IEC 63137-1

Edition 1.0 2019-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Standard test radio-frequency connectors –
Part 1: Generic specification – General requirements and test methods

Connecteurs d'essai normalisés pour fréquences radioélectriques –
Partie 1: Spécification générique – Exigences générales et méthodes d'essai

IEC 63137-1:2019-08(en-fr)

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STANDARD TEST RADIO-FREQUENCY CONNECTORS –

Part 1: Generic specification – General requirements and test methods

FOREWORD

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International Standard IEC 63137-1 has been prepared by subcommittee 46F: RF and microwave passive components, of IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
46F/459/FDIS	46F/470/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 63137 series, published under the general title *Standard test radio-frequency connectors*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of January 2020 have been included in this copy.

STANDARD TEST RADIO-FREQUENCY CONNECTORS –

Part 1: Generic specification – General requirements and test methods

1 Scope

This part of IEC 63137 defines general requirements for standard test radio frequency (RF) connectors (grade 0), including terms and definitions, ratings and characteristics, general requirements, test methods, quality assessment procedures, and etc.

Standard test radio frequency (RF) connectors (grade 0) are intended to measure grade 1 and grade 2 RF connectors for electrical performances. Typically, a standard test radio frequency (RF) connector (grade 0) is an adapter with one end (normally a precision connector interface) which can be connected with measurement equipment and the other end (normally a standard test connector interface) which can be connected with grade 1 or grade 2 connectors.

This specification applies to grade 0 standard test connectors (called connector, hereinafter).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60457-1, *Rigid precision coaxial lines and their associated precision connectors – Part 1: General requirements and measuring methods*

IEC 60617, *Graphical symbols for diagrams*

IEC 61169-1-2[1], *Radio frequency connectors – Part 1-2: Electrical test methods – Insertion loss*

IEC 61169-1-4:__[2], *Radio-frequency connectors – Part 1-4: Electrical test methods – voltage standing wave ratio, return loss and reflection coefficient*

IEC 62153-4-4 *Metallic communication cable test methods – Part 4-4: Electromagnetic compatibility (EMC) – Test method for measuring of the screening attenuation as up to and above 3 GHz, triaxial method*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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1 Under preparation. Stage at the time of publication: IEC/FDIS 61169-1-2:2019.

2 Under preparation. Stage at the time of publication: IEC/CDV 61169-1-4:2019.

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
standard test connector: Grade 0
precisely made connector of a particular type used to carry out return loss measurements on Grade 1 and Grade 2 connectors, contributing only negligible errors to the measuring result

Note 1 to entry: The standard test connector is often part of an inner-type adaptor which allows connection with a precision connector forming part of the measuring equipment.

3.2
precision connector
connector that has coincident mechanical and electrical reference planes, air dielectric, and has the property of making connections with a high degree of repeatability without introducing significant reflections, loss or leakage

Note 1 to entry: It is intended for mounting on air-lines and instruments. Precision connectors can be of the hermaphroditic type, flange type or of the pin and socket type as stated in IEC 60457-1.

3.3
within-type adaptor
adaptor for use between two or more connectors all of the same type

3.4
inter-type adaptor
adaptor for use between two or more connectors of different types

3.5
ellipticity
ratio of the difference between the maximum inner diameter of outer conductor or the maximum outer diameter of inner conductor and the minimum inner diameter of outer conductor or minimum outer diameter of inner conductor, to the nominal inner diameter of outer conductor, or outer diameter of inner conductor, expressed as a percentage

Use Formula (1):

$$E = \frac{D_{\text{max}} - D_{\text{min}}}{D_{\text{nom}}} \times 100\,(\%) \tag{1}$$

where

E is the ellipticity of inner or outer conductor;

D_{nom} is nominal inner diameter of outer conductor, or outer diameter of inner conductor, in mm;

D_{max} is the measured maximum inner diameter of outer conductor, or maximum outer diameter of inner conductor, in mm;

D_{min} is the measured minimum inner diameter of outer conductor, or minimum outer diameter of inner conductor, in mm.

Note 1 to entry: The measurements for D_{max} and D_{min} should be made at the same cross section.

3.6
eccentricity
ratio of the axial deviation between outer diameter of an inner conductor and inner diameter of an outer conductor to the nominal inner diameter value of the outer conductor, expressed as a percentage

Use Formula (2):

$$E = \frac{e}{D} \times 100\ (\%) \tag{2}$$

where

E is inner to outer conductor eccentricity;

e is axial deviation between outer diameter of inner conductor and inner diameter of outer conductor, in mm;

D is nominal inner diameter value of outer conductor, in mm.

3.7
repeatability without rotation
maximum measured difference in the specified parameter of a connector pair between the extreme values of measurements of this parameter during the specified number of connect/disconnect cycles at fixed angular orientation (i.e. without rotation)

Note 1 to entry: For example, the repeatability shall not exceed the specified values for return loss $|S_{11}|$, insertion loss $|S_{21}|$, phase $\Delta\arg|S_{11}|$, etc..

3.8
repeatability with rotation
maximum measured difference for return loss magnitude and insertion loss magnitude with rotation

Note 1 to entry: Determine the extreme values during rotation of connector orientation of 16 approximately 45° increments over two complete 360° cycles.

4 Design and construction

4.1 General

The connectors shall be designed and constructed to ensure these features including adequate accuracy, uniform impedance, long mechanical durability, and good repeatability. The relevant specification is not intended to restrict those designs and dimensions for details of construction which do not influence interchangeability or performance, nor are they to be used as manufacturing drawings.

All of mechanical drawings shall be made as specified in IEC 60617. The dimensions and tolerances shall be given in metric units. During conversion of dimensions given in inches into millimetres, they shall, in principle, be rounded to the nearest 0,000 1 mm or 0,000 05 in.

4.2 Materials and finishes

The materials and finishes used for the connectors shall be as specified in the safety, environmental regulations and the relevant specifications. Dissimilar metals between which an electromotive couple may exist shall not be placed in contact with each other.

4.3 Connector interface dimensions and gauge

The interface dimensions and gauge for the connectors shall be as specified in the relevant specifications.

5 Standards ratings and characteristics

The ratings and characteristics applicable to each connector type and style shall be specified in the specification. They should normally include:

a) the return loss as a function of frequency;

b) any other rating or characteristic, as applicable.

6 IEC type designation

The purpose of the IEC type designation is to identify a particular connector within the scope of IEC RF connector standardization. It is not intended to include information in excess of this.

In practice, it is usually necessary to identify a manufacturer's product because, although complying with the IEC standard, there may be features not covered by the standard.

The connectors complying with the relevant specification shall be designated by the following information:

a) the number of the specification;

b) the letters "IEC";

c) the series codes of both interface ends of the connector (series code-polarity code). For example:

   1) for inter-type adapters, “2.4-F/SMP-M” denotes that one end is 2.4 series female connector interface, and the other end is SMP series male connector interface;

   2) for within-type adapters, “2.4-F/M” denotes that one end is 2.4 series female connector interface, and the other end is 2.4 series male connector interface;

d) additional indication method as specified in the relevant specification.

NOTE When an IEC type designation is used, either for the marking of the product or in a description of the product, it is the responsibility of the manufacturer to ensure that the item meets the requirements of the relevant specification.

7 Requirements and test methods

7.1 General

Unless otherwise specified, the following conditions shall be applied.

Measurements for mechanical and electrical performances shall be carried out under these ambient conditions: at 20 °C to 30 °C temperature, 20% to 80% relative humidity, and 86 kPa to 106 kPa atmospheric pressure.

The connectors shall be preconditioned under the ambient conditions, as specified above, to reach thermal stability before measurements are made.

When a nominal value only is given for an applied stress and/or the duration of application, the specified value shall be taken to indicate the minimum test severity to be applied.

The test shall be carried out with connectors – as received from the supplier. In no case shall the contact parts be cleaned or otherwise prepared prior to tests, unless explicitly specified in the specification.

Nominal coupling torque value shall be specified for screw-coupled connectors in the relevant specification.

7.2 Visual inspection

7.2.1 Requirements

a) Workmanship

The connectors shall be manufactured in a precise manner. Connectors and associated fittings shall be processed in such a manner as to be uniform in quality and shall be free from visible sharp edges, burrs and other defects that will affect life, serviceability or appearance.

b) Deterioration after electrical and mechanical tests

Unless otherwise specified, there shall be no visible deterioration likely to influence the performance.

c) Marking

It shall be correct in accordance with 9.1, and be legible after any of the specified tests.

d) Marking on the package

It shall be in accordance with 9.2.

7.2.2 Inspection procedure

The inspection will be performed visually or under a magnification as specified in the relevant specification.

7.3 Dimensions and interchangeability

7.3.1 Requirements

7.3.1.1 Dimensions

Interface dimensions and outline dimensions for the connectors shall be as specified in the relevant specification.

7.3.1.2 Interchangeability

The connectors shall be connected and disconnected normally with their mating counterparts.

7.3.2 Inspection procedure

The connectors shall be inspected as follows:

a) inspection for interface dimensions shall be performed by mating the gauge specified in the relevant specification with the connector;

b) inspection for outline dimensions shall be performed using measuring tool with adequate accuracy;

c) inspection for interchangeability shall be performed by mating the connector with at least three counterparts, respectively.

7.4 Ellipticity

7.4.1 Requirements

The ellipticity of inner and outer conductor of the connector shall not exceed limit value, as given in the relevant specification.

7.4.2 Inspection procedure

The diameters of inner and outer conductors of connectors shall be measured using a measuring tool with adequate accuracy. Then calculate the ellipticities from Formula (1).

7.5 Characteristic impedance

7.5.1 Requirements

Unless otherwise specified in the relevant specification, an error in the characteristic impedance caused by the most adverse combination of diameter tolerances and eccentricity of the inner and outer conductors used in constructing a standard test connector shall not more than the value specified in the relevant specification.

7.5.2 Inspection procedure

The diameters of inner and outer conductor of the connector as well as axial deviation between outer diameter of inner conductor and inner diameter of outer conductor shall be measured using a measuring tool with adequate accuracy.

Then calculate the eccentricities from Formula (2).

The characteristic impedance shall be calculated from Formula (3).

$$Z_0 = \frac{60}{\sqrt{\varepsilon_r}} \times \ln\frac{D}{d} = \frac{138}{\sqrt{\varepsilon_r}} \times \log\frac{D}{d} \tag{3}$$

where

ε_r is relative permittivity of the dielectric;

D is effective inner diameter of the outer conductor, in mm;

D is effective outer diameter of the inner conductor, in mm;

Z_0 is characteristic impedance, in Ω.

Variation of the characteristic impedance due to diameter tolerances of the inner and outer conductors shall be calculated from Formula (4).

$$\Delta Z_0 = \frac{60}{\sqrt{\varepsilon_r}} \left(\frac{\Delta D}{D} - \frac{\Delta d}{d} \right) \tag{4}$$

where

Δd is diameter tolerances of the outer diameter of the inner conductor, in mm;

ΔD is diameter tolerances of the inner diameter of the outer conductor, in mm;

ΔZ_0 is variation of the characteristic impedance, in Ω.

Variation of the characteristic impedance due to inner to outer conductor eccentricity shall be calculated from Formula (5).

$$\Delta Z_0 \approx -240 \left(\frac{e^2}{D^2 - d^2} \right) \tag{5}$$

When the characteristic impedance is 50 Ω, Formula (5) may be simplified as the following:

$$\Delta Z_0 \approx -296\left(\frac{e^2}{D^2}\right) = -296E^2 \quad (6)$$

where

Z is impedance, in Ω;

E is inner to outer conductor eccentricity;

e is axial deviation between outer diameter of inner conductor and inner diameter of outer conductor, in mm.

7.6 Electrical inspections

7.6.1 Return loss

7.6.1.1 Requirements

Return loss of connectors shall be in accordance with the value specified in the relevant specification over the whole frequency range.

7.6.1.2 Test procedure

The test shall be performed using time domain method as specified in 7.2 in IEC 61169-1-4:__[3].

7.6.1.3 Information to be given in the relevant specification

The following information shall be given in the relevant specification:

a) frequency range to be measured;

b) minimum return loss value;

c) details of the connector to be mated to the connector under test (or detail drawing);

d) necessary characteristics of the appropriate precision terminal load;

e) any deviation from the standard test method.

7.6.2 Return loss repeatability

7.6.2.1 Requirements

The maximum differences for the return loss of connectors shall not exceed the value specified in the relevant specification over the whole frequency range.

7.6.2.2 Test procedure

a) Test without rotation:

The connector to be tested shall be connected into the test system, and tested as specified in 7.6.1. The following details shall be applied:

1) calibration: calibrate measurement system by using an open/short/load (termination) at the end of precision airline;

2) connect the connector to be tested and behind parts to the end of precision airline, and the resulting return loss S_{11} is observed and stored;

3) disconnect the connector to be tested, and then connect it again. The resulting return loss S_{11} is observed and stored again;

4) repeat step 3), and do five times;

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[3] Under preparation. Stage at the time of publication: IEC/CDV 61169-1-4:2019.

5) calculate the maximum difference among six test results at any frequency point.

b) Test with rotation:

The connector to be tested shall be connected into the test system, and tested as specified in 7.6.1. The following details shall be applied:

1) calibration: calibrate measurement system by using an open/short/load (termination) at the end of precision airline;

2) connect the connector to be tested and behind parts to the end of precision airline, and the resulting return loss S_{11} is observed and stored;

3) disconnect the connector to be tested and then connect it gain. Rotate it with 45° increments. The resulting return loss S_{11} is observed and stored again;

4) repeat step 3), and do sixteen times; and obtain sixteen test results over two complete 360° cycles.

5) Calculate the maximum difference among all test results at any frequency point.

7.6.2.3 Information to be given in the relevant specification

The following information shall be given in the relevant specification:

a) test frequency range;

b) requirements for return loss repeatability;

c) details of the connector to be mated to the connector under test (or detail drawing);

d) necessary characteristics of the appropriate precision terminal load;

e) any deviation from the standard test method.

7.6.3 Insertion loss

7.6.3.1 Requirements

Insertion loss of connectors shall not exceed the value specified in the relevant specification over the whole frequency range.

7.6.3.2 Test procedure

The test shall be performed as specified in IEC 61169-1-2.

7.6.3.3 Information to be given in the relevant specification

The following information shall be given in the relevant specification:

a) test frequency range;

b) limit value of insertion loss;

c) details of the connector to be mated to the connector under test (or detail drawing);

d) any deviation from the standard test method.

7.6.4 Insertion loss repeatability

7.6.4.1 Requirements

Numeric differences for the insertion loss of connectors shall not exceed the value specified in the relevant specification over the whole frequency range.

7.6.4.2 Test procedure

a) Test without rotation

Perform measurement of insertion loss as in 7.6.3. The following details shall be applied: