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**Aircraft — Connectors for ground  
electrical supplies —**

Part 1:  
**Design, performance and test  
requirements**

*Aéronefs — Prises de courant d'alimentation au sol —*

*Partie 1: Exigences concernant la conception, le fonctionnement et les  
essais*

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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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 461-1 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 461-1:1985), which has been technically revised. This edition brings the document up to date in terms of the connectors now being used on aircraft and anticipates future requirements. The testing regime for connectors has been changed to reflect existing industry practices.

ISO 461 consists of the following parts, under the general title *Aircraft — Connectors for ground electrical supplies*:

- *Part 1: Design, performance and test requirements*
- *Part 2: Dimensions*

## Introduction

Throughout this part of ISO 461, the minimum essential criteria are identified by the use of the imperative or the key word “shall”. Recommended criteria are identified by the use of the key word “should” and, while not mandatory, are considered to be of primary importance in providing serviceable, economical and practical connectors. Deviation from the recommended criteria should occur only after careful consideration, extensive testing and thorough service evaluation have shown alternative methods to be satisfactory.

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# Aircraft — Connectors for ground electrical supplies —

## Part 1: Design, performance and test requirements

### 1 Scope

This part of ISO 461 specifies the design, performance and test requirements for electrical connectors used to supply electrical power from a ground source to an aircraft.

NOTE ISO 461-2 specifies the dimensions of the connectors.

### 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 461-2, *Aircraft — Connectors for ground electrical supplies — Part 2: Dimensions*

ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment*<sup>1)</sup>

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 3.1

##### **aircraft fixed connector (receptacle)**

connector, installed in an aircraft, which accepts an electrical power supply via the ground supply free connector from an external ground source

#### 3.2

##### **ground supply free connector (plug)**

connector, fitted to cables from the external ground source of electrical power, which, when properly fitted to the aircraft fixed connector, permits an electrical supply to be passed to the aircraft

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1) Endorsement, in part, of the publication EUROCAE ED-14/RTCA DO-160 (a document published jointly by the European Organization for Civil Aviation Electronics and the Radio Technical Commission for Aeronautics).

## 4 Design and performance requirements

### 4.1 General

#### 4.1.1 Construction

The ground supply free connector shall be robust in construction and capable of withstanding heavy mechanical shocks and hard wear in use, and shall be designed to provide safe handling, for example by the avoidance of sharp edges.

#### 4.1.2 Fungus resistance

Materials used in the construction of fixed and free connectors shall be fungus-inert.

#### 4.1.3 Metallic materials

Metals used shall be corrosion-resistant or treated to resist corrosion.

#### 4.1.4 Dissimilar materials

Dissimilar materials used in intimate contact shall be protected against electrolysis and electrolytic corrosion.

#### 4.1.5 Temperatures

Aircraft fixed connectors and ground supply free connectors shall be capable of engagement, disengagement and operation at ambient temperatures between  $-65\text{ }^{\circ}\text{C}$  and  $+65\text{ }^{\circ}\text{C}$ . They shall be capable of operating at  $105\text{ }^{\circ}\text{C}$ , allowing for the temperature rise due to current carried by the connectors.

#### 4.1.6 Automatic uncoupling

Style 4 connectors shall be equipped with a positive-coupling device which will release automatically, without damage to the aircraft fixed connector or its mounting, should the aircraft or ground supply move before uncoupling has been carried out.

### 4.2 Polarity or phase sequence

Indications of polarity or phase shall be permanently marked on the aircraft fixed connectors and the ground supply free connectors at points adjacent to the contacts, as indicated in the relevant figures in ISO 461-2. The markings shall be permanent and legible and shall be marked on the front and rear of the insert of the aircraft fixed connector.

### 4.3 Current ratings

4.3.1 Each of the main current-carrying contacts of the fixed and free connectors (as distinct from any cables connected to them) shall be capable of carrying up to 300 A (Styles 1, 2 and 3) or 350 A (Style 4) continuously, i.e. for 1 h or more (direct current or r.m.s. alternating current).

4.3.2 Each of the control male and female contacts shall be capable of carrying 35 A continuously.

### 4.4 Control current female contact

The control current female contact of the d.c. ground supply free connector may be in two sections, insulated electrically from each other, connected only by the entry of the control male contact of the aircraft fixed connector, or the female contact may be of a one-piece construction.

## 4.5 Voltage rating

The aircraft fixed connectors and ground supply free connectors shall be capable of working continuously at the voltages specified in ISO 461-2.

## 4.6 Replaceability of contacts in the ground supply free connectors

All the ground supply free connectors shall be capable of being replaced or repaired such that the existing cables attached to the ground supply free connector may be reused.

## 5 Inspection and testing

### 5.1 Inspection

Connectors shall be examined to ensure that they meet the requirements of this part of ISO 461 and the dimensional requirements of ISO 461-2.

### 5.2 Testing

#### 5.2.1 Type tests

Type tests shall be carried out to prove conformance to the requirements of this part of ISO 461. Unless otherwise indicated, the tests shall be conducted at an ambient temperature between 15 °C and 25 °C. The tests specified in 5.3.1 to 5.3.10 shall be conducted on 11 test samples (A to K) using the sample allocation and the test order given in Table 1. Each sample shall consist of an aircraft fixed connector and an appropriate ground supply free connector.

#### 5.2.2 Quality control tests

Quality control tests shall be made on one fixed and free connector per 100, at least once a year. The sample shall be subjected to the tests specified in 5.3.4.1 and 5.3.6. If the sample fails any test, the batch shall be deemed not to conform to the requirements of this part of ISO 461.

**Table 1 — Type testing — Allocation of samples and order of testing**

Test	Sample and test order		
	A	B	C
Engagement and disengagement forces (see 5.3.1)	1		
Side-load test (see 5.3.2)	2		
Endurance (see 5.3.3)	3		
Current overload and voltage drop test (see 5.3.4)	4		
Salt spray test (see 5.3.5)		1	
High-voltage and insulation resistance test (see 5.3.6)		2	
Vibration test (aircraft fixed connector only) (see 5.3.7)		3	
Shock test (ground supply free connector only) (see 5.3.8)			1
Extremes of temperature — Engagement and disengagement test (see 5.3.10)			2
Fluid susceptibility test (initial qualification only) (see 5.3.9)	Samples D to K (one per fluid)		

## 5.3 Tests

### 5.3.1 Engagement and disengagement forces

#### 5.3.1.1 Styles 1, 2 and 3

Two test fixed connectors shall be constructed for each configuration of ground supply free connector, each fixed connector having male contacts of hardened and ground steel, with a surface finish of between 0,1  $\mu\text{m}$  and 0,4  $\mu\text{m}$  (4  $\mu\text{in}$  and 16  $\mu\text{in}$ ), mounted at the centres shown in the appropriate figure in ISO 461-2, except that the tolerance on contact position shall be  $\pm 0,025$  mm ( $\pm 0,001$  in). No shrouds shall be fitted.

One test fixed connector shall have male contacts of the maximum tolerance dimension  $\pm 0,005$  mm ( $\pm 0,000 2$  in) and the other test fixed connector shall have male contacts of the minimum tolerance dimension  $\pm 0,005$  mm ( $\pm 0,000 2$  in).

Fully engage and disengage the ground supply free connector being tested 50 times using the maximum size test fixed connector followed by 5 times using the minimum size test fixed connector. Engagement and complete separation may be accomplished by machine.

Measure the force necessary to engage and disengage the ground supply free connector on the first and last insertion of each test fixed connector. For 3-pin connectors, the engaging force shall not be greater than 223 N (50 lbf) and the disengaging force shall be between 134 N and 223 N (30 lbf to 50 lbf). For 5- and 6-pin connectors, the engaging force shall not be greater than 445 N (100 lbf) and the disengaging force shall be between 267 N and 445 N (60 lbf to 100 lbf). The rate of insertion and withdrawal shall be 177 mm/min to 229 mm/min (7 in/min to 9 in/min).

#### 5.3.1.2 Style 4

The engaging force shall not be greater than 534 N (120 lbf) and the disengaging force shall be between 400 N and 534 N (90 lbf to 120 lbf).

### 5.3.2 Side-load test

#### 5.3.2.1 Styles 1, 2 and 3

After the test described in 5.3.1.1, engage the ground supply free connector with an appropriate aircraft fixed connector mounted with its axis horizontal.

With the main current-carrying male contacts one-third engaged, apply a side load of 890 N (200 lbf) to the extremity of the ground supply free connector body. No damage or permanent deformation of the fixed or free connector shall ensue from this test.

#### 5.3.2.2 Style 4

After the test described in 5.3.1.2, engage and latch the ground supply free connector with an appropriate aircraft fixed connector mounted with its axis horizontal. Apply a side load of 890 N (200 lbf) to the extremity of the ground supply free connector body. No damage or permanent deformation of the fixed or free connector or the latching mechanism shall ensue from this test.

### 5.3.3 Endurance

After the tests described in 5.3.1 and 5.3.2, fully engage and disengage the ground supply free connector 500 times with an appropriate aircraft fixed connector mounted with its axis horizontal. Engagement and disengagement shall be at a rate not exceeding 15 cycles/min.

Measure the voltage drop at the end of this test. It shall meet the requirements of 5.3.4.2.

### 5.3.4 Current overload and voltage drop test

#### 5.3.4.1 Current overload

Connect a mated connector pair to a power supply and circuitry to pass a d.c. or a.c. r.m.s. current through the contacts of the connector. The cables between the power supply and the large contacts shall be size 00 gauge or larger and the cables for the small contacts size 12 gauge or larger. The current through the large contacts shall be 700 A (Styles 1, 2 and 3) or 900 A (Style 4) and through the small contacts shall be 35 A. Maintain the current at these levels for 3 min. During application of the current overloads and after the overloads have been removed, there shall be no shorting, loss of continuity, burning, rupture or other damage detrimental to either the free or fixed connector. Smoke shall not be cause for failure if the connector operation is not otherwise impaired. After removal of the overload current, allow the connectors to cool to ambient temperature and test the connectors for voltage drop at rated current levels in accordance with 5.3.4.2.

#### 5.3.4.2 Voltage drop at rated current

Use the same circuit as was used for the current overload test to provide a d.c. or a.c. r.m.s. current through the contacts of the connector. The current through the large contacts shall be 300 A (Styles 1, 2 and 3) or 350 A (Style 4) and through the small contacts shall be 15 A. Maintain the current at these levels for 5 min, then measure the voltage drop of all contacts at these current levels. Measure the voltage drop from the end of the contact on the back of the fixed connector receptacle to a point on the conductor of the cable within 25 mm (1 in) of the point of cable attachment to the free connector plug. The cable conductor may be accessed by use of a needle probe on the voltage-measuring leads. If the small control contacts of the free connector have been wired together internally, measure the voltage drop between the ends of the fixed connector contacts on the rearside of the fixed connector receptacle. The voltage drop of each large current-carrying contact shall be 45 mV or less, and the voltage drop of each small control contact shall be 30 mV or less.

#### 5.3.5 Salt spray test

Subject one aircraft fixed connector and one ground supply free connector, disengaged, to the salt spray test, as defined in ISO 7137<sup>2)</sup> (for Category S equipment only).

After completion of the 48 h exposure, leave the fixed and free connectors in normal laboratory atmospheric conditions, at a temperature of between 15 °C and 25 °C. After a period of between 1 h and 1,5 h, engage the items and measure the voltage drop. It shall meet the requirements of 5.3.4.2.

#### 5.3.6 High-voltage and insulation resistance tests

**5.3.6.1** Immediately following the salt spray test described in 5.3.5, subject the mated fixed and free connectors to the following high-voltage and insulation resistance tests.

**5.3.6.2** Apply 2 000 V r.m.s, 50/60 Hz a.c. for 1 min between adjacent contacts and between all contacts connected together and the shroud. There shall be no electrical breakdown.

**5.3.6.3** If a split control current contact is used (see 4.4), carry out an insulation test at 500 V d.c. between all adjacent contacts and between all contacts connected together and the shroud, during which the insulation resistance shall be not less than 100 M $\Omega$ .

**5.3.6.4** Carry out an insulation test at 500 V d.c. between the two halves of each of the control current female contacts, during which the insulation resistance shall be not less than 20 M $\Omega$ .

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2) Section 14 of EUROCAE ED-14/RTCA DO-160.