to fire (fireproofness) requirements laid down in ISO 2100, test No. 21.

1) Normal atmospheric pressure is equivalent to 96 to 103 kPa (960 to 1 029 mbar).

5.4 Vibration, acceleration and resistance to climatic conditions

The connectors shall be designed and constructed so as to satisfy the requirements laid down in ISO 2100 with respect to vibration, acceleration and climatic conditions, tests Nos. 12, 18 and 19.

5.5 Resistance to fluids

The connectors, together with their accessories, shall be designed, so as to be resistant to aircraft fluids when tested in accordance with the requirements laid down in ISO 2100, test No. 10. A list of such fluids shall be included in the detail specification.

NOTE — Any limitations in this respect should be declared in the detail specification and on a declaration of design and performance.

5.6 Salt spray

The materials, finishes and design of the connectors shall be such as to resist contamination by salt spray when tested in accordance with the requirements laid down in ISO 2100, test No. 22.

5.7 Dust

Compliance with the requirements of this International Standard with respect to resistance to dust contamination is not mandatory, but when specifically requested by the user, or claimed by the connector manufacturer, the connectors shall satisfy the requirements laid down in ISO 2100, test No. 23.

5.8 Magnetic effect

The connectors and their accessories shall be designed to satisfy the requirements laid down in ISO 2100, test No. 17.

NOTE — Exceptions to this requirement may be stated in the detail specification and in the declaration of design and performance.

6 Mechanical specifications

6.1 Styles

Ranges shall include male or female contacts in fixed and free styles.

6.2 Contact engagement

The control drawings shall define the position of the electrical engagement range of the contact relative to the reference plane. On new designs the parallel part of the male contacts shall always exceed the range by at least 0,75 mm and the electrical contact point (point of maximum pressure) of the female contacts shall always lie within the range under all tolerance conditions when the free member has moved to the outward limit of any travel permitted by the engaged coupling device.

6.3 Engagement and polarization

The connector shall be designed so that the only engagement sequence is shells, keys/keyways, coupling devices and, finally, contacts.

Correct engagement shall be achieved by the combined use of the following systems:

a) A minimum of three keys and keyways shall be provided.

NOTE — This requirement may be relaxed for existing designs.

b) The keys and keyways shall ensure that the axis of the free shell remains substantially coincident with the axis of the fixed shell after the search for correct polarization.

c) An alternative polarization shall be provided within each shell size by orientating keys with respect to the master key to prevent cross-mating.

d) It shall not be possible to engage keys or make contacts or start the coupling device between differing orientations in the same shell size.

e) Orientation by insert rotation shall not be used for new designs of connector.

6.4 Coupling

The coupling arrangement shall ensure that

a) full engagement and disengagement can be achieved without the use of tools — the maximum and minimum forces shall be declared in the detail specification;

b) free and fixed shells are retained in the correct position when engaged, and the correct engagement can be visually checked.

6.5 Thread form

Screw threads shall comply with established national standards.

6.6 Locking

The coupling rings and accessories may contain wire-locking facilities. Adequate material shall be provided around any wire-locking hole to prevent the wire from breaking out. Screw coupling connectors shall incorporate a means to prevent uncoupling under shock or vibration.

6.7 Engagement endurance

Connectors shall be capable of at least 500 engagements/separations.

6.8 Inserts

6.8.1 Inserts for housing female contacts shall be of the hard-faced restricted entry type so as to prevent penetration by wrongly positioned or oversize contacts.

6.8.2 For new designs any retention mechanism for contacts shall be captive within the insert.

6.8.3 Inserts for class N and K connectors shall provide adequate wire insulation support and shall be capable of accepting a full complement of the maximum size of wire of the type declared by the manufacturer.

6.9 Contacts

Contacts shall conform to the requirements of the detail specification control drawings.

If crimped type contacts are used, the resulting crimp shall comply with the requirements laid down in ISO 1966.

6.10 Sealing (not applicable to class U connectors)

6.10.1 Connectors shall be sealed at the following points:

a) insert-to-shell;

b) connectors' insert interface;

c) shell-to-shell, preferably using a dynamic seal;

d) cable entry — mandatory for classes N and K, optional for classes H and S;

e) contact-to-insert for classes H and S.

NOTE — It may also be required to seal the fixed shell to its mounting.

6.10.2 The control drawings shall define the positional tolerance of the mating faces necessary to ensure compression of any interfacial and/or peripheral seals. Future connector designs shall ensure seal compression when the free member has moved to the outward limit of any travel permitted by the engaged device. On screw coupling connectors, a mechanical stop shall be provided to prevent damage.

6.11 Filler plugs

The detail specification shall define any filler plugs required, and their use.

7 Electrical specifications

7.1 Voltage

The working voltages of the engaged (or capped) connectors between contacts, and between contacts and the shell under any natural combination of the environmental conditions (as specified in clause 5) shall be at least 350 V d.c. or a.c. peak.

7.2 Current rating

Contacts shall be provided to accommodate standard conductors.

Ratings shall be shown in the detail specification.

7.3 Insulation resistance

The connectors shall satisfy the requirements laid down in ISO 2100 (see test No. 3).

7.4 Contact resistance

The connectors shall satisfy the requirements laid down in ISO 2100 (see test No. 2).

7.5 Shell-to-shell conductivity (where applicable)

Stable low-resistance continuity shall be obtained between engaged connectors to satisfy the requirements laid down in ISO 2100 (see test No. 4).

7.6 Conductor accommodation

Contacts shall be designed to accept the range of conductors shown in the detail specification.

7.7 Concentric contacts

Where concentric contacts are specified, they shall be fully interchangeable with existing sizes of contact.

8 Marking

8.1 Contact identification

Removable contacts shall be identified by the manufacturer's symbol. The marking shall not distort the contact dimensions or shape beyond the drawing limits.

Class N contacts and thermocouple contacts shall also be colour coded; a future International Standard will cover colour coding.

8.2 Contact position identification

Identification of the contact position should be preferably by numerals, either where contact cavities are in parallel lines or in a helical arrangement. Where possible the start of the contact identification count should be indicated and every tenth contact shall be identified. A means to enable rapid identification of the contact position shall be provided and this shall be legible and unambiguous. Where insert arrangements allow, the numerals should be printed on the front and rear faces of the connector. A large scale replica of the contact identification of each connector shall be available at the customer's request.

Figures 1 and 2 show examples of contact position identification.

8.3 Connector identification

The identification of the connector shall be legible and indelible; it shall appear on the body or shell. Connectors having rear insertion/release contacts shall be marked with a blue circumferential line.

8.4 Accessory identification

Each accessory item shall be legibly and permanently identified.

9 Fixtures and accessories

9.1 Attachment method

Three basic types of fixed shells shall be provided, as follows:

a) panel mounting, i.e. suitable for wall and box mounting;

b) single-hole mounting (class N or H) (circular connectors only);

c) hermetic solder/welded mount.

9.2 Panel thickness

Square flange and single-hole mounting shells shall accommodate panels of 2,5 or 3,3 mm thickness as specified in the detail specification.

9.3 Screening

Provision shall be made for terminating all types of cable screening.

9.4 Cable outlets

Straight and elbow outlets shall be provided. These outlets shall be capable of fitting to either free or fixed connectors of the same shell size without adaptation.

All tightening and cable torque shall be transmitted to the connector shell.

9.5 Protective caps or covers

Protective caps or covers fitted by normal connector engagement methods shall be available to provide protection against ingress of moisture or foreign matter, to protect live contacts and to guarantee the performance of disengaged, live items. Caps shall be provided which are attached to the connector by means of a link chain or equivalent.

9.6 Cable clamps

Provision may be made for cable clamps when the particular design necessitates the use of separate strain relievers.

10 Tools

10.1 Contact insertion and extraction tools

If contact insertion and extraction tools are necessary, their use shall not adversely affect compliance with the performance requirements laid down in this International Standard. Any such tools should preferably be non-metallic and shall not require lubrication for satisfactory insertion.

10.2 Crimping tools

Crimping tools shall be such that they produce a crimp joint performance which complies with the requirements laid down in ISO 1966.

Section two : Type approval testing

11 Sampling for type tests

11.1 For type approval of any particular range of connectors, a number of samples shall be chosen representing all variations in the range (i.e. shell size, type, class and insert arrangements) together with all variations of accessories. The selection shall be subject to agreement of the approving authority and shall be included as an appendix to the detail specification (see clause A.2).

A specimen shall consist of an engaging pair of connectors (with accessories, if so required). In addition to the above specimens, a complete set of detail parts representative of those used to produce the connectors shall be provided.

11.2 Specimen Nos. 1, 4, 7 and 10 shall be wired with a full complement of the largest size of wire for which the connector is declared suitable.

Specimen Nos. 2, 5, 8 and 11 shall be wired with a full complement of the smallest size of wire for which the connector is declared suitable.

Specimen Nos. 3, 6, 9 and 12 shall have approximately 25 % of the wire entries sealed by means of the specified filler plugs and the remainder shall be wired with the smallest size of wire for which the connector is declared suitable.

11.3 For the type approval test, suitable lengths of the appropriate type of wire shall be used. Wire of the same generic type shall be used for all specimens, except those which are to be subjected to the resistance to fire (fireproofness) test. The types of wires used shall be stated in the test reports.

11.4 For approval for the use of connectors for other types of wire, supplementary tests may be required by the approving authority.

11.5 The specimens shall be subjected to the tests in the sequence shown in annex B.

Any practical difficulties experienced in assembling or wiring the connector shall be referred to in the test report.

12 Test conditions

Unless otherwise specified, all tests shall be carried out in standard temperature, pressure and humidity conditions, i.e.:

— temperature: between 15 and 35 °C;

— atmospheric pressure: 86 to 106 kPa (860 to 1 060 mbar);

— relative humidity: not greater than 80 %.

13 Test methods

13.1 Measurements

When measurements are required, the precise values obtained shall be recorded in the type test report.

13.2 Mounting

When mounting is specified, the connector shall be rigidly mounted on a metal plate, using the shell of a fixed item for free members and the normal fixing for fixed members. The dimensions of the plate shall exceed those of the contours of the specimens.

13.3 Contacts

When individual contact tests are specified and there are more than six contacts of the same rating contained in the connector, the number of contacts tested shall be at least six. These shall be selected from those having the least nominal spacing between contacts and the metal housing.

14 Test details

14.1 Dimensional checks

14.1.1 The manufacturer shall carry out a dimensional inspection of the complete set of detail parts (see 11.1) to ensure that these components conform to the manufacturer's relevant manufacturing drawings.

NOTES

1 This information should only be released to the inspection authority.

2 Inspection reports made at the time of manufacture of the piece parts may be used for this purpose.

14.1.2 The interchangeability features of every assembled connector shall be gauged or otherwise established to the satisfaction of the inspection authority.

14.1.3 After the tests have been completed, all specimens and accessories shall be examined from the point of view of the legibility of the marking (see 8.3 and 8.4), except for those specimens which have been subjected to the resistance to fire (fireproofness) test (see ISO 2100, test No. 21).

14.2 Tests

Detailed test procedures for the following tests are specified in ISO 2100:

Title of test	Test No.
Engagement and separating (locking and unlocking) forces	1
Contact resistance	2
Insulation resistance	3
Shell continuity	4
Sealing (classes H and S only)	5
Contact holding force	6
Contact retention	7
Low temperature handling	8
Immersion at low air pressure	9
Resistance to fluids	10
Voltage proof	11
Vibration	12
Thermal shock	13
Endurance at maximum temperature	14
Resistance to damage by test prod	15
Mechanical endurance	16
Magnetic effect	17
Climatic	18
Acceleration	19
Insert retention (in shell)	20
Resistance to fire (fireproofness) (class K only — see 5.1)	21
Salt spray	22

14.3 Optional tests

If required, the following tests specified in ISO 2100 may also be carried out:

Title of test	Test No.
Dust	23
Flammability	24
Contact walk-out	25