
International Standard



461/1

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

**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

First edition — 1985-04-15

ITeH STANDARD PREVIEW
(standards.iteh.ai)

ISO 461-1:1985

<https://standards.iteh.ai/catalog/standards/sist/8de49d13-882f-4789-999f-3845c3a5c771/iso-461-1-1985>

UDC 629.7.064.5 : 621.316.541

Ref. No. ISO 461/1-1985 (E)

Descriptors : aircraft industry, aircraft equipment, airport equipment, electric connectors, socket connectors, plug connectors, specifications, tests, marking.

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 461/1 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*.

Together with ISO 461/2, it cancels and replaces ISO Recommendation R 461-1965, of which it constitutes a technical revision.

Aircraft — Connectors for ground electrical supplies — Part 1: Design, performance and test requirements

1 Scope and field of application

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 References

ISO 461/2, *Aircraft — Connectors for ground electrical supplies — Part 2: Dimensions.*

ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment.*¹⁾

3 Definitions

For the purposes of this part of ISO 461, the following definitions apply.

3.1 aircraft fixed connector (receptacle): The 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): The 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.

4 Design and performance requirements

4.1 General

4.1.1 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 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.

4.2 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 recessed 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 male and female contacts of the fixed and free connectors (as distinct from any cables connected to them) shall be capable of carrying the following currents (direct current or r.m.s. alternating current):

- 450 A continuously (i.e. for 1 h or more);
- 1 500 A for 1 min.

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 shall be in two sections, insulated electrically from each other, connected only by the entry of the control male contact of the aircraft fixed connector.

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

4.5 Sealing

The aircraft fixed connector when fitted to the aircraft may be required to form a seal in the pressurized structure. The plug shall therefore provide a pressure seal at altitudes up to 31 000 m.

4.6 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.

4.7 Replaceability of female contacts

All the female contacts in the ground supply free connectors shall be detachable and capable of being replaced.

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 made to prove compliance with the requirements of this part of ISO 461. Unless otherwise indicated, the tests shall be conducted at an ambient temperature between 15 and 25 °C. The tests specified in 5.3.1 to 5.3.11 shall be conducted on eleven test samples (A to K) using the sample allocation and the test order given in the table. 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 sample 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, 5.3.6 and 5.3.8.

If the sample fails any test, the batch shall be deemed not to comply with the requirements of this part of ISO 461.

5.3 Tests

5.3.1 Engagement and disengagement forces

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 and 0,4 µm (4 and 16 µin), mounted at the centres shown in the appropriate figure in ISO 461/2, except that the tolerance on contact position shall be ± 0,025 mm (± 0.001 in). No shrouds shall be fitted.

One test fixed connector shall have male contacts of the maximum tolerance dimension ± 0,005 mm (± 0.000 2 in) and the other test fixed connector shall have male contacts of the minimum tolerance dimension ± 0,005 mm (± 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.

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, it shall not be less than 122 N (27.5 lbf) or greater than 356 N (80 lbf). For 5- and 6-pin connectors, it shall be not less than 178 N (40 lbf) or greater than 623 N (140 lbf). The rate of insertion and withdrawal shall not exceed 76 mm/min (3 in/min).

Table – 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		
Temperature rise 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	
Temperature and pressure test (aircraft fixed connector only) (see 5.3.8)		4	
Shock test (ground supply free connector only) (see 5.3.9)			1
Extremes of temperatures. Engagement and disengagement test (see 5.3.11)			2
Fluids susceptibility test (initial qualification only) (see 5.3.10)	Samples D to K. One per fluid		

5.3.2 Side load tests

After the test described in 5.3.1, 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.

5.3.3 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 5.3.4.1 b).

5.3.4 Temperature rise and voltage drop test

The tests described in 5.3.4.1 and 5.3.4.2 shall be conducted with two size 00 cables not less than 1,8 m (6 ft) in length connected to each termination of each of the main current-carrying male and female contacts, and with one size 10 cable connected to the termination of each section of each of the control current-carrying female contacts. These tests shall be conducted at an ambient temperature of +65 °C.

NOTE — This test is intended as a test on the male and female contacts and therefore, for the purposes of this test only, it will be necessary to make each of the main cable terminations on both the aircraft fixed connector and the ground supply free connector suitable for carrying two size 00 cables.

5.3.4.1 Pass a current of 450 A through each of the main current-carrying male and female contacts and 35 A through each of the control current-carrying male and female contacts for a period of 1 h. At the end of this time, the following requirements shall be met:

- a) the temperature rise of each of the cables, measured on the outside of the conductors underneath the insulation at a point 100 mm from the end of each cable termination to the unit, shall not exceed 40 °C;
- b) the voltage drop along each of the main current-carrying contacts, measured at the cable connections, shall not exceed 20 mV when carrying 450 A. On the control current-carrying contacts, the voltage drop shall not exceed 10 mV when carrying 35 A.

5.3.4.2 After the test described in 5.3.4.1, cool to the ambient temperature specified in 5.2.1, then pass a current of 1 500 A through each of the main current-carrying male and female contacts for a period of 1 min. At the end of this time, the tem-

perature rise shall not exceed 40 °C. Upon reducing the current to 450 A, the voltage drop along each of the main current-carrying male and female contacts measured at the cable connections shall not exceed 40 mV.

5.3.5 Salt spray test

One aircraft fixed connector and one ground supply free connector, disengaged, shall be subjected to the salt spray test, as defined in ISO 7137¹⁾, category S.

After completion of the 48 h exposure, leave the fixed and free connector in normal laboratory atmospheric conditions, at a temperature of between 15 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 5.3.4.1 b).

5.3.6 High voltage and insulation resistance tests

Immediately following the salt spray tests described in 5.3.5, the mated fixed and free connectors shall be subjected to the following high voltage and insulation resistance tests.

5.3.6.1 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.

5.3.6.2 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 MΩ.

5.3.6.3 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 MΩ.

5.3.7 Vibration test (aircraft fixed connector only)

One aircraft fixed connector shall be subjected to the vibration test defined in ISO 7137²⁾, except that there is no requirement to operate the equipment under test.

Wire the fixed connector to two size 00 cables, one to each main current-carrying male contact, and with a size 16 cable to the control male contact. The cables shall be secured to the vibration table at a distance of not less than 400 mm from the fixed connector.

The following severe vibration environment test curves²⁾ shall be used:

- vibration response survey, figure 8-6: curve W1;
- robustness test, sinusoidal, figure 8-6: curve W1;
- robustness test, random, figure 8-5: curve D1.

At the conclusion of the test, there shall be no signs of loosening of fixings or cable terminations.

1) Clause 14 of EUROCAE ED-14A/RTCA DO-160A.

2) Clause 8 of EUROCAE ED-14A/RTCA DO-160A.

5.3.8 Temperature and pressure test (aircraft fixed connector only)

Mount the aircraft fixed connector on a suitable panel in such a way that a differential air pressure can be applied between the two sides of the panel and leakage through the connector can be measured.

NOTE — This test is intended to detect leakage through the connector and not the connector/panel interface.

Place the aircraft fixed connector in a suitable chamber. Heat the chamber to $+ 105 \pm 1$ °C over a period of 3 h, and maintain at that temperature for at least 16 h. Allow the chamber and specimen contained in it to cool naturally for 7 h. Then reduce the temperature of the chamber to $- 65 \pm 1$ °C during the next 16 h, and maintain at that temperature for at least 4 h. Repeat this temperature cycle. At the end of the second 4 h period and while the aircraft fixed connector is still at the minimum temperature, apply a differential air pressure of 140 kPa between the two sides of the mounting panel, the positive pressure being applied on the aircraft side. The leakage of the aircraft plug shall not exceed 1 cm³/min.

5.3.9 Shock test (ground supply free connector only)

Drop the ground supply free connector, with 6 m of attached cable, ten times from a height of 3,6 m (12 ft) on to a concrete surface. For the test, the free end of the cable shall be fixed at a point allowing the cable to assume an angle of approximately 45° before the ground supply connector is released. The ground supply free connector shall then be subjected to the requirements of 5.3.11 using an appropriate aircraft fixed connector.

5.3.10 Fluids susceptibility test (initial qualification only)

Aircraft fixed connectors and ground supply free connectors shall be subjected, unmated, to the spray test defined in ISO 7137¹⁾ using test categories XC, XD, XF, XG, XJ, XL and XM. No fluid test marking requirements exist. Additionally they shall be tested in trichloroethane. Operation and compliance with ISO 7137 shall be demonstrated as follows:

- a) clean the connectors using trichloroethane and wipe dry with a clean dry cloth;
- b) they shall then meet the requirements of the high voltage and insulation resistance test (see 5.3.6);
- c) it shall be shown, to the satisfaction of the Approval Authority, that the complete connectors can be engaged and disengaged by hand.

5.3.11 Extremes of temperatures — Engagement and disengagement test

It shall be shown, to the satisfaction of the Approval Authority, that the complete connectors can be engaged and disengaged by hand at a temperature of $- 65$ °C and $+ 65$ °C.

6 Marking and ordering procedures

6.1 Marking

The connector housing shall be clearly marked, by either embossing or engraving, with the number of this part of ISO 461 and the style number, as specified in ISO 461/2.

Example:

ISO 461/1-1A

6.2 Ordering

The following information shall be given when ordering to this part of ISO 461:

- a) the number of this part of ISO 461;
- b) the style number and description, as specified in ISO 461/2;
- c) details of any marking required in addition to the requirements of 6.1;
- d) requirements for the provision of assembly instructions;
- e) packaging requirements.

1) Clause 11 of EUROCAE ED-14A/RTCA DO-160A.

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