IEC 61169-1

Edition 2.0 2013-07

INTERNATIONAL STANDARD

colour inside

Radio frequency connectors –
Part 1: Generic specification – General requirements and measuring methods

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE XA

ICS 33.120.30

ISBN 978-2-8322-0925-7

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

RADIO FREQUENCY CONNECTORS –

Part 1: Generic specification – General requirements and measuring methods

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61169-1 has been prepared by subcommittee 46F: R.F. and microwave passive components, of IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories.

This second edition cancels and replaces the first edition, published in 1992, its Amendments 1 (1996) and 2 (1997). This edition constitutes a technical revision.

With respect to the previous edition, tests methods have been updated as well as terminology.

The text of this standard is based on the following documents:

CDV	Report on voting
46F/216/CDV	46F/226/RVC

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

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

A list of all the 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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

RADIO FREQUENCY CONNECTORS –

Part 1: Generic specification – General requirements and measuring methods

1 Scope

This part of IEC 61169, which is a generic specification, relates to radio frequency connectors for r.f. transmission lines for use in telecommunications, electronics and similar equipment.

It provides the basis for the sectional standards, which apply to individual connector types. It is intended to establish uniform concepts and procedures concerning:

– terminology;
– standard ratings and characteristics;
– testing and measuring procedures concerning electrical, mechanical and climatic properties;
– classification of connectors with regard to climatic testing procedures involving temperature and humidity.

The test methods and procedures of this standard are intended for acceptance and type approval testing.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available from: http://www.electropedia.org)

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:1990, *Environmental testing – Part 2-1: Tests – Test A: Cold*[1]

IEC 60068-2-2:1974, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*[2]

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-11, *Environmental testing – Part 2-11: Tests – Test Ka: Salt mist*

IEC 60068-2-13, *Environmental testing – Part 2-13: Tests – Test M: Low air pressure*

IEC 60068-2-14:2009, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-17, *Environmental testing – Part 2-17: Tests – Test Q: Sealing*

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[1] This publication has been withdrawn.

[2] This publication has been withdrawn.

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-29, *Environmental testing – Part 2: Tests – Test Eb and guidance: Bump*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-42, *Environmental testing – Part 2-42: Tests – Test Kc: Sulphur dioxide test for contacts and connections*

IEC 60068-2-52:1996, *Environmental testing – Test Kb: Salt mist, cyclic (sodium, chloride solution)*

IEC 60068-2-54, *Environmental testing – Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method*

IEC 60068-2-61:1991, *Environmental testing – Part 2-61: Test methods – Test Z/ABDM: Climatic sequence*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

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* (available from: http://std.iec.ch/iec60617)

IEC 62153 (all parts), *Metallic communication cables test methods*

IEC 61726, *Cable assemblies, cables, connectors and passive microwave components – Screening attenuation measurement by the reverberation chamber method*

IEC 62037 (all parts), *Passive RF and microwave devices, intermodulation level measurement*

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units*[3]

3 Terms and definitions

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

NOTE Some of the terms defined are not used in the present document, but may be used in the different sectional specifications.

3.1 General, parts of connectors

3.1.1
contact (electrical)
state in which individual electrically conductive parts are in such close mechanical touch as to provide a low resistance path to electrical current in either direction

3.1.2
contact
conductive element in a component which mates with a corresponding element to provide an electrical path (to provide electrical contact)

[3] This publication has been withdrawn.

3.1.3
male (pin) contact
contact intended to make electrical engagement on its outer surface and which will enter a female (socket) contact

3.1.4
female (socket) contact
contact intended to make electrical engagement on its inner surface and which will accept entry of a male (pin) contact

3.1.5
hermaphroditic contact
contact which is intended to mate with an identical contact

3.1.6
resilient contact
contact having elastic properties to provide a force to its mating part

3.2 Basic connector terms

3.2.1
connector
component normally attached to a cable or mounted on a piece of apparatus (excluding an adaptor) for electrically joining separable parts of a transmission line system

3.2.2
connector pair
two connectors having complementary mating faces and locking means, so as to be mateable and interlockable

3.2.3
series type
terms characterizing the particular mating faces and locking means of a connector pair with regard to construction and dimension

Note 1 to entry: The term "series" is sometimes used as an approximate synonym of 'type' for designating the entirety of connector styles with identical mating face and locking means.

3.2.4
style
particular form or shape of connector, as well as a combination of connectors of the same type

Note 1 to entry: For "adaptor", see 3.5.1 to 3.5.5: a 'within-type adaptor" may also be considered as a particular style of a given type.

Note 2 to entry: Examples are: free and fixed connectors, both straight and right angle, within-type adaptors straight and right angle.

3.2.5
variant
variation of a style, in particular details, such as cable-entry dimensions

3.2.6
grade
qualification of a connector with regard to mechanical and electrical precision in particular with respect to a defined return loss

3.2.7
general purpose connector: Grade 2
connector making use of the widest permitted dimensional deviations (tolerances) so as still to guarantee minimum stated performance and intermateability

Note 1 to entry: A requirement for the return loss may or may not be specified.

3.2.8
high performance connector: Grade 1
connector for which limits of return loss are specified as a function of frequency.

Note 1 to entry: No tighter dimensional tolerances than those applicable to Grade 2 are normally specified. The manufacturer is responsible, however, for choosing tighter tolerances where necessary to ensure that the return loss requirements are met.

3.2.9
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.

3.2.10
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.

3.2.11
laboratory precision connector
LPC
precision connector without dielectric support for the centre conductor

3.2.12
general precision connector
GPC
precision connector with self-contained dielectric support capable of supporting the un-supported centre conductor of an LPC and standard air-line which it is mated

3.3 Constructional terms

3.3.1
male connector/pin connector
connector containing a male (pin) centre contact

3.3.2
female connector/socket connector
connector containing a female (socket) centre contact

3.3.3
plug connector
connector featuring the active part of the coupling mechanism, i.e. the nut or bayonet ring, and which normally is a free contact

Note 1 to entry: Depending on the particular type, a plug may be a male or female connector.

3.3.4
socket
connector complimentary to the plug

3.3.5
hermaphroditic connector
connector which mates with an identical connector

3.3.6
free connector
connector for attachment to a free end of a cable

Note 1 to entry: If not specified as fixed, a connector is assumed to be free.

3.3.7
fixed connector
connector with provision for attachment to a mounting surface

3.3.8
triaxial
transmission line comprising three concentric conductors having a common axis and with each conductor insulated from the other two

3.4 Sealing

3.4.1
sealed connector
connector employing a seal capable of fulfilling specified gas-, moisture- or liquid tightness requirements

3.4.2
barrier seal
seal preventing the passage of gases, moisture or liquids in an axial direction within the body shell of a connector

3.4.3
panel seal
seal preventing the passage of gases, moisture or liquids between the fixed connector or adaptor body shell and the panel via the mounting hole(s)

Note 1 to entry: The sealing member is often provided as a discrete item.

3.4.4
mating face seal
seal preventing the passage of gases, moisture or liquids into the interface space of a pair of mated connectors

3.4.5
hermetic seal
seal meeting the requirements specified on application of Test Qk of IEC 60068-2-17

3.5 Miscellaneous terms

3.5.1
adaptor
two-port device for joining two transmission lines having non-mating connectors

3.5.2
fixed adaptor
adaptor with provision for attachment to a mounting surface

Note 1 to entry: If not specified as fixed, an adaptor is assumed to be free.

3.5.3
within-type adaptor
adaptor for use between two or more connectors all of the same type

3.5.4
inter-type adaptor
adaptor for use between two or more connectors of different types

3.5.5
standard test adaptor
inter-type adaptor for test purposes, having a standard test connector at one end and a precision connector at the other end

3.5.6
standard air line
homogenous air dielectric transmission line having the smallest possible irregularities in diameter and straightness of conductors, no self-contained supports for the inner conductor and using non-magnetic material with good conductivity

3.5.7
reference line
air-line similar to the standard air-line but with dielectric support of the inner conductor, and with a design such that the internal return loss is kept at a minimum within the frequency range made use of for measurements

3.5.8
proof coupling torque
maximum torque to be applied to the screw-coupling mechanism of a specific connector series for testing the mechanical strength of the coupling mechanism

3.5.9
normal coupling torque
maximum/minimum values of torque to be applied in normal use to the coupling of screw type connectors

3.5.10
engagement and separation torque
torque required to overcome friction, compression of springs, etc. during the engagement and separation of connectors with rotary type coupling mechanisms before or after complete engagement

Note 1 to entry: This is intended to check for undue tightness of threads, burrs on bayonet-cams, freedom of rotation of coupling rings, etc.

3.5.11
push-on
connectors with interfaces that engage/disengage in an axial direction

3.6 General electrotechnical terms

3.6.1
nominal value
typical value used to designate or identify a component, device or equipment

Note 1 to entry: It follows from the definition that a nominal value is not subject to tolerances.

Note 2 to entry: Typical and nominal are interchangeable.

3.6.2
limiting value
in a specification, the greatest and/or smallest admissible value of one of the quantities

3.6.3
rated value
operational values that are provided in the detailed specification

4 Units, symbols and dimensions

4.1 Units and symbols

Units, graphical symbols, letter symbols and terminology shall whenever possible, be taken from the following IEC publications:

60027: Letter symbols to be used in electrical technology.

60050: International Electrotechnical Vocabulary (IEV).

60617: Graphical symbols for diagrams.

Other publication:

ISO 1000: SI units and recommendations for the use of their multiples and of certain other units.

4.2 Dimensions

4.2.1 Details to be provided in relevant specifications

Each relevant specification shall provide the following.

a) Sufficient dimensional information on the mating faces of connectors should be provided to ensure intermateability and compliance with performance requirements.

b) Information on the connector envelope maximum dimensions shall be provided to enable the user to accommodate the connectors in their equipment.

c) The relevant specification is not intended to restrict details of construction which do not affect interchangeability or performance, nor are they to be used as manufacturing drawings.

4.2.2 Dimensional units to be used in specifications

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 0,001 mm or 0,000 05 in. Where, however, mechanical and electrical considerations permit, the rounding shall usually be to the nearest 0,01 mm or 0,000 5 in.

5 Standards ratings and characteristics

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

a) a short description of the connector construction stating in particular the inner diameter of the outer conductor and, if applicable, the preferable cable types to be used with the connector;

b) the return loss as a function of frequency for the different grades (if applicable) together with the conditions for which it is valid;

c) the working voltage at different altitudes (pressures);

d) the climatic categories;

e) any other rating or characteristic applicable.

6 Classifications into climatic categories

The classification of connectors with regard to climatic conditions is based on IEC 60068-1 and indicated by a series of three sets of digits separated by oblique strokes corresponding respectively to tests at low temperature (minus sign not shown), high temperature and the number of days of exposure to damp heat, steady state.

The climatic severities are referenced by a cold temperature, high temperature and damp heat steady state duration. Examples of climatic category of this are shown in Table 1:

Table 1 – Preferred climatic categories (see IEC 60068-1)

Category designation	Letter	Temperature range	Damp heat steady state
40/85/21	A	–40 °C to +85 °C	21 days
55/125/21	B	–55 °C to +125 °C	21 days
55/155/56	C	–55 °C to +155 °C	56 days

7 IEC type designation

The purpose of the IEC type designation is to identify a particular connector within the scope of IEC r.f. 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.

Connectors complying with the relevant specification shall be designated by the following indications and in the order given:

a) the number of the specification;

b) the letters "IEC";

c) additional identification as indicated 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.

8 Testing

Unless otherwise specified, the following conditions shall apply:

a) tests shall be carried out under standard atmospheric conditions for testing as specified in IEC 60068-1;

b) before measurements are made, the connectors shall be preconditioned under standard atmospheric conditions for testing for a time sufficient to allow the entire connector to reach thermal stability;

c) recovery conditions for the interval after a conditioning and the next measurement of test shall be in accordance with IEC 60068-1.

The test schedule is shown in 10.3 and details of conditioning in 9.4.1.

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 stated in the specification.

If it is required that a cable shall be attached to a connector, this shall be done in accordance with the connector manufacturer's instructions.

Mated sets of connectors shall be fully engaged and screw-coupled connectors shall be tightened to the normal coupling torque quoted in the relevant specification.

In the case of mounted connectors subjected to environmental conditioning, care shall be taken to ensure that the back-of-panel portion of such fixed connectors, when appropriate, is protected.

For tests involving exposure to extreme temperatures, a cable with appropriate temperature capability should be used.

9 Test methods

9.1 Mechanical inspection

9.1.1 Visual inspection

Visual inspection shall include a check on

a) the marking: it shall be correct in accordance with 11.1 and be legible after any of the specified tests;

b) the manufacture: it shall have been carried out in a careful and workmanlike manner;

c) deterioration after electrical, mechanical and climatic tests: unless otherwise specified, there shall be no visible deterioration likely to affect the performance;

d) the marking on the package: it shall be in accordance with 11.1.

9.1.2 Dimensions

9.1.2.1 General

The dimensions shall be checked and shall comply with those specified by the relevant specification.

Any suitable method may be used except that gauges shall be used when specified by the relevant specification.

9.1.2.2 Mechanical compatibility

The dimensions of the mating face shall be in accordance with the mating face drawings prescribed in the relevant specification. Use of compatibility gauges is optional. When used, specimens shall accept the gauges.

9.2 Electrical tests and measuring procedures

9.2.1 Return loss

9.2.1.1 General considerations

Return loss is useful for quantifying the level (amount) of the reflected signal due to the deviation from the nominal impedance and structural effects of the connector, which is useful when system performance is the primary interest.

The return loss of connectors shall be measured with the test specimen mated with a standard test connector. Adaptors shall be mated with standard test connectors on both sides.

The relevant specification for a particular connector shall also specify the pertinent standard test connector (connector of Grade O). Mated pairs of standard test connectors shall exhibit closest uniformity of characteristic impedance throughout the pair inclusive of the transitions to precision lines or cables.

Cable connectors shall be attached to an appropriate cable in accordance with the instructions supplied by the connector manufacturer. The cable to be used shall preferably be of the close tolerance type.

9.2.1.2 Frequency domain test

9.2.1.2.1 Test equipment

A vector network analyzer (VNA) capable of performing s-parameter measurements using calibration standards (open, short, load) is recommended.

A vector network analyser is a test system that enables the RF performance of radio frequency (RF) and microwave devices to be characterised in terms of network scattering parameters, or S parameters.

The return loss of the connector(s) under test shall be measured with the VNA over the specified frequency range of interest.

A detailed description of the error correction (calibration) procedure is given in the manual of the VNA.

Precision test connectors with small inherent reflections (see note below) shall be fitted on both ends of the test specimen to allow direct connection to the network analyzer, analyzer test leads and/or, terminating load.

NOTE Small inherent reflections ≤ 1,035:1 VSWR.

9.2.1.2.2 Procedure

The two-connector procedure uses cable of a known value attached to the connector.

Time domain reflectometry (TDR) shall be used to check the homogeneity of the measuring set-up, to localize imperfections and to examine the accuracy of the characteristic impedance of the sections of coaxial lines used.

When available on the network analyser, gating will be performed for removing errors due to the cable.

The procedure is illustrated in Figures 2 and 3.

The interconnecting cable of the connectors shall consist either of a prescribed cable of verified performance or an adequate cable simulator.

As a check of the accuracy of the system, it is recommended to repeat the measurements with the connector assembly reversed between the standard test connectors.

The typical return loss graphical symbols are described in Figure 1:

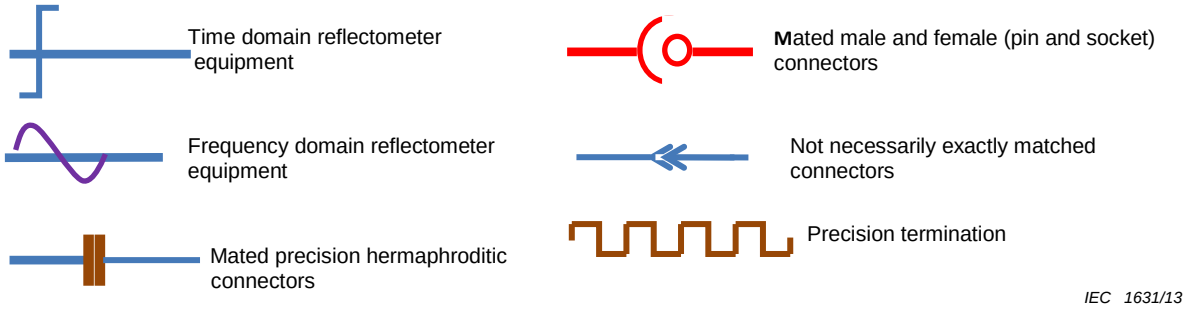


Figure 1 – graphical symbols

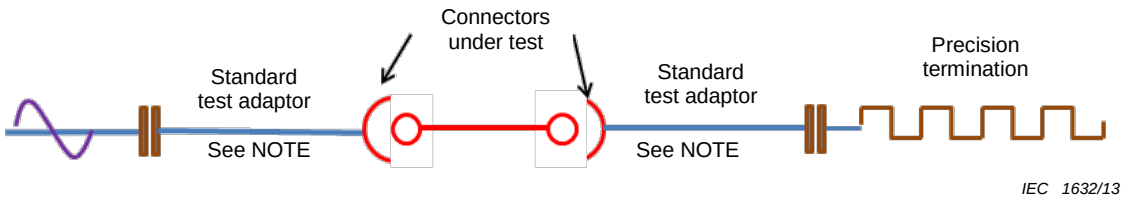


Figure 2 – General principle

NOTE Standard tests connectors are either directly used on the analyzer port, analyzer test leads and/or the precision termination or are connected through standard test adaptors.

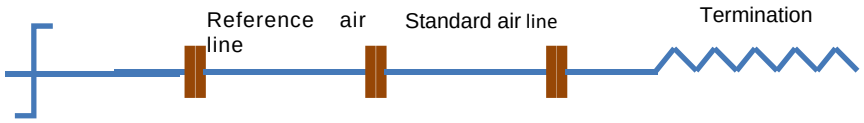
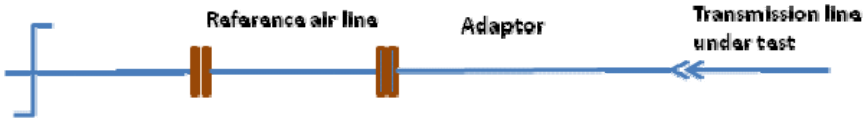
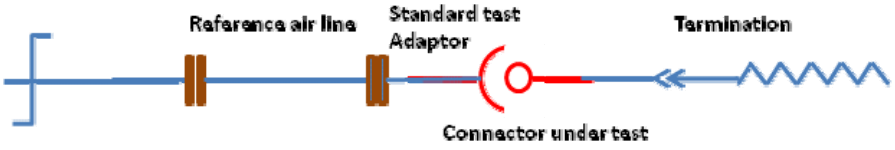
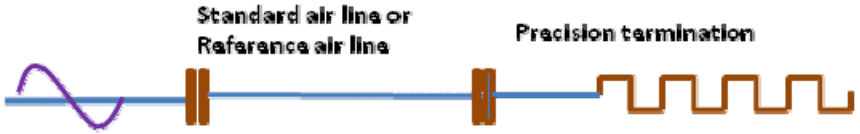
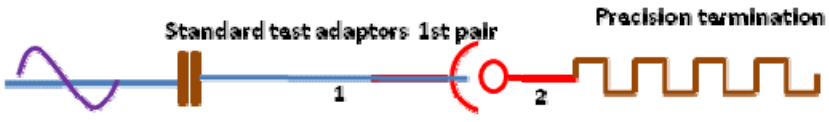
Purpose	Test method	Notes
Selection and verification of reference line by comparison with standard air line		
Selection and verification of transmission line for use during subsequent measurements by comparison with reference line		Adaptors need be neither precision or calibrated
Verification of performances of standard test adaptors		
Routine equipment check		Verification of equipment and termination errors
Additional equipment check		Verification of overall error
Verification of performance of standard test adaptors (1,2,3 and 4)		Standard test adaptors may also be checked cross-coupled and reversed
		

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Figure 3 – Measuring set-up for two-connector procedure

9.2.1.3 Method of time domain reflectometry (TDR)

9.2.1.3.1 Theoretical considerations

Assuming the incident signal has the ideal form of a step function, the reflected $s(f) = r(t)$ is converted to the complex return loss as a function of frequency by:

$$r(\omega) = j\omega \int_0^T s(t) \times e^{-j\omega t} \times \mathrm{d}t$$

where 0 to T is the time interval comprising the portion of $s(t)$ due to the reflection arising from the connector under test.

Restricting the upper frequency limit to values such that $\omega T < 1$, $e^{-j\omega t} = 1$ allows the expression to be simplified to:

$$r(\omega) = 2\pi f \int_0^T s(t) \times \mathrm{d}t = A \times f$$

$$A = 2\pi \int_0^T s(t) \times \mathrm{d}t$$

Figure 4 shows an example of a time-domain reflectometer recording.

NOTE As only the magnitude of the return loss is of importance, the sign of the reflected signal integral is omitted. A positive sign results from an inductive series, a negative sign from a capacitive parallel disturbing element.

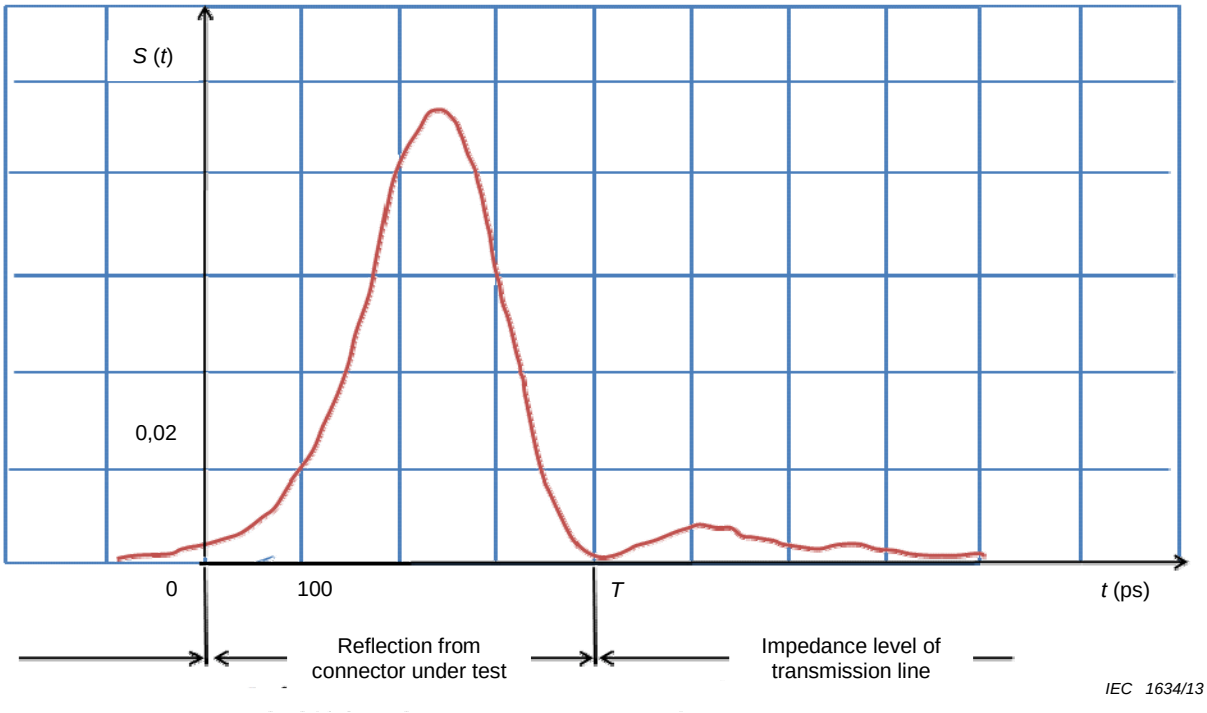


Figure 4 – Example of a time domain reflectometer measurement recording

In the example, the surface under the curve from 0 to T is:

$$\int_0^T s(t) \times \mathrm{d}t = 17{,}5 \text{ ps}$$

Therefore, at 100 MHz: r = 0,011.

9.2.1.3.2 Measuring procedure

The verification of the equipment and the elements used is carried out as shown in the first three boxes of Figure 3. The set-up for carrying out the measurement is illustrated by Figure 5.

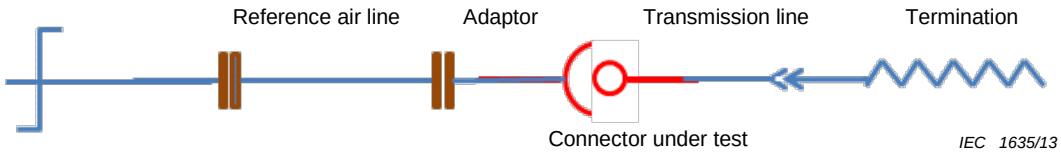


Figure 5 – Equipment set-up for the measurement of reflection in time domain

Both the time and the return loss scales of the TDR equipment shall be calibrated by independent references. For the time scale, this can be done by using air lines of known length, sliding short-circuits or by time standards. The return loss scale is calibrated by using known impedance mismatches or input signals of known amplitude. For routine calibration between measurements, open or short-circuiting is also satisfactory.

In addition to the calibration, the measuring equipment should be checked for the following sources of error.

a) The step form shall be adjusted for minimum ripple and irregularities before the calibration.

b) Losses in air lines and equipment cables distort the incident step. Excessive lengths should be avoided.

c) Multiple reflections in the measuring system added to the reflection from the connector under test, especially if the system includes unmatched components. Their effect can be minimized by selecting the lengths of air lines and cables so that the reflections from different sources are separated in time.

d) Leaky connections or unshielded terminations may cause interference signals in the measuring system.

e) Errors are often due to an uncertainty in defining the line corresponding to zero reflection. This is particularly important if the reflected signals are small.

9.2.1.4 Information to be given in the relevant specification

The following information shall be given in the relevant specification:

a) limits for the return loss appropriate to the grade;

b) measuring accuracy;

c) details of the standard test connector;

d) necessary characteristics of the appropriate cable;

e) any deviation from the standard test method.

9.2.2 Power rating

9.2.2.1 Definitions

Power rating is the input power at which neither the peak working voltage nor the maximum dielectric temperature of the connector is exceeded, if the connector is terminated with specified cable or interface.

The nominal value of voltage-limited power rating is defined as follows:

$$P_{u,max} = \frac{U^2 max}{2Z}$$

where

U_{max} is the peak working voltage;

Z is the characteristic impedance;

$P_{u,max}$ implies sinusoidal c.w. excitation.

The nominal value of temperature-limited power rating is defined by the steady state power at which the inner conductor reaches its maximum temperature as per Table 2 below (alternatively as per climatic category). The nominal value is stated for an ambient temperature of 40 °C.

Table 2 – Dielectric materials ratings

Dielectric material	Maximum inner conductor temperature °C
Polyethylene (LD-PE)	+85
Polytetrafluoroethylene (PTFE)	+200
Fluorinated ethylene propylene (FEP)	+180

9.2.2.2 General measuring conditions

Cable connectors shall be attached to the appropriate cable, as per manufacturer's instructions.

The specimen shall be placed horizontally in still air, allowing free air convection, and screened from the influence of other heat sources.

The test duration shall be long enough to establish thermal balance.

9.2.2.3 Measuring methods

Ideally, the specimen is terminated in its characteristic impedance and then fed with power until maximum working voltage or maximum inner conductor temperature is reached.

9.2.3 Contact resistance, outer conductor and centre conductor continuity (mated cabled connectors)

9.2.3.1 General measuring requirements and procedure

Measurements will be carried out with alternating current (a.c.). In case of dispute, however, the measurement with direct current shall govern.

The contact resistance shall be calculated from the potential difference measured between the points intended for inner conductor and outer conductor contact of mated pairs, which may include the length of the cable and the current. The contact shall be made before the current is switched on.

When direct access to the terminations is impractical, as in the case of mated cabled connectors, a measurement of the centre conductor continuity shall be made.

The measuring set-up shall be such as to ensure that the result is within ± 10 % of the resistance to be measured, unless another accuracy is given in the relevant specification.

In general, the resistances of the centre contact and the outer contact R_o of a pair of connectors shall be measured separately. The relevant specification shall state explicitly if the total resistance R_{tot} of the two contacts in series is to be determined by a direct measurement.

It is most desirable to have contact resistances for every combination of cable size, centre conductor and shield configuration as close to zero as possible.

A control jumper is made from the cable used in test to verify circuit stability and accuracy.

The approximate contact resistance values can be determined by the use of the conductor and loop resistance values. For example, a single tape and braid construction that has a maximum centre conductor resistance of 31,10 Ω / 1 000 ft ($31{,}10 \times 10^{-3}$ Ω /ft) and a maximum d.c. loop resistance of 41,16 Ω / 1 000 ft ($41{,}16 \times 10^{-3}$ Ω /ft). This results in an outer conductor resistance of 10,06 Ω / 1 000 ft ($10{,}06 \times 10^{-3}$ Ω /ft).

Therefore, if the cable sample is approximately 1 foot in length, the resistance calculated is approximately 10×10^{-3} Ω or 10 mΩ. If the measured resistance is in the area of 25 mΩ, 65 mΩ and 90 mΩ, the interface might be suspect.

9.2.3.2 Procedure

The relevant value of the contact resistance is the mean value calculated from five consecutive measuring cycles. No individual value shall exceed twice the mean value.

One measuring cycle consists of:

a) when measuring with a.c.:
   1) making the contact (engaging the connectors);
   2) connection of voltage source;
   3) measurement;
   4) disconnection of voltage source;
   5) breaking the contact (disengaging the connectors);

b) when measuring with d.c.:
   1) making the contact (engaging the connectors);
   2) connection of voltage source in one polarity;
   3) measurement;
   4) connection of voltage source in reverse polarity;
   5) measurement;
   6) disconnection of voltage source;
   7) breaking the contact (disengaging the connectors).

9.2.3.3 Requirements

The pass fail criteria may invoke the following.

a) Contact resistance and outer conductor continuity

   The values shall not exceed those specified by the relevant specification.

b) Centre conductor continuity, and outer conductor and screen continuity (mated cabled connectors).

The overall resistances of the mated connectors and their attached cables shall be measured between the free ends of the cable conductors. The connectors shall not be disengaged between making the last measurement prior to the conditioning and the first measurement after conditioning.

The changes in resistance of the centre conductor, outer conductor and, when applicable, the screen of a mated pair of connectors inclusive of cable resistance, shall not deviate, after conditioning, by more than the appropriate maximum permitted values indicated in the relevant specification.

9.2.3.4 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) upper limit of resistance for centre contact and outer conductor/screen continuity as appropriate;

b) the maximum percentage change of the initial total measured resistances of mated cabled connectors to be permitted after conditioning;

c) any deviation from standard procedure.

9.2.4 Centre and outer conductor contact continuity under severe mechanical conditioning

9.2.4.1 Testing procedure

The continuity of the centre and the outer contacts of a mated pair of connectors shall be tested during the vibration (see 9.3.3), the bump (9.3.13) and the shock test (9.3.14), as required by the relevant specification.

9.2.4.2 Requirements

There shall be no intermittences under the conditions specified by the relevant specification.

9.2.4.3 Information to be given in the relevant specification

See 9.3.3.2, 9.3.13.2 and 9.3.14.2.

9.2.5 Insulation resistance

9.2.5.1 Procedure

The insulation resistance shall be measured between the contacts with a d.c. voltage of 500 V ± 50 V or with the rated voltage of the connector, whichever is less.

The test equipment shall have a suitable range to cover the resistance being measured.

Both ends of the connector under test (CUT) shall be prepared such that, when the specified voltage is applied to the conductors, there shall be no breakdown or significant partial discharges at the terminations.

The test shall be preferably performed on an un-mated connector (plug or jack) without any attached cable (see Figure 6).

When the test is performed on a mated pair of connectors or when a cable is attached to one connector, this should be reported in the relevant specification.

The test shall be performed under standard laboratory conditions to avoid humidity on dielectric beads.

The insulation resistance shall be measured after an electrification time of 1 min ± 5 s.

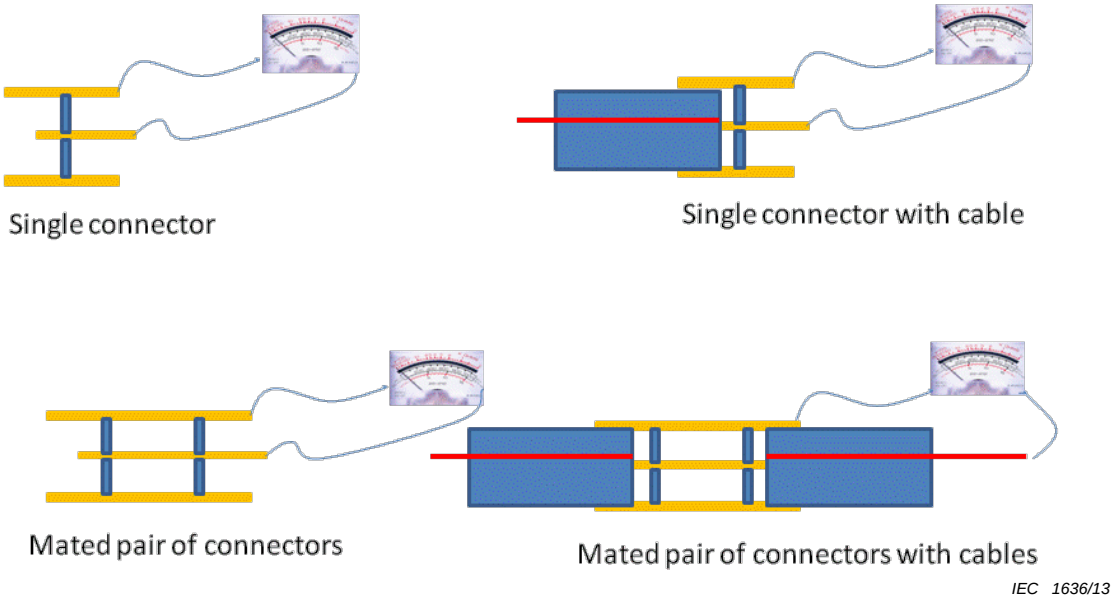


Figure 6 – Possible test arrangements

9.2.5.2 Requirements

The value of the insulation resistance shall be not less than the value specified by the relevant specification.

9.2.5.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) value of the test voltage if other than 500 V;

b) minimum value of insulation resistance;

c) test arrangement (mated or un-mated connector with or without cables);

d) any deviation from the standard test procedure.

9.2.6 Voltage proof

9.2.6.1 Procedures and requirements

Connectors shall withstand without breakdown or flashover the voltage specified in the relevant specification.

When applicable, an appropriate cable shall be attached to the connectors and the connectors shall be tested both mated and unmated.

An a.c. voltage at a frequency between 40 Hz and 65 Hz shall be applied for 60 s for qualification approval and for 5 s for quality conformance inspection unless otherwise prescribed in the relevant specification.

The relation between the rated voltage U and the test voltage E (r.m.s. values) is given by:

$E = 3\ U$ for connectors having a rated voltage up to and including 1 kV, and

$E = 1{,}5\ U$ with a minimum of 3 kV, for connectors having a rated voltage exceeding 1 kV.

NOTE If the cable capacitance does not allow the a.c. test to be performed, a d.c. voltage proof is done at 1,414 times the r.m.s. value of the a.c. voltage.

9.2.6.2 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) value of the test voltage;

b) any deviation from the standard test procedure;

c) leakage current.

9.2.7 Screening effectiveness

9.2.7.1 General considerations

Screening effectiveness in the context of radio-frequency coaxial transmission lines is the ability of the outer conductor to protect the transmission line from being disturbed by outside electromagnetic fields, and vice-versa. With respect to r.f. coaxial connectors, a longitudinal current flowing on the outer shell should not cause an undue voltage in the coaxial circuit.

The quotient of the transferred electromotive force, or the equivalent voltage U_t, by the outside longitudinal current I_l : $\frac{U_t}{I_l} = Z_t$ is called the "transfer impedance" and is generally an adequate quantity for defining the screening effectiveness of r.f. coaxial connectors. It shall be emphasized that the transfer impedance of r.f. connectors, and thus the screening effectiveness, has by no means a stable, fixed value applicable to each particular specimen or pair. In particular, Z_t is mostly much dependent on mechanical and contact circumstances.

For radio-frequency applications, the transfer impedance Z_t shall be expressed as a function of frequency and, in general, be measured in the frequency domain.

In order to measure the screening effectiveness of the mating part of a connector pair, suitable cables are attached to the connectors in such a way as to exclude any leakage at the cable entries.

For type testing, measurements shall always be carried out at the first engagement on a number of pairs of fresh connectors. It is not recommended that a standard test connector should be coupled to the specimen under test with the intention of attributing measured screening deficiencies to the specimen under test.

The relevant specification shall state the number of pairs to be measured, the tightening torque for the coupling nut and, where relevant, the frequency range.

9.2.7.2 Measurement

Depending upon the requirements (Z_t or screening attenuation), the measurement will be performed according to the appropriate relevant clauses of IEC 62153 and IEC 61726.

9.2.8 Discharge test (corona test)

9.2.8.1 Procedure and requirements

An appropriate cable shall be attached to the connector and the test voltage shall be applied between the conductors of the cable.

The application of a high voltage to the test samples immediately before the discharge test may affect the measured results; a rest interval is therefore recommended, after previous voltage application, before carrying out the discharge test.

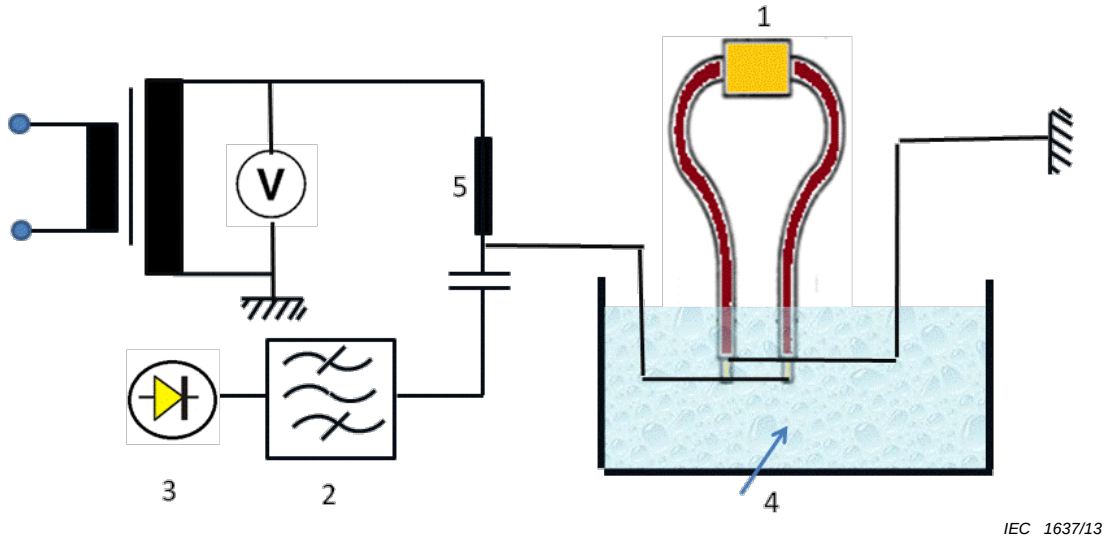
Care shall be taken to avoid spurious effects caused by corona at the cable ends. An example of test arrangement of given in Figure 7.

The connectors shall be tested only in the mated condition.

The voltage to be applied shall have a frequency between 40 Hz and 65 Hz. The total duration of the application of the voltage shall not exceed 5 min.

To allow the measurement of the discharges, the components of the test circuit shall be corona free to the extent that discharges of 5 pC or more occurring in the test specimen are not obscured.

The voltage shall be slowly increased until the detector, operated at a sensitivity of 5 pC, indicates a sustained corona discharge. Then the voltage shall immediately be decreased until corona is at the 5 pC level, the corresponding voltage being the corona level of the connector under test.



Key

1 connectors under test
2 band Pass Filter (10 KHz 50KHz)
3 detector
4 oil
5 choke

Figure 7 – Measuring circuit for the discharge test

The test may be carried out at reduced atmospheric pressure when required by the relevant specification to simulate high altitude applications.

9.2.8.2 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) minimum value of the extinction voltage;

b) atmospheric pressure;

c) any deviation from the standard test procedure.

9.2.9 Intermodulation level (PIM)

9.2.9.1 General

IM interference is caused by sources of non-linearity of mostly unknown nature, location and behaviour. Experience shows that the generation of intermodulation products originates from point-sources inside a device under test (DUT) and are propagating equally into all available directions. The generation of passive intermodulation products (PIM) does not necessarily follow the law of the usual non-linear equation of quadratic form. Therefore, accurate calculation to other power levels causing the intermodulation is not possible.

PIM generation can be frequency-dependent. When PIM generation is frequency-dependant, the PIM performance shall be investigated over the specified frequency band.

An appropriate cable shall be attached to the connector and tested in accordance to IEC 62037.

9.2.10 Surge withstand

Under consideration.

9.3 Mechanical tests and measuring procedures

9.3.1 General

The surges considered do not exceed one half-cycle of the normal mains waveform (fundamental frequency) in duration. They can be periodic or random events and can appear in any combination of line, neutral, or grounding conductors. They include surges with amplitudes, durations, or rates of change sufficient to cause equipment damage or operational upset.

Measurements to be made at any stage of these tests shall be indicated in the relevant specification.

9.3.2 Soldering

9.3.2.1 General

Terminations and surfaces to which soldered connections are to be made shall be tested to ensure that the surfaces wet easily and that damage does not occur due to the heating effect of the soldering processes. Tests shall be carried out in accordance with Test Ta of IEC 60068-2-20, and when required, the relevant specification shall identify the termination(s) and provide the information as indicated for Test Ta. Test Tb may be applied if specified in the relevant specification.

9.3.2.2 Solderability

Tests shall be made in accordance with Test Ta of IEC 60068-2-20. This test may be carried out on piece-parts/sub-assemblies taken from batches prior to assembly into connectors and, if prescribed, subject to prior conditioning or ageing.

When applied to assembled connectors, the requirements shall be laid down in the relevant specification which shall also prescribe:

a) soldering iron method – the size of the bit;

b) solder bath – the depth of the immersion.

Solderability of printed board mounting connectors may be tested in accordance with Test Ta of IEC 60068-2-54 using the wetting balance method. This method may also be used as a reference method for terminations irrespective of shape. When requiring use of this method, the appropriate parameters of one or more of the following requirements shall be given in the relevant specification:

1) for the onset of wetting;

2) for the progress of wetting;

3) for the stability of the wetting.

9.3.2.3 Resistance to soldering heat

This test shall be carried out on assembled connectors in the unmated condition. They shall be subjected to Method 1b or Method 2 of IEC 60068-2-20 which includes details of the normal requirements and the information to be given in the relevant specification.

9.3.3 Vibration

9.3.3.1 Procedure

Unless otherwise specified, the test duration level should be selected from one of the columns specified in Table 3. The test shall be carried out on mated sets of connectors in accordance with Test Fc of IEC 60068-2-6.

The vibration severity shall be defined by the combination of three parameters: frequency range, vibration amplitude and duration of endurance. The relevant specification shall prescribe the appropriate requirement for each parameter selected from the following preferred values:

Swept frequency ranges:

a) 10 Hz to 150 Hz;

b) 10 Hz to 500 Hz;

c) 10 Hz to 2 000 Hz.

Vibration amplitude (with cross-over frequency 57 Hz to 62 Hz).

Table 3 – Severities for vibration

Peak displacement (not peak to peak) amplitude below cross-over frequency	Acceleration amplitude above cross-over frequency		Severity level duration			
mm	m/s^2	gn	Level 1	Level 2	Level 3	Level 4
0,5	50	5	16	40	96	180
0,75	100	10	2	5	12	20
1,0	150	15	-	2	4	6
1,5	200	20	-	1	2	3

The connectors shall be vibrated in each of three perpendicular directions, one of which shall be parallel to the common axis of the connectors.

The centre and the outer contact continuity shall be monitored as specified in 9.2.4.

9.3.3.2 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) appropriate cable to be used, details of mounting connectors and clamping of cables;

b) severities;

c) performance requirements;

d) any deviation from the standard test procedure;

e) connector performance should be evaluated on the assembly tested.

9.3.4 Insertion force (resilient contacts)

9.3.4.1 Procedure and requirements

Resilient contacts, either female (socket) or male (pin) shall be tested in the following manner using the specified gauges.

a) The gauge causing the maximum deformation shall be applied to the contact and withdrawn three times. For a centre female contact, the diameter of the gauge shall be the maximum specified diameter of the mating male contact. For the outer male contact, the inner diameter of the gauge shall be the minimum specified diameter of the female body.

b) The gauge causing minimum deformation shall then be engaged with the contact. The contact shall support the gauge when the gauge is hanging from the contact in the vertical position. For a centre female contact, the diameter of the gauge shall be the minimum specified diameter of the mating male contact. For an outer male contact, the inner diameter of the gauge shall be the maximum specified diameter of the female body.

9.3.4.2 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) dimensional details of the gauge(s) for pre-conditioning;

b) dimensional details and mass of the gauge(s) for checking the retention force;

c) when required, the insertion force of the pre-conditioning gauge(s);

d) any deviation from the standard test procedure.

9.3.5 Centre contact captivation

9.3.5.1 Procedure

Free connectors shall be fitted with an appropriate cable and fixed connectors with a wire.

An axial torque and/or force, as specified by the relevant specification, shall be applied smoothly to the centre contact in both directions.

9.3.5.2 Requirements

After removal of the stress, the permanent displacement of the centre contact with regard to the connector body shall not exceed the value specified in the relevant specification.

9.3.5.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) appropriate cable to be used;

b) magnitude, duration and sense of torque and force;

c) any deviation from standard procedure and requirements.

9.3.6 Engagement and separation forces and torques

9.3.6.1 General

When applicable, engagement and separation involve axial movements requiring insertion and withdrawal forces. Operation of the coupling mechanism may involve additional rotary movement of a coupling ring requiring a torque.

NOTE Connectors with threaded coupling nuts are covered by 9.3.11.

9.3.6.2 Procedure

The test shall be carried out on connector pairs or with a gauge if specified by the relevant specification. There shall be five successive cycles of engagement and separation on the same test specimens. The forces and torques as applicable shall be measured on the fifth cycle.

9.3.6.3 Requirement

The insertion force and the coupling torque shall not exceed the value specified by the relevant specification.

The momentary maximum decoupling torque and withdrawal force shall be within the limits specified by the relevant specification.

9.3.6.4 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) maximum value of insertion force and coupling torque, where applicable;

b) momentary maximum and minimum values permitted for the decoupling torque where applicable, and the withdrawal force;

c) any deviation from the standard procedure.

9.3.7 Effectiveness of clamping device against cable rotation (nutation of cable end)

9.3.7.1 Procedure

This test is applicable to connectors that are intended to be attached to flexible cables.

The cable as specified in the relevant specification shall be attached to the connector according to the manufacturer's instructions.

The length of the cable shall not exceed the cable's minimum bend radius and shall be long enough to conduct and evaluate the test.

The connector shall be securely fixed and the free end of the cable deflected to such an amount that the minimum-bending radius will be obtained at the connector/cable interface. Holding this deflection constant, the cable end shall then be circumferentially moved along a circle in a plane perpendicular to the axis of the connector for a prescribed number of revolutions (nutations). During this procedure, the cable shall not rotate within the attachment to the connector.

Unless otherwise specified, the number of rotations shall be 10 in each direction as shown in Figure 8.

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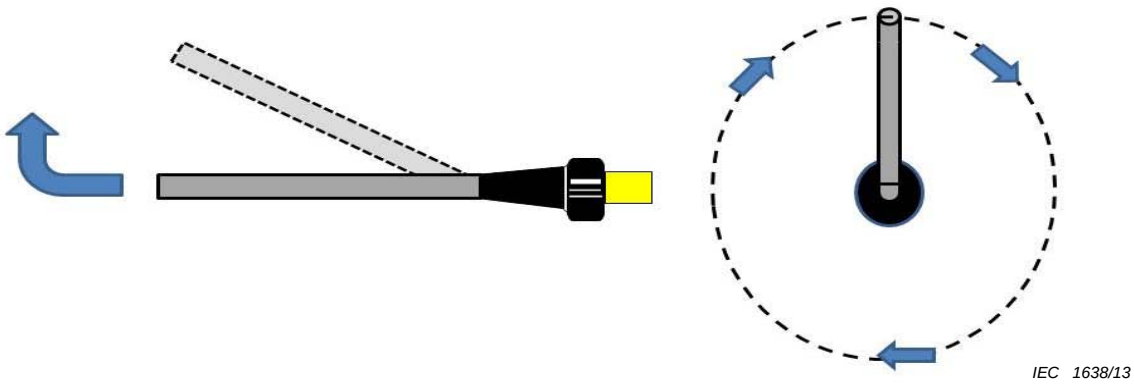


Figure 8 – Test arrangement for nutation

9.3.7.2 Requirements

After the test, the cable and connector and junction between them shall not show any sign of deterioration.

9.3.7.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) necessary characteristics of the appropriate cable;

b) minimum bending radius of the cable;

c) number of revolutions (nutations) in each direction if other than 10;

d) any deviation from the standard test method.

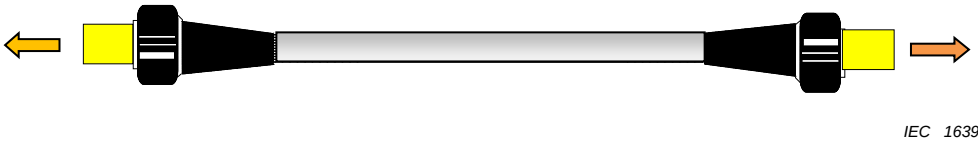
9.3.8 Effectiveness of clamping device against cable pulling

9.3.8.1 Procedure

The cable as specified in the relevant specification shall be attached to the connector(s) in accordance with the manufacturer's instructions.

The length of the cable shall be of a length to not exceed the cables minimum bend radius and long enough to conduct and evaluate the test.

A tensile force as specified by the relevant specification shall be applied to the free end of the cable. If connectors are fitted to both ends of the cable, the force shall be applied between the two connectors along the common axis of the cable and cable outlets. Unless otherwise specified, the force shall be applied for a period of 60 s minimum as shown in Figure 9.



IEC 1639/13

Figure 9 – Test arrangement for pulling

9.3.8.2 Requirements

Neither the dielectric nor the sheath shall have moved in relation to the cable outlet of the connector(s).

9.3.8.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) cable to be used;

b) value of force, method of application and its point of application;

c) duration of application of force if other than 60 s minimum;

d) any deviation from the standard test procedure.

9.3.9 Effectiveness of clamping device against cable bending

9.3.9.1 Procedure

The cable as specified in the relevant specification shall be attached to the connector(s) in accordance with the manufacturer's instructions.

The length of the cable shall be of sufficient length to perform the necessary tests after the bend test.

The assembled connector shall be held or clamped in a horizontal position. A bending force shall then be applied to the cable by attaching to its free end a mass, sufficient to cause the cable to assume its minimum bend radius commencing at the point of cable entry into the connector (see Figure 10). The specified force shall be applied for a period of 60 s minimum.

The mass is then removed and the cable returned to its original straight position. These operations shall be regarded as one bending cycle.

The number of bending cycles and bend radius shall be specified by the relevant specification.

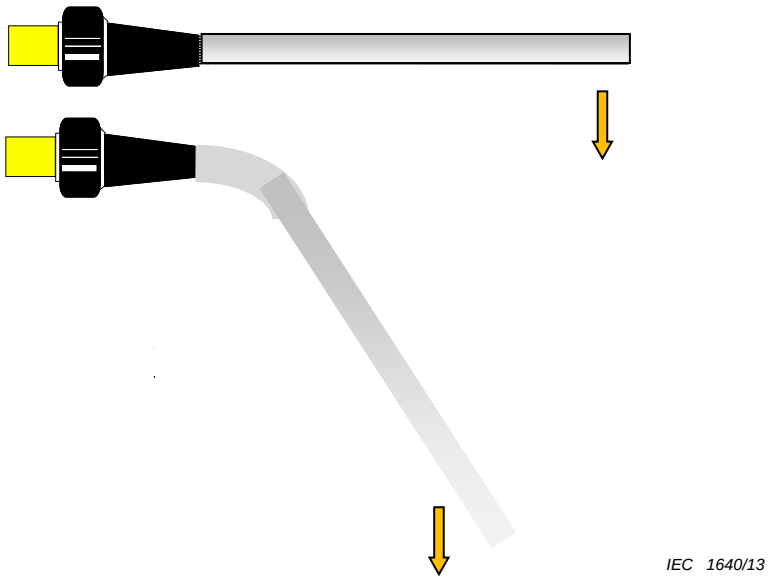


Figure 10 – Bending

9.3.9.2 Requirements

After the test, the cable shall still be firmly attached to the connector with no visible deterioration of the connector-to-cable junction.

9.3.9.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) type of cable to be used;

b) minimum bending radius of the cable;

c) length of cable from cable outlet to point of attachment;

d) value of the mass necessary to produce the minimum bending radius;

e) number of bending cycles;

f) any deviation from the standard test method.

9.3.10 Effectiveness of clamping device against cable torsion

9.3.10.1 Procedure

The cable as specified in the relevant specification shall be attached to the connector(s) in accordance with the manufacturer's instructions.

The length of the cable shall be of a length to not exceed the cables minimum bend radius and long enough to conduct and evaluate the test.

An axial torque of specified magnitude shall be applied to the free end of the straight cable for a duration of 60 s minimum (see Figure 11).

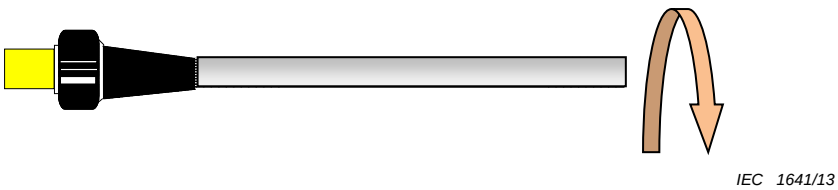


Figure 11 – Cable torsion

9.3.10.2 Requirements

The cable shall neither slip nor rotate in relation to the connector(s).

9.3.10.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) the cable to be used;

b) value of the torque and method of its application;

c) duration of application of the torque if other than 60 s minimum;

d) any deviation from the standard test procedure.

9.3.11 Strength of coupling mechanism

9.3.11.1 Object

To determine the mechanical ability of the coupling mechanism to withstand an axial tensile force and, additional in the case of screw coupled connectors, a proof torque.

9.3.11.2 Procedure

An axial tensile force shall be applied smoothly to mated connector pairs the coupling of which, in the case of screw coupled connectors, has been tightened to the normal coupling torque.

In the case of screw-coupled connectors, the coupling is then additionally tightened to the proof torque and loosened again three times.

Unless otherwise specified, the applied force shall be maintained for a period of 60 s minimum.

9.3.11.3 Requirements

No damage shall occur and the coupling mechanism shall not fail.

If required by the relevant specification, the connector pairs shall then be subjected to the tests and measurements of 9.3.6 and shall meet the requirements specified by the relevant specification.

9.3.11.4 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) value of the force;

b) bending moment;

c) duration of application of the force;

d) value of normal coupling torque;

e) value of proof torque;

f) number of connector pairs to be tested;

g) requirement whether or not the tests and measurements of 9.3.6 shall be applied;

h) any deviation from the standard test procedure.

9.3.12 Safety wire hole pull-out bending moment (and shearing force)

9.3.12.1 Procedure

Mated sets of connectors shall be subjected to a bending moment in such a way that the coupling mechanism is stressed.

One of the connectors shall be fixed either by the normal means of attachment (fixed connector), or by a suitably strong clamp (free connector). The bending moment shall be produced by a force perpendicular to the connector axis at a suitable distance from the reference plane. If appropriate, a special mechanical test plug shall be used for this purpose. The force shall be applied smoothly.

NOTE This method of producing the bending moment causes also a shearing force, which may be kept small by using a long lever arm.

9.3.12.2 Requirements

No damage shall occur and the coupling mechanism shall not fail.

The connector pairs shall then be subjected to the tests and measurements of 9.3.6 and shall meet the requirements specified by the relevant specification.

9.3.12.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) value of the force and the point of its application;

b) duration of application of the force;

c) any deviation from the standard test procedure.

9.3.13 Bump

9.3.13.1 Procedure

When the connector is intended to be in application of repeated bumping, the following is applicable.

The bump test shall be carried out in accordance with IEC 60068-2-29, on mated pairs of connectors.

The connectors shall be attached to a suitable length of appropriate cable and the mated pair of connectors mounted in one of the following ways as prescribed by the relevant specification:

a) clamping both the connectors and the cable;

b) clamping the cables only and thus leaving the connectors freely suspended;

c) if one of the connectors is a fixed style, this connector shall be mounted using the intended means.

Unless otherwise specified, the severities indicated in the relevant specification shall be chosen from the preferred values given in Table 4.

Table 4 – Recommended severities for bump

Severity			
Peak acceleration		**Duration** ms	**Number of bumps in each specified direction**
gn	Equivalent m/s^2		
15	150	6	4 000 +10
40	400	6	1 000 +10
40	400	6	4 000 +10

The relevant specification shall state in which directions and senses the specified bumps shall be applied.

During the bumping, the centre and outer contact continuity shall be monitored as specified in 9.2.4.

9.3.13.2 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) appropriate cable to be used and its length;
b) details of mounting of connectors and cables;
c) severities;
d) directions and sense of conditioning;
e) performance requirements;
f) any deviation from the standard procedure.

9.3.14 Shock

9.3.14.1 Procedure

The shock test shall be carried out in accordance with IEC 60068-2-27, on a mated pair of connectors.

The connectors shall be attached to a suitable length of appropriate cable and the mated pair of connectors mounted in one of the following ways as prescribed by the relevant specification:

a) clamping of both the connectors and the cable;
b) clamping the cables only and thus leaving the connectors freely suspended;
c) if one of the connectors is a fixed style, this connector shall be mounted using the intended means.

The shock test severity to be prescribed by the relevant specification shall, preferably, be selected from amongst the preferred values given in Table 5:

Table 5 – Recommended severities for shocks

Severity			
Peak acceleration		Corresponding duration of nominal pulse ms	Pulse shape
gn	Equivalent m/s^2		
30	300	18	Half-sine
50	500	11	Half-sine
100	1 000	6	Half-sine

The relevant specification shall state in which directions and senses the specified shocks shall be applied, and the number of shocks.

During each shock, the centre and outer contact continuity shall be monitored as specified in 9.2.4.

9.3.14.2 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) appropriate cable to be used and its length;
b) details of mounting of connectors and clamping of cables,
c) severities;
d) directions and senses of shocks;
e) performance requirements;
f) any deviation from the standard procedure.

9.3.15 Mechanical endurance

9.3.15.1 Procedure

Connectors shall be subjected to a mechanical endurance test in accordance with the relevant specification. If required, the endurance test may be divided into two parts, separated by other tests.

The endurance test consists of repeated engagement and disengagement of connector pairs. One operation consists of full engagement, including the operation of the coupling mechanism, if any, with screw coupled connectors being tightened to the normal coupling torque, and subsequent disengagement.

When permitted by the relevant specification, the locking devices, where fitted, may be tested separately from the insertion and withdrawal action; thus there will be two series of tests.

The number of operations shall be 25, unless otherwise specified. The relevant specification shall give the frequency of the operation, duly taking into account that the sliding speed during the engagement and disengagement of the connectors should be 0,1 m/s.

9.3.15.2 Final tests and measurements

At the conclusion of the endurance conditioning, the connectors shall meet the requirements of the relevant specification for the following properties, unless otherwise specified:

a) contact resistance, using the same pairs as subjected to the endurance test;

b) voltage proof;

c) engagement and separation forces and torques;

d) gauge retention force;

e) sealing.

9.3.15.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) frequency of the operations, maximum sliding speed 0,1 m/s;

b) number of operations, if other than 500;

c) requirements for the final measurements;

d) any deviation from the standard test procedure.

9.4 Climatic conditionings and tests

9.4.1 Conditionings

9.4.1.1 Survey of conditionings

The climatic conditionings and tests comprise the following:

a) Climatic sequence based on the standard climatic sequence:
   - dry heat; Test Ba, of IEC 60068-2-2;
   - damp heat, cyclic; first cycle of Test Db, of IEC 60068-2-30;
   - cold; Test Aa, of IEC 60068-2-1;
   - low air pressure; Test M, of IEC 60068-2-13;
   - damp heat, cyclic; remaining cycle(s) of Test Db;

b) test Cab; Damp heat, steady state, of IEC 60068-2-78;

c) test Na; Change of temperature, of IEC 60068-2-14, Clause 7:2009;

d) test Q; Sealing, of IEC 60068-2-17;

e) test Ka; Salt mist, of IEC 60068-2-11;

f) test Kc; Sulphur dioxide test for contacts and connections, of IEC 60068-2-42;

g) test L; Dust and sand (under consideration).

9.4.1.2 General procedure

From a sub-sample of connectors subjected to the conditioning procedures and subsequent recovery period, half the numbers of specimens shall be mated and half the number shall stay unmated, unless otherwise specified.

An appropriate cable shall be attached to cable connectors and the free ends prepared in such a way that the inner and outer conductors can be electrically connected for measuring purposes. Where necessary, the free ends shall be treated to prevent ingress of moisture. Fixed connectors shall be mounted in accordance with the manufacturer's instructions, and the back of panel portion shall, where appropriate, be protected against ingress of moisture.

Special attention should be paid to connector specimens intended for the measurement of the return loss (see 9.2.1).

The climatic severities for the low and high temperatures, and the duration of the damp heat, steady state, exposure shall correspond to the climatic category of the connector, as prescribed in the relevant specification.

If applicable, the specimens shall be pre-conditioned and then visually examined and electrically and mechanically checked prior to subjecting them to the conditionings and tests, as prescribed in the relevant specification.

9.4.2 Climatic sequence

9.4.2.1 Procedure

The climatic sequence shall be carried out in accordance with Test Z/ABDM using the procedure and severities specified in the relevant specification. Unless otherwise prescribed, procedure 1 shall be used for qualification approval testing.

Unless otherwise prescribed in the relevant specification, the low air pressure test (Test M) shall be carried out at a pressure of 4,4 kPa (44 mbar) for a duration of 1 h. During the last 5 min of the conditioning, the low air pressure proof voltage prescribed in the relevant specification shall be applied. There shall be no breakdown or flashover.

NOTE For test purposes, 4,4 kPa (44 mbar) is considered to be the approximate equivalent air pressure at altitudes of 70 000 feet (approximately 20 km).

9.4.2.2 Concluding tests

The insulation resistance and voltage proof tests are to be carried out within 15 min of removal from the chamber.

9.4.2.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) climatic procedure if other than procedure 1;

b) pre-conditioning procedures, if any;

c) electrical and mechanical checks to be made before conditioning;

d) severity of each step of the applicable climatic procedure;

e) minimum value of insulation resistance at high temperature;

f) low air pressure proof test voltage(s);

g) requirements for the final measurements;

h) requirements for extended recover, if any;

i) any deviations from the standard test procedure.

9.4.3 Damp heat, steady state

9.4.3.1 Procedure

The test shall be carried out in accordance with Test Cab of IEC 60068-2-78 as follows unless otherwise specified.

a) temperature 40 °C ± 2 °C;

b) humidity: 93 % RH ± 3 %;

c) duration: determined by severity rating.

Immediately after removal of the specimens from the chamber, they shall be shaken to remove surface moisture, and within 15 min the sea-level environmental test voltage as specified in the relevant specification shall be applied between the centre and outer conductor(s) of the connectors for 5 min. In the case of tri-axial connectors, an appropriate test voltage as specified in the relevant specification shall be applied between the outer conductor and screen. There shall be no breakdown or flashover.

The specimens shall then be exposed to the standard atmospheric recovery conditions for 1 h 30 to 2 h.

9.4.3.2 Final tests and measurements

At the conclusion of the recovery period, the connectors shall meet the requirements of the relevant specification for the following properties, unless otherwise specified:

Mated connectors

a) Contact resistance

b) Voltage proof

c) Visual inspection

Unmated connectors

a) Insulation resistance

b) Voltage proof

c) Contact resistance on resilient contacts individually

d) Visual inspection

NOTE The insulation resistance measurement and the voltage proof test is carried out within 30 min of the recovery period.

The mated connectors should not be disturbed prior to the contact resistance measurement.

9.4.3.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) voltage for the test immediately after conditioning;

b) requirements for the final measurements;

c) any deviation from the standard procedure.

9.4.4 Change of temperature

9.4.4.1 Procedure

This test shall be carried out in accordance with Test Na of IEC 60068-2-14 with either test Na or Nb.

The low conditioning temperature shall be the low category temperature, and the high temperature the high category temperature of the specimens.

If test method Nb is used, the transition between the upper and lower limit shall be equivalent to 3 °C per minute and the number of cycles increased to 10.

Unless otherwise prescribed in the relevant specification, the number of cycles shall be five, the transition time 2 min to 3 min and the duration of exposure at each of the two temperatures 30 min. A longer period of exposure may be prescribed by the relevant specification if required to ensure thermal equilibrium is achieved.

At the end of the last cycle, the specimens shall be subjected to standard atmospheric conditions for recovery for 1 h 30 to 2 h.

9.4.4.2 Final tests and measurements

At the conclusion of the recovery period, the connectors shall meet the requirements of the relevant specification for the following properties, unless otherwise specified:

Mated connectors	Unmated connectors
a) Contact resistance	a) Insulation resistance
b) Voltage proof	b) Voltage proof
c) Visual inspection	c) Contact resistance on resilient contacts individually
	d) Sealing
	e) Visual inspection

NOTE The insulation resistance measurement and the voltage proof test is carried out within 30 min of the recovery period.

The mated connectors should not be disturbed prior to the contact resistance measurement.

9.4.4.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) requirements for the final tests and measurements;

b) any deviation from the standard test procedure.

9.4.5 High temperature endurance

9.4.5.1 Procedure

This test shall be carried out on mated pairs of connectors.

The chamber used for this test shall be capable of maintaining in any region where the specimens are placed the specified endurance temperature with a tolerance of ± 5 °C. The specimens shall not be exposed to direct radiation from the heating elements of the chamber.

Unless otherwise specified, the specimens shall be introduced into the chamber while its air temperature is at 70 % of the specified endurance temperature. Once thermal equilibrium has been achieved, the temperature of the chamber shall be increased to the endurance temperature. Throughout the duration of endurance, no current shall be passed through the contacts unless otherwise required by the relevant specification.

The endurance severity to be prescribed by the relevant specification shall, preferably, be selected from the following preferred values:

Endurance temperature:	85 °C
	125 °C
	155 °C
Duration:	50 h
	250 h
	1 000 h

Following the endurance conditioning, the specimens shall be exposed to the standard atmospheric temperature after the recovery conditions for 1 h 30 to 2 h.

9.4.5.2 Final measurements

At the conclusion of the recovery period, the connectors shall meet the requirements of the relevant specification for the following properties, unless otherwise specified:

a) contact resistance;

b) insulation resistance;

c) voltage proof;

d) sealing.

The mated connectors should not be disturbed prior to the contact resistance measurement.

9.4.5.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) temperature and duration for the endurance conditioning;

b) requirements for final measurements;

c) any deviation from the standard test procedure.

9.4.6 Low temperature endurance

9.4.6.1 Procedure

This test shall be carried out on mated pairs of connectors.

The chamber used for this test shall be capable of maintaining in any region where the specimens are placed the specified endurance temperature with a tolerance of ± 5 °C. The specimens shall not be exposed to direct radiation from the heating elements of the chamber.

Unless otherwise specified, the specimens shall be introduced into the chamber while its air temperature is at 70 % of the temperature difference between ambient temperature and endurance temperature. Once thermal equilibrium has been achieved, the temperature of the chamber shall be decreased to the endurance temperature. Throughout the duration of endurance, no current shall be passed through the contacts unless otherwise required by the relevant specification.

The endurance severity to be prescribed by the relevant specification shall, preferably, be selected from the following preferred values (see Table 6).

Table 6 – Recommended severities for low temperature tests

Endurance Temperature	Duration
–20 °C	2 h
–40 °C	4 h
–60 °C	72 h

Following the endurance conditioning, the specimens shall be exposed to the standard atmospheric recovery conditions for 1 h 30 to 2 h.

9.4.6.2 Final measurements

At the conclusion of the recovery period, the connectors shall meet the requirements of the relevant specification for the following properties, unless otherwise specified:

a) contact resistance;

b) insulation resistance;

c) voltage proof;

d) sealing.

The mated connectors should not be disturbed prior to the contact resistance measurement.

9.4.6.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) temperature and duration for the endurance conditioning;

b) requirements for final measurements;

c) any deviation from the standard test procedure.

9.4.7 Sealing non-hermetic sealed connectors

9.4.7.1 General

Non-hermetic sealed connectors are connectors with seals of any kind whose leakage may have a magnitude detectable by one of the test methods Qa or Qc of IEC 60068-2-17.

The connectors are regarded as having type B seals (seals working in both directions), but a test in one direction only, as for type A seals, is considered satisfactory.

9.4.7.2 Procedure

The test shall be carried out in accordance with Test Qa of IEC 60068-2-17.

Panel-sealed, as well as panel-and barrier-sealed connectors (thus fixed connectors) shall be mounted on a rigid plate forming part of a test jig (a closed box) permitting the application of the required air pressure.

Free connectors fitted both with barrier and mating face seals shall be tested by mating them with an appropriate complementary fixed connector permanently mounted with a panel seal to the test jig but allowing the passage of air to the free space inside the mated connectors.

Free connectors fitted only with barrier seal, but no mating face seal, shall be appropriately sealed to the test jig. This may be achieved by means of a constricting compression gland of a suitable size to grip the body shell.

9.4.7.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) requirements for pressure;

b) requirements for leakage rates;

c) any deviation from the standard test procedure.

9.4.8 Hermetically sealed connectors

9.4.8.1 Procedure

The test shall be carried out in accordance with Test Qk of IEC 60068-2-17, using the tracer gas procedure.

To ensure that an undetected shift in the sensitivity of the set-up has not occurred during the test period, the calibration of the system shall be re-checked using the reference leak at the conclusion of testing.

In the event of a significant change occurring in the calibration during a test period, it will be necessary to retest the connector(s) involved once the stability of calibration has been re-established.

For quantitative measurements, the test set-up shall be calibrated, using a calibrated leak in place of the connector to be tested.

Leaks at the test specimen may be localized by sweeping it with a fine jet of helium at low pressure, the flexible pocket or the cap, of course, being omitted.

9.4.8.2 Requirements

The leakage rate under standard conditions as mentioned above shall not exceed 10^{-3} Pa cm^3/s (10^{-8} bar cm^3/s), unless otherwise prescribed by the relevant specification.

9.4.8.3 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) test parameter, if different from the standard value(s);

b) limit of leakage rate, if different from the value mentioned above;

c) any deviation from the standard procedure.

9.4.9 Water immersion test

9.4.9.1 General

Visible liquid penetrant is used to simultaneously identify leakage into connector/cable interfaces of a double-ended test assembly (jumper) as defined in the detailed specifications. This test is intended for flexible and semi flexible coaxial cables up to 50 mm in diameter. It may also be used to determine the liquid tightness of integral or external seals, encapsulates or other environmental protection devices.

An acceptable performance level for a given cable/connector combination per test is derived from the visual appearance and condition of the interfaces.

9.4.9.2 Procedure

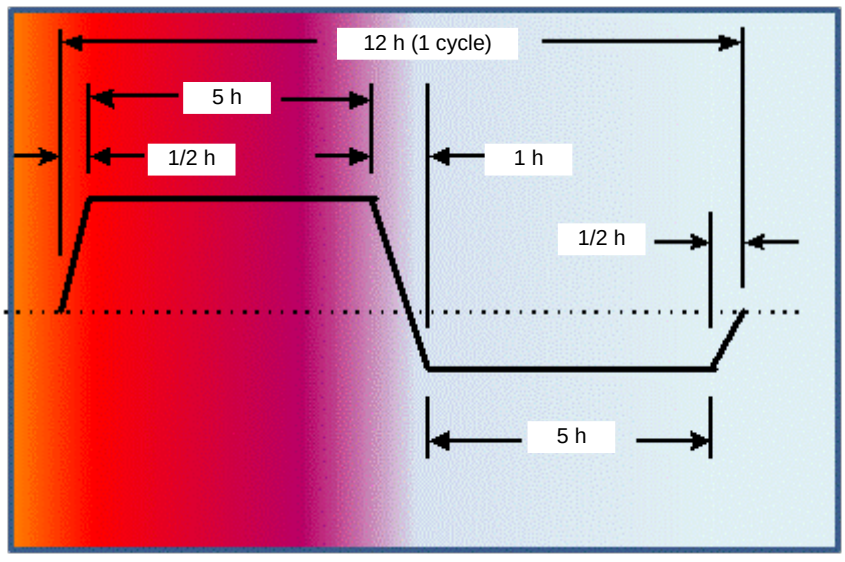
Mix one gram of the Phenol Red (ASC reagent, CAS#143-74-8) dye per 3,785 l of distilled water. Add approximately 20 drops of Sodium Hydroxide (CAS#1310-73-2) to turn the solution a rosy red color.

The solution shall be placed into container(s) of adequate size and shape to allow complete submerging of the test samples. The container and penetrant shall be conditioned or allowed to establish room temperature (21 °C) before samples are immersed into the solution.

Suitably mated connectors fitted with mating seals shall be attached on each end of an appropriate cable according to the installation instructions. If required by the relevant specification, connectors shall be tested without suitable seals.

A minimum of 5 test jumpers shall be used to provide adequate observations. The test jumpers shall be conditioned or allowed to establish room temperature prior to the test.

Place the test jumpers vertically into the container of penetrant ensuring that the cable of the test jumper is exposed to the conditioned air of the temperature chamber. Program the temperature chamber as defined in Figure 12.



IEC 1642/13

Figure 12 – Temperature curve profile

Place the containers with test jumpers into the temperature chamber parallel to the airflow in the chamber as shown in Figure 13.

It is desirable to have a container established in the temperature chamber prior to the placement of the test jumpers.

Caution: careful handling is required to avoid kinked or damaged cables.

Insure that all test ends are completely submerged in the penetrant solution.

NOTE As evaporation of the penetrant solution occurs, additional penetrant is added as needed, to ensure adequate submersion during the course of the test.

A minimum of 5 samples of each cable type shall be tested.

The length of the cable used for the test is dependent on the minimum bend radius of the cable.

For cables that are less than 25 mm in diameter, the cable length shall be 600 mm ± 100 mm.

For cables from 26 mm to 50 mm, the cable shall be 30 times the diameter of the cable.

Starting at ambient temperature, set the environmental chamber to cycle 10 times from 1,7 °C to 60 °C for five days or 120 h.

One cycle is 12 h in duration. Dwell times at the upper and lower temperature limits shall be 300 min ± 20 min with ramp times from ambient temperature, to either the upper or lower limits shall be 30 min ± 10 min as shown in Figure 1.

After completion of the test, remove test samples from the containers and let air dry or oven dry for 24 h at 30 °C ± 1 °C for 24 h.

Remove end interface of the jumpers and observe and record presence or absence of penetrant at the interface. Look for visible red penetrant or water droplets on either the inner conductor, dielectric or inside surfaces of the outer conductors.

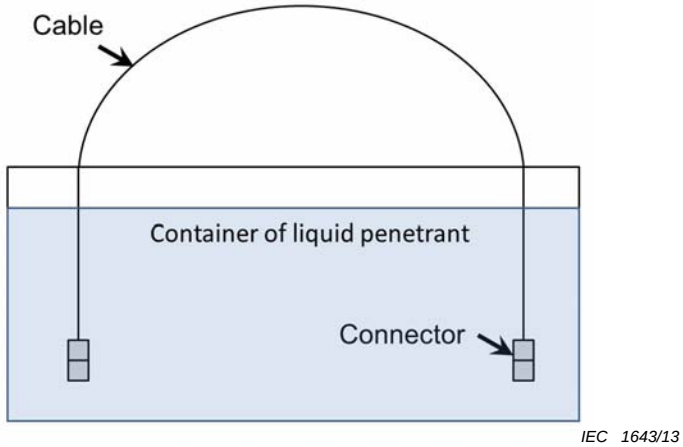


Figure 13 – Container/jumper arrangement

Carefully make a radial cut in the jacket, just behind the end of the connector, slit the cable jacket down the length to expose the shielding. Observe and note the presence or absence of contamination.

Look for visible red penetrant, white chalky substance or water droplets on any of the shield(s). If there is a presence, record the length of contamination from the end surface of the connector to the end of the contamination.

Perform insulation resistance and voltage proof test according to 9.2.5 and 9.2.6.

9.4.9.3 Information to be given in the relevant specification

The following information shall be specified:

a) test method used;

b) value of the test voltage;

c) value of the insulation resistance;

d) any deviation from the standard test procedure;

e) visual observation and location of contamination and/or water.

9.4.10 Salt mist

9.4.10.1 General

For either of the salt mist tests, the cable connectors shall have the appropriate cable attached, with the free ends treated to prevent ingress of moisture. Unless otherwise prescribed by the relevant specification, half of the specimens shall be mated and half unmated.

9.4.10.2 Salt mist (corrosion)

This test shall be carried out in accordance with Test Ka of IEC 60068-2-11. Unless otherwise prescribed, the duration of spraying shall be 48 h.

At the conclusion of the recovery procedure and period, the connectors shall meet the requirements as follows, unless otherwise prescribed by the relevant specification:

a) visual inspection; should show no change in appearance;

b) engagement and separation shall be achievable by hand, or in the normal manner.

9.4.10.3 Salt mist, cyclic (marine environment)

This test shall be carried out in accordance with Test Kb of IEC 60068-2-52, at the severity prescribed by the relevant specification which may also prescribe the use of the simulated sea-water solution given in Annex A of this specification. The unmated connectors shall be fitted with protective covers.

Within 15 min after removal from the chamber at the conclusion of the conditioning, the relevant environmental test voltage shall be applied to the connectors between the centre and outer conductors for 5 min. There shall be no breakdown or flashover. The connectors shall then be washed as indicated in the specification. At the conclusion of the recovery period, measurements shall be made on the mated sets of connectors as below:

Mated connectors	**Unmated connectors**
a) Inner conductor and outer conductor continuity	a) Insulation resistance
b) Insulation resistance	b) Voltage proof
c) Voltage proof	c) Visual inspection
d) Visual inspection	d) Separation and engagement achievable in the normal manner
e) Separation and engagement achievable in the normal manner	

9.4.11 Resistance to solvents and contaminating fluids

9.4.11.1 Procedure

A separate pair of mated connectors is to be used for each of the test fluids to which resistance is to be declared. The test fluids shall be prescribed in the relevant specification and shall be preferably selected from Table 6 and Table 7 below. Unless otherwise prescribed by the relevant specification, the period of immersion shall be 18 h at the test temperature indicated.

Mated connector shall be immersed in the test fluid.

After completion of the conditioning, the specimen shall be wiped clean of surplus fluid and then allowed to dry for 2 h at 70 °C, unless a lower value is prescribed by the relevant sectional or detail specification, whereupon they are exposed to standard atmospheric recovery conditions for 1 h 30 h to 2 h.

9.4.11.2 Test fluids

Fluids with possible detrimental effect on r.f. cables are given in Tables 7 and 8 below, together with the temperature at which the conditioning should be carried out.

Other test fluids, test temperatures and test times may be agreed between customer and supplier.

Table 7 – Fuels, lubricants, hydraulic fluids and anti-freeze agents

	Test fluid	Test temperature °C
1	A mixture of toluene (aromatic) 30 % and isooctane (aliphatic) 70 % (volume)	40 ± 2
2	Wide cut aviation turbine fuel Fluids a) and b) are representative of the worst possible combination of solvents likely to be encountered in cable applications	70 ± 2
3	Di-octyl sebacate (aircraft turbine engine lubrication oil) *	150 ± 2
4	Mineral oil, viscosity approximately 15 cSt at 38 °C	70 ± 2
5	Castor oil 20 %, 2-ethoxyethanol 80 % (volume) (this represents a normal hydraulic fluid)	20 ± 2
6	Phosphate ester hydraulic fluid (synthetic hydraulic fluid)	70 ± 2
7	Dimethyl silicone fluid (high temperature hydraulic fluid) a	150 ± 2
8	Lithium soap/synthetic oil grease (low temperature grease)	20 ± 2
9	Monopropylene glycol (de-icing fluid)	20 ± 2
10	Diesel fuel	20 ± 2
* These fluids are only to be tested on special high temperature cable with a specified operating temperature ≥150 °C.		

Table 8 – Cleaning agents and moisture repellents

	Test fluid	Test temperature °C
1	Carbon tetrachloride*	15 to 35
2	Trichloroethylene, type C*	15 to 35
3	White spirit	15 to 35
4	Petroleum jelly	15 to 35
* optional		

9.4.11.3 Precaution

Many of the fluids listed are highly flammable and may also have toxic effects.

9.4.11.4 Final measurements

At the conclusion of the recovery period, the connectors shall meet the requirements of the relevant specification for the following properties, unless otherwise specified:

a) insulation resistance;

b) engagement and separation;

c) visual inspection.

9.4.11.5 Information to be given in the relevant specification

The following information shall be reported in the relevant specification:

a) applicable conditioning fluids;

b) drying temperature, if different from 70 °C;

c) requirements for final measurements;

d) any deviation from the standard test procedure.

9.4.11.6 Requirements

Pass fail criteria shall be:

a) no visible damage or visible change;

b) the electrical and mechanical characteristics shall remain within the specified limits.

9.4.12 Sulphur dioxide test

9.4.12.1 Procedure

This test shall be carried out in accordance with Test Kc of IEC 60068-2-42. Unless otherwise specified, the direct injection method of generating the conditioning atmosphere as given in Annex A of that publication shall be used.

This test may be preceded by the mechanical endurance test.

The duration of exposure to be prescribed by the relevant specification shall, preferably, be selected from amongst the following preferred values: 4 days, 10 days or 21 days.

The specimens shall then be removed from the chamber and stored under standard atmospheric recovery conditions for 1 h 30 to 2 h.

9.4.12.2 Final tests and measurements

At the conclusion of the recovery period, the connectors shall meet the requirements of the relevant specification for the following properties, unless otherwise specified:

Mated connectors	**Unmated connectors**
a) Contact resistance	a) Contact resistance, immediately after the first engagement of pairs
b) Visual Inspection	b) Visual Inspection

The mated connectors should not be disturbed prior to contact resistance measurement.

9.4.12.3 Information to be given in the relevant specifications

The following information shall be reported in the relevant specifications:

a) measurements, checks and mechanical endurance test to be made prior to the test;

b) duration of exposure;

c) requirements for the final measurements;

d) any deviation from the standard test procedure.

10 Quality assessment

10.1 General

This standard provides details of the general procedures for qualification approval testing and quality conformance inspection. Clause 10 includes information on related documents and procedures, standardized test methods, a basic schedule for test relating to quality conformance inspection and qualification approval, and the preparation of detail specifications.

10.2 Quality assessment steps

10.2.1 Primary stage of manufacture

For quality assessment purpose, the primary stage of manufacture is understood as the first process subsequent to the manufacture of finished piece-parts and sub-assemblies.

10.2.2 Structurally similar components

RF connectors and their accessories are considered as structurally similar for the purpose of sampling inspection and qualification approval provided that they are:

– embodying common principle such as cable attachment, coupling mechanism;

– such that the results of a given test, carried out on one of these components, can be regarded as valid for the other structurally similar components;

– produced with essentially the same design, materials, processes and methods.

Application of structural similarity should be the subject of prior agreement with the certification body.

10.2.3 General principle for obtaining quality conformance

Each sectional specification shall produce a similar schedule of tests appropriate to the type of r.f. connectors covered together with information on the mandatory tests, sampling and quality levels, and details of any deviations from the standard test methods.

The details of the test and inspection schedule in each sectional specification shall form the basis of the test schedule in each dependent detail specification.

Using the test schedule in the detail specification, quality conformance and its maintenance shall normally consist of:

– use of fixed quantity sample procedure

  The total number of specimens required by the detail specification for group D tests, as indicated for the appropriate level, shall be drawn from current production and shall first be subjected to the sequence of tests in test group A1. The sample shall then be divided into groups and subjected to the tests in group D.

– use of specimens selected from inspection lots

  Specimens for group D tests as required by the detail specification for the appropriate level shall be selected from three consecutive inspection lots passing test groups Al and B1 as technically applicable.

The appropriate requirements for passing the group D tests shall be met successfully. There are no group C tests.

Quality conformance inspection shall consist of test groups Al and B1 on a lot-by-lot basis together with group D tests on a periodic basis.

10.3 Test schedule and inspection requirements

10.3.1 Acceptance tests

Table 9 describes the acceptance tests to be performed.

Table 9 – Acceptance tests

–	IEC 61169-1:2013 subclause	Assessment level M (higher)				Assessment level H (lower)			
		Test required	IL	AQL %	Period	Test required	IL	AQL %	Period
Group A1					Lot by Lot				Lot by Lot
Visual examination	9.1.1	a	II	1		a	S3	1,5	
Group B1									
Outline dimension	9.1.2	a	S4	0,4		a	S3	4	
Mechanical compatibility	9.1.2.2	a	II	1		a	S3	1,5	
Engagement and separation	9.3.6	a	S4	0,4		a	S3	1,5	
Gauge retention (resilient contacts)	9.3.5	ia	II	1		ia	S3	1,5	
Insertion retention force (resilient contacts)	9.3.4	ia	II	1		ia	S3	1,5	
Sealing									
non hermetic	9.4.7	ia	II	0,65		ia	S3	1	
hermetic	9.4.8	ia	II	0,015		ia	S3	0,025	
Water immersion	9.4.9	Ia	LI	0,015		ia	S3	0,025	
Voltage proof	9.2.6	a	II	0,4		a	II	4	
Solderability (d)	9.3.2.2	ia	S4	0,4		ia	S3	4	
Insulation resistance	9.2.5	a	S4	0,4		a	S3	4	
For the symbols, abbreviations and procedures, see the end of Table 10.									

10.3.2 Periodic tests

There are no group C tests for levels H and M. Table 10 lists the periodic tests to be performed.

Table 10 – Periodic tests

	IEC 61169-1:2013 subclause	Assessment level M (higher)				Assessment level H (lower)			
Group D1 (d)			**6**	**1**	**3 years**		**3**	**1**	**3 years**
Solderability connector assemblies	9.3.2.1	ia				ia			
Resistance to soldering heat	9.3.2.2	ia				ia			
Mechanical tests on cable fixing									
cable rotation (nutation)	9.3.7	na				na			
cable pulling	9.3.8	ia				ia			
cable bending	9.3.9	ia				ia			
cable torsion	9.3.10	ia				ia			
Group D2 (d)			6	1	3 years		3	1	3 years
Contact resistance, outer conductor and centre conductor continuity	9.2.3	a				a			
Vibration	9.3.3	a							
Damp heat, steady state	9.4.3	a				a			
Group D3 (d)			1	1	3 years		1*	1	3 years
Dimensions piece-parts and materials	9.1.2	a				a			
Group D4 (d)			6	1	3 years		3	1	3 years
Mechanical endurance	9.3.15	a				a			
High temperature endurance	9.4.5	a				a			
Discharge test	9.2.8								
Climatic conditioning	9.4	na				na			
Group D5 (d)			6	1	3 years		3	1	3 years
Return loss	9.2.1	a				a			
Screening effectiveness	9.2.7	a				a			
Water immersion	9.4.9	ia				ia			
Group D6 (d)			6	1	3 years		3	1	3 years
Contact captivation	9.3.5	a				a			
Rapid change of temperature	9.4.4	na				na			
Climatic sequence	9.4.2	a				a			

	IEC 61169-1:2013 subclause	Assessment level M (higher)				Assessment level H (lower)			
Group D7 (d)			1§		3 years		1§		3 years
Salt mist	9.4.10	a							

a = suggested as applicable
ia = test suggested (if technically applicable)
na = not applicable
IL = inspection level
AQL = acceptable quality level
* = one set of piece-parts each style and variant, unless using common piece parts
# = for Qualification Approval (QA), a total of two failures only permitted for level H and 1 failure only for level M from groups D1 to D7
§ = Group D7 – number of pairs for each solvent
(d) = destructive tests – specimens shall not be returned to stock

10.4 Procedures for quality conformance

10.4.1 Quality conformance inspection

This shall consist of test group A1 and B1 on a lot-by-lot basis.

10.4.2 Quality conformance and its maintenance

10.4.2.1 General procedure

This shall consist of three consecutive lots passing test groups A1 and B1 followed by selection of specimens from the lots as appropriate. These specimens shall successfully pass the specified periodic D tests.

10.4.2.2 Procedure for quality conformance involving structural similarity

During the initial procedure, the declared structurally similar styles and variants may be included by merely subjecting the distinguishing piece-part(s) to sub-group D3 testing.

When structurally similar styles or variants are to be added to an existing conformance document, they shall be assembled and subject to group A1 and group B1 testing and any appropriate group D tests. The distinguishing piece-parts shall be subjected to sub-group D3 testing before inclusion of the additional style or variant on the conformance document.

It should be noted that:

a) connector styles and variants of styles may be qualified by invoking structural similarity when applicable;

b) it may not always be considered necessary to assemble and test all structurally similar styles and variants as complete connectors.

10.5 Test and measurement procedures

10.5.1 General

The related clauses cover the majority tests and measuring procedures required for the qualification approval and conformance inspection of r.f. connectors. However,

– not all the tests are applicable to all sectional and detail specifications;

– the sectional specification shall prescribe the tests (and any additional tests) applicable to a particular connector type;

– detail specifications shall identify which of the non-mandatory tests prescribed in the relevant sectional specification are applicable to a particular style/variant of connector;

– any additional test methods shall be clearly identified as such.

10.5.2 Schedule of basic test groupings for acceptance and periodic tests

10.5.2.1 General

Unless otherwise prescribed in the sectional specification (SS), the schedule below shall provide the basis for qualification approval and quality conformance inspection tests to be included in each SS.

Details of any deviations necessary from the standard test method and/or conditions are to be indicated. Tests are to be carried out in the order shown unless otherwise prescribed.

10.5.2.2 Sampling and lot by lot system

One of the following procedures is to be used:

a) Fixed quantity sample procedure

This shall consist of the appropriate fixed quantity sample passing test groups A1 and B1 followed by selection of specimens from the lots as appropriate. These specimens shall successfully pass the specified periodic D tests.

b) Lot-by-lot

This shall consist of three consecutive lots passing test groups A1 and B1 followed by the selection of specimens from the lots as appropriate. These specimens shall successfully pass the specified periodic D tests.

10.6 Specifications

10.6.1 Specification structures

The relationship between the generic, general blank detail, sectional and detail specifications is detailed hereafter.

10.6.2 Sectional specification (SS)

Each sectional specification relates only to a particular series or type of r.f. connector, e.g. Type SMA, Type N, Type BNC, etc.

It prescribes:

– mating face dimensions for general purpose and for test connectors;

– gauging information – particularly that applicable to resilient contacts;

– performance parameters common to all connector styles within the series;

– mandatory tests, indicated by "a" for applicable in the test schedule, and levels of conformance inspection for two levels of quality assessment to be observed when writing an associated detail specification.

The SS also provides recommended ratings, performance characteristics and test conditions to be considered when writing a DS together with any general deviations from the test conditions.

10.6.3 Detail specification (DS)

Detail specifications for levels M and H shall normally be prepared using the blank detail specification provided in 10.6.5 and periodicity of certain specialized tests is dependent upon the physical and electrical characteristics of the individual connector style/variant(s) covered by the DS.

The detail specification, when completed, shall provide the user, manufacturer, test house and certification body with all the necessary information for the approval testing and quality conformance inspection relating to a connector style and any variants within a specific series of r.f. connectors.

10.6.4 Blank detail specification

10.6.4.1 General

Detail specifications (DS) writers shall use the appropriate blank detail specification (BDS). The following pages comprise the BDS dedicated for use with Type XXXX connectors. As such, it will have already entered on it information relation to:

a) the basic specification number applicable to all the detail specifications covering connector styles of the series covered by the sectional specification;

b) the connector series designation.

The specification writer should enter the details relating to the connector style to be covered as indicated. The numbers in brackets in the BDS correspond to the following indications, which shall be given.

10.6.4.2 Identification of the component

1) Enter the following details:
   - Style: the style designation of the connector including type of fixing and sealing if applicable.
   - Attachment: by deletion of the inapplicable options of cable/wire given for centre and outer conductors.
   - Special feathers and marking: as applicable.
   - Series designation: in bold characters/digits approximately 15 mm high.
2) Enter detail of assessment level and the climatic category.
3) A reproduction of the outline drawing and details of the panel piercing (if applicable). It shall provide the maximum envelope dimensions, also the position of the reference plane and, in the case of a fixed connector, the position of the mounting plane(s) relative to the front face of the connector.
4) Any maximum panel thickness limitation for fixed connectors shall be stated.
5) Particulars of all variants covered by the DS. As appropriate, the information shall include
   - cable type (or sizes) applicable to each variant,
   - alternative plated or protective finishes,
   - details of alternative mounting flanges having either tapped or plain mounting holes,
   - details of alternative solder spills or solder buckets including, when applicable, those for use with microwave integrated circuit (MIC) components.

10.6.4.3 Performance

6) Performance data listing the most important characteristics of the connector in accordance with the requirements of the relevant sectional specification. Deviations from the minimum requirements shall be clearly indicated. Non applicable shall be marked “na”.

10.6.4.4 Marking, ordering information and related matters

7) Insert marking and ordering information as appropriate, together with details of related documents and any invoked structural similarity.

10.6.4.5 Selection of tests, test conditions and severities

8) “na” shall be used to indicate non-applicable tests. All tests marked “a” by detail specification writer shall be mandatory.

   When using the normal procedure with a dedicated BDS, the letter “a” for applicable shall be entered in the “test required” column against each of the tests indicated as being mandatory in the test schedule of the relevant sectional specification. Any additional test required at the discretion of the specification writer shall also be indicated by an “a”.

   The specification writer shall also indicate, when necessary, details of deviations from the standard test conditions, including any relevant deviations given in the test schedule of the sectional specification.

10.6.5 Blank detail specification pro-forma for XXXX connectors

The following pages contain the complete BDS pro-forma.

<table>
<tr><td colspan="3">(1)</td><td colspan="3">Page 1 of
(2)</td></tr>
<tr><td colspan="3">ELECTRONIC COMPONENT OF ASSESSED QUALITY IN ACCORDANCE WITH GENERIC SPECIFICATION IEC 61169-1:2013
NATIONAL REFERENCE</td><td colspan="3">ISSUE
(3) .
(4) .</td></tr>
<tr><td colspan="4">(5) Detail specification for radio frequency coaxial connector of assessed quality</td><td colspan="2">Type</td></tr>
<tr><td colspan="3">Style</td><td colspan="3">Special features and markings</td></tr>
<tr><td colspan="2">Method of cable/wire+ attachment</td><td colspan="4">centre conductor – solder/crimp+
outer conductor – solder/clamp/crimp +
+ delete as appropriate</td></tr>
<tr><td colspan="2">(6) Assessment level</td><td colspan="2">Characteristic impedance ...
Ω</td><td colspan="2">Climatic category..../.../.../</td></tr>
<tr><td colspan="3">(7) Outline and maximum dimensions</td><td colspan="3">Panel piercing and mounting details</td></tr>
<tr><td colspan="6">(8) Variants</td></tr>
<tr><td>Variant No.

01</td><td>Description of variant</td><td>IEC 61196</td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Information about manufacturers who have components qualified under the IECQ Conformity Assessment System is available through the IECQ on-line certificate system.</td></tr>
</table>

(9) Performance (including limiting conditions of use)

Ratings and characteristics	Variant No. Designation	IEC 61169-1:2013 subclause	Value	Remarks including any deviations from standard test methods
Electrical				
Nominal impedance			Ω	
Frequency range Return loss	01	9.2.1	GHz GHz GHz GHz	Measurement frequency range
Centre contact resistance		9.2.3	≤ mΩ ≤ mΩ	Initial After conditioning
Centre conductor continuity	01	9.2.3	≤ mΩ ≤ mΩ ≤ mΩ ≤ mΩ	Resistance change due to conditioning
Outer contact continuity		9.2.3	≤ mΩ ≤ mΩ	Initial After conditioning
Insulation resistance		9.2.5	≥ GΩ ≥ GΩ	Initial After conditioning
+ Proof voltage at sea level	01	9.2.6	kV kV kV kV	86 kPa to106 kPa
+ Proof voltage at 4,4 kPa	01	9.2.6	kV kV kV kV	kPa (if not 4,4 kPa)
Screening effectiveness	01	9.2.7	dB at GHz	Z_t ≤ mΩ
Discharge test (corona) at sea level	01	9.2.8	≥ V ≥ V ≥ V ≥ V	Extinction voltage
ADDITIONAL ELECTRICAL CHARACTERISTICS				
+ Voltage values are r.m.s. values at 50 Hz to 60 Hz, unless otherwise specified.				

Ratings and characteristics	Variant No. Designation	IEC 61169-1:2013 subclause	Value	Remarks including any deviations from standard test methods
Mechanical				
Soldering - bit size		9.3.2		
Gauge retention resilient contacts - inner contact - outer contact		9.3.4	 N N	
Centre contact captivation - axial force - permitted displacement in each direction - torque		9.3.5	 N mm Nm	
Engagement and separation - axial force		9.3.6		
Strength of coupling mechanism		9.3.11	N	
Effectiveness of cable fixing against - cable rotation	01	9.3.7	Rotations	
- cable pulling	01	9.3.8	N N N N	
- cable bending	01	9.3.9	cycles	Length of cable and mass
- cable torsion	01	9.3.10	Nm	
Bending moment		9.3.12	Nm	Relative to reference plane
Bumps total		9.3.13	m/s^2 to Hz	(g_n acceleration)
Vibration		9.3.3	m/s^2 to Hz	(g_n acceleration)
Shock		9.3.14	m/s^2 Shape ms	(g_n acceleration)
ADDITIONAL MECHANICAL CHARACTERISTICS				

Ratings and characteristics	Variant No. Designation	IEC 61169-1:2013 subclause	Value	Remarks including any deviations from standard test methods
Environmental				
Climatic category			/* /	
Sealing non-hermetically sealed connectors		9.4.7	cm^3/h	100 kPa to 110 kPa pressure differential
Sealing hermetically sealed connectors		9.4.8	10^{-5} $bar/cm^3/h$	100 kPa to 110 kPa pressure differential
Water immersion		9.4.9		
Salt mist		9.4.10	h	Duration of spraying
ADDITIONAL ENVIRONMENTAL CHARACTERISTICS				
Endurance				
Mechanical		9.3.15	operations	
High temperature		9.4.5	h at °C	
ADDITIONAL ENDURANCE CHARACTERISTICS				
CHEMICAL CONTAMINATION				
Resistance to solvents and contaminating fluids to be used Applicable fluids		9.4.11		
Sulphur dioxide		9.4.12	days	

(10) Supplementary information

– Marking of the component: in accordance with 11.1 of IEC 61169-1:2013 in the following order of procedure 1) Identity of manufacture 2) Manufacturing date code year /week 3) Component identification variant No./designation Identification . . . .
– Marking and contents of package: in accordance with 11.2 of IEC 61169-1:2013 1) Information prescribed in 11.1 of IEC 61169-1:2013 detailed above 2) Nominal characteristic impedance Ω 3) Assessment level code letter 4) Any additional marking required
– **Ordering information**: 1) Number of the detail specification /variant code Assessment level code letter 2) Body finish (if more than one listed) 3) Any additional information or special requirements
– Related documents (if not included in IEC 61169-1:2013 or sectional specification): .
– Structural similarity in accordance with 10.2.2 of IEC 61169-1:2013
Relevant information on a basic style should be entered as variant 01.

11 Marking

11.1 Marking of component

Each component shall be legibly and durably marked, where space permits and in the following order of precedence, with:

a) identity code of the manufacturer;

b) manufacturer's connector identification code or IEC connector designation.

If the nominal impedance of a connector is to be indicated by colour coding, the following convention shall be used:

50 : no additional colouring 75 Ω: yellow or black band

11.2 Marking and contents of package

The package shall be marked with the information prescribed in 11.1 and, in addition, the following information shall be given:

a) nominal characteristic impedance;

b) manufacturing date code;

c) any additional marking required by the relevant specification.

When required by the relevant specification, the package shall also include instructions for assembling the connector(s) and instructions for the use of any special tools or materials, as necessary.

Annex A
(informative)

Simulated sea-water solution for use with salt mist test (marine environment, see 9.4.10.3)

When prescribed by the detail specification, the following solution should be used in place of the standard sodium chloride solution, details of which are given in Clause 5 of IEC 60068-2-52:1996.

Simulated sea-water solution:

The solution shall be prepared by dissolving the following salts in distilled or demineralized water and making up to 1 l:

sodium chloride	NaCl	26,5 g
magnesium chloride	$MgCl_2$,	2,4 g
magnesium sulfate	$MgSO_4$	3,3 g
calcium chloride	$CaCl_2$	1,1 g
sodium bicarbonate	$NaHCO_3$	0,20 g
potassium chloride	KCl	0,73 g
sodium bromide	NaBr	0,28 g

The above quantities shall be accurate to within ± 10 %.

These quantities refer to the anhydrous version of the salts. The salts shall be of laboratory reagent grade or similar purity.

The pH value of the solution, when checked and maintained in accordance with 5.1.2 of IEC 60068-2-52:1996, shall be between 6,5 and 8,5.

Bibliography

IEC 60096-1, *Recommendations for radio-frequency cables – Part 1: General requirements and measuring methods*[4]

IEC 60096-2, *Radio-frequency cables – Part 2: Relevant cable specifications*[5]

IEC 60410, *Sampling plans and procedures for inspection by attributes*

IEC 60419 (all parts), *Guide for the inclusion of lot-by-lot and periodic inspection procedures in specifications for electronic components (or parts)* [6]

IEC 60457 (all parts), *Rigid precision coaxial lines and their associated precision connectors*

IEC 61196 (all parts), *Coaxial communication cables*

ISO 129-1, *Technical drawings – Indication of dimensions and tolerances – Part 1: General principles*

ISO 286-1, *Geometrical product specifications (GPS) – ISO code system for tolerances on linear sizes – Part 1: Basis of tolerances, deviations and fits*

ISO 1302, *Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation*

ISO 2015, *Numbering of weeks*[7]

ISO 2859-0, *Sampling procedures for inspection by attributes – Part 0: Introduction to the ISO 2859 attribute sampling system* [8]

ISO 2859-1, *Sampling procedures for inspection by attributes – Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection*

ISO 3166, *Codes for the representation of names of countries* [9]

ISO 5459, *Geometrical product specifications (GPS) – Geometrical tolerancing – Datums and datum systems*

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4 This publication has been withdrawn.

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