IEC 61169-1-6

Edition 1.0 2022-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Radio-frequency connectors –
Part 1-6: Electrical test methods – RF power

Connecteurs pour fréquences radioélectriques –
Partie 1-6: Méthodes d'essai électrique – Puissance RF

IEC 61169-1-6:2022-02(en-fr)

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RADIO-FREQUENCY CONNECTORS –

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FOREWORD

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IEC 61169-1-6 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. It is an International Standard.

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

Draft	Report on voting
46F/598/FDIS	46F/612/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 61169 series, published under the general title *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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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RADIO-FREQUENCY CONNECTORS –

Part 1-6: Electrical test methods – RF power

1 Scope

This part of IEC 61169 provides test methods for RF power rating and power handling of RF connectors at specified frequency, temperature and altitude.

This document is applicable to cabled RF connectors, microstrip RF connectors and RF connector adapters. It is also suitable to test RF channels in multi-channel RF connectors and hybrid connectors.

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 61169-1, *Radio frequency connectors – Part 1: Generic specification – General requirements and measuring methods*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61169-1 and the following apply.

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

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

3.1
power rating
input power at which neither peak working voltage nor maximum dielectric temperature for an RF connector is exceeded, if it is terminated

Note 1 to entry: See Annex A for typical dielectric materials for RF connectors and their maximum withstanding temperatures.

3.2
average power
power that is averaged over the defined frequency range and periods at the specified temperature and altitude and that can be handled by RF connectors

3.3
peak power
maximum power P_{max} that the RF connectors shall withstand for a pulse duration τ over a period T with a duty cycle R at the specified temperature and altitude, where the relationship between duty cycle, pulse duration, and period is expressed by formula (1)

Note 1 to entry: See Figure 1.

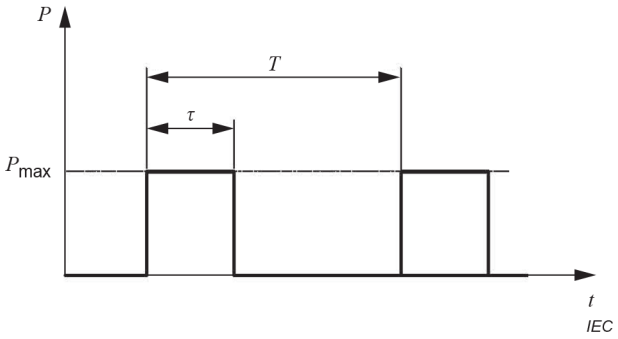

Figure 1 – Illustration of peak power

$$R = \frac{\tau}{T} \times 100(\%) \quad (1)$$

where

R is the duty factor, in %;

τ is the pulse duration, in s;

T is the period of pulse, in s.

3.4
continuous wave power
power transmitted in almost a straight line whose duty factor R = 1 in Formula (1)

3.5
power handling
ability of the RF connectors to handle the power specified in the relevant specification at the stated temperature, altitude and frequency

4 Preparation of test sample (TS)

4.1 Cabled RF connector

The cabled RF connector shall be made into a double-ended cable assembly as a test sample (TS) using a length of pre-selected RF cable with a power capacity greater than the connector.

4.2 Microstrip connector

The microstrip connector shall be provided with an appropriate test fixture at the microstrip end as specified in the relevant specification, and the microstrip connector with test fixture as a whole should be treated as a test sample (TS).

4.3 Adapter

The adapter shall be tested directly or indirectly by being mated to additional adapters at the ends that are suitable for the test setup interfaces and sufficient to meet the power capability requirements of the test. An adapter is just a test sample (TS). When the adapter is needed, the power capacity of the adapter should be greater than that of the sample.

When needed, it is recommended to drill a small hole in the test sample (TS) on the inner conductor to place a thermodetector (such as a fiber optic temperature sensor) to measure the temperature of the inner conductor.

5 Test conditions

The stability of test conditions includes temperature stability and altitude stability.

a) Temperature stability:

When the change of temperature of the test sample is not more than ± 2 °C in 5 min, the temperature shall be considered stabilized.

When the chamber is used for testing and the change of temperature of the chamber and the test sample have been not more than ± 2 °C in 5 min, the temperature shall be considered stabilized.

b) Altitude stability:

When requirements are specified for pressure in the relevant specifications, the altitude of the low-pressure test chamber that is stable within the range of ±5 % of the specified value in 10 min is considered a stable altitude.

6 Test principle

A combination of power source, directional coupler, fixed attenuator (when required) and power meter is used for the test, as shown in Figure 2. When the incident power P_i passes through the coupler, the coupling power P_f is produced at its coupling port, and then is attenuated to the range of the power meter by a fixed attenuator (when necessary), so as to obtain the indication value of power P_0.

Since the coupling factor C (calculated from Formula (2)) of coupler and attenuation value D (calculated from Formula (3)) of the fixed attenuator are invariable, the actual incident power of the sample can be obtained from Formula (4).

$$C = 10\lg\frac{P_i}{P_f} \tag{2}$$

$$D = 10\lg\frac{P_f}{P_g} \tag{3}$$

$$P = P_0 + D + C \tag{4}$$

where

C is the coupling factor of the coupler, in dB;

D is the attenuation of the fixed attenuator, in dB;

P_i is the incident power of the test system, in dB;

P_f is the power value of the coupling end of the coupler, in dB;

P_g is the power value attenuated by the fixed attenuator, in dB;

P is the measured power value, in dB;

P_0 is the indicated value by power meter, in dB.

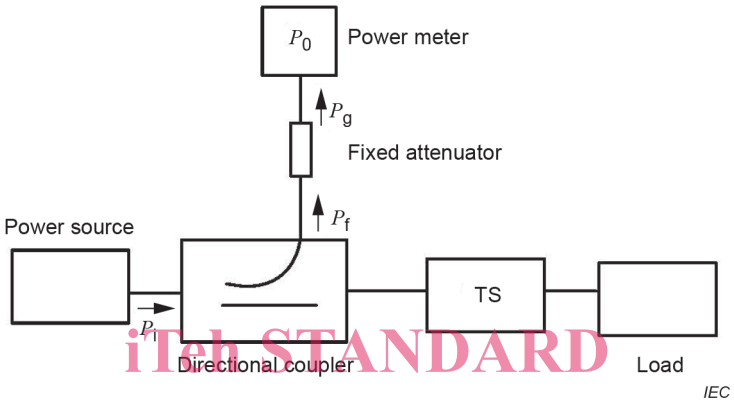

Figure 2 – Test principle

7 Test equipment

Test equipment is as follows:

a) Power source, directional coupler, fixed attenuator, power meter, high-power load (or absorber), etc. The rated power of selected couplers, fixed attenuators, high-power loads and other devices shall be more than 2 to 2,5 times the maximum power measured, to prevent the devices from burning out due to overheating in case of nonsteady power.

b) The thermodetector shall be able to measure inner and outer conductor temperatures, and have sufficient sensitivity with an accuracy of ±1 °C.

c) Temperature - altitude test chamber (if applicable) shall meet the test requirements stated in the relevant specifications.

d) For the power rating test, the voltage standing wave ratio (VSWR) of the load should be less than 1,05; for power handling tests, unless otherwise specified, VSWR of the load shall not be less than 1,75.

e) A test room to prevent air circulation, e.g. of fans of the climatic cabinet. If necessary, the test room should fit the climatic cabinet and be large enough so that the test items can be 20 cm (8 in) away from the walls of the test room.

8 Test procedure

8.1 Average power / Continuous wave power rating

8.1.1 Average power rating test

The test procedure is as follows:

a) The insertion loss and VSWR of the sample shall be measured in accordance with IEC 61169-1-2 and IEC 61169-1-4 respectively. The measured values shall be as specified in the relevant specification.

b) Connect the test sample (TS) to the power test system as shown in Figure 2, and use the thermodetector to monitor the inner conductor temperature t_i, and the outer conductor temperature t_o as well as the test environment temperature t_e, respectively. Record the temperature values t_i, t_o and t_e individually, at the time when the temperature is stabilized.

c) Set test parameters: test frequency and average power / continuous wave power (a lower estimated value), and start the test.

d) Continue the test for a sufficient time to stabilize the temperature at this frequency and power, and then record the temperature values t_i and *t*o at this time

e) At this frequency, slowly increase the power until the temperature t_i of the inner conductor reaches the maximum temperature that the sample can withstand and is stabilized at this level. The power at this point is power rating at this frequency. Record the power P, the inner conductor temperature t_i and the outer conductor temperature t_o at this time.

f) After the test, take out the sample, and when the inner conductor temperature t_i and outer conductor temperature t_o are restored to room temperature or standard test atmosphere, the VSWR of the sample shall be measured in accordance with IEC 61169-1-4, and shall comply with the relevant specification.

g) When environmental temperature and altitude are required, the sample shall be placed in the temperature-altitude test chamber and tested in accordance with steps from b) to f). The temperature and altitude of the test chamber shall be monitored during the test.

8.1.2 Conversion of average power rating at other frequencies

In the operating frequency range of an RF connector, when the average power rating at a certain frequency is known, the average power rating at the other frequency can be converted from that known average power rating using the insertion loss values at that frequency and at any other frequency through Formulae (5) and (6).

$$P_{if1} \times (1 - 10^{-\frac{\alpha_{f1}}{10}}) = P_{if2} \times (1 - 10^{-\frac{\alpha_{f2}}{10}}) \quad (5)$$

When $\alpha_{f1} \leq 1$ and $\alpha_{f2} \leq 1$, Formula (5) can be simplified as Formula (6) as follows:

$$P_{if1} \times \alpha_{f1} = P_{if2} \times \alpha_{f2} \quad (6)$$

where

α_{f1} is the attenuation of RF connector at frequency f_1, in dB;

α_{f2} is the attenuation of RF connector at frequency f_2, in dB;

P_{if1} is the average power rating at frequency f_1, in W;

P_{if2} is the average power rating at frequency f_2, in W.

8.1.3 Conversion of average power rating at different environment temperatures

Average power ratings at different environment temperatures from 15 °C to 40 °C can be converted to the average power ratings at 40 °C. When a test at 40 °C standard ambient temperature is required in the relevant specification, the following approximate Formula (7) can be used to convert the average power rating at a certain environment temperature to the average power rating at 40 °C:

$$P = P_1\left(\frac{t-T}{t_1-T_1}\right)^{1,14} \tag{7}$$

where

T_1 is the ambient temperature from 15 °C to 40 °C during the test, in °C;

T is the standard ambient temperature (40 °C), in °C;

t_1 is the measured inner conductor temperature, from (t − 15) to t, in °C;

t is the maximum inner conductor temperature (as specified in the relevant specification);

P_1 is the input power measured under conditions t_1 and T_1, in W;

P is the power rating (at limit temperature), in W.

The conditions for Formula (7) are as follows:

a) Test environment temperature T_1 ranges from 15 °C to 40 °C;

b) For the test, the temperature of the inner conductor shall not be less than 15 °C below the maximum allowable temperature between (t − 15) and t.

8.1.4 Average power rating estimation

When it is not possible to test the average power rating directly, the average power rating can be estimated using the method shown in Annex B.

8.2 Power handling

8.2.1 Average power / Continuous wave power

The test procedure is as follows:

a) The insertion loss and VSWR of the sample shall be measured in accordance with IEC 61169-1-2 and IEC 61169-1-4 respectively. The measured values shall be as specified in the relevant specification.

b) Connect the test sample (TS) to the power test system as shown in Figure 2, and use the thermodetector to monitor the temperature of the test sample.

c) The test sample (TS) shall be placed in the temperature and/or altitude test chamber for testing when the temperature and/or altitude are specified in the relevant specification. Temperature and/or air pressure in the temperature and/or altitude test chamber shall conform to the relevant specification and shall be monitored throughout the test.

d) Set test parameters: test frequency and average power / continuous wave power.

e) Keep the test at that frequency and power for the period specified in the relevant specification. The temperature of the sample should be recorded when required in the relevant specification.