

**Harmonized system of quality
assessment for electronic components**

Radio-frequency connectors —

**Part 1: Generic specification —
General requirements and measuring
methods**

The European Standard EN 61169-1:1994 with the inclusion of amendments A1:1996 and A2:1997 has the status of a British Standard

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Committees responsible for this British Standard

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- AEA Technology
- BEAMA Electrical Cable and Conductor Accessory Manufacturer's Association
- British Telecommunications plc
- Federation of the Electronics Industry
- Ministry of Defence
- National Supervising Inspectorate (BSI QA)
- Society of Cable Telecommunication Engineers

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National foreword

This British Standard has been prepared by Subcommittee EPL/46/4. It is the English language version of EN 61169-1:1994 *Radio frequency connectors — Part 1: Generic specification — General requirements and measuring methods*, including amendments A1:1996 and A2:1997, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with

IEC 61169-1:1992 (QC 220000) including amendments 1:1996 and 2:1997 published by the International Electrotechnical Commission (IEC).

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Publication referred to	Corresponding British Standard
	BS 4727 <i>Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms</i> Part 1: <i>Terms common to power, telecommunications and electronics</i>
IEC 50(151):1978	Group 2:1980 <i>Electrical and magnetic devices terminology</i> BS EN 60068 <i>Environmental testing</i>
EN 60068-1:1995 ^a (IEC 68-1:1988)	BS EN 60068-1:1995 <i>General and guidance</i>
	BS EN 60068-2 <i>Test methods</i>
EN 60068-2-1:1993 (IEC 68-2-1:1990)	BS EN 60068-2-1:1993 <i>Tests A. Cold</i>
EN 60068-2-2:1993 (IEC 68-2-2:1974)	BS EN 60068-2-2:1993 <i>Tests B. Dry heat</i>
IEC 68-2-6:1982	BS EN 60068-2-6:1995 <i>Test Fc. Vibration</i>
EN 60068-2-17:1994 (IEC 68-2-17:1994)	BS EN 60068-2-17:1995 <i>Test Q. Sealing</i>
EN 60068-2-27:1993 (IEC 68-2-27:1987)	BS EN 60068-2-27:1993 <i>Test Ea and guidance: Shock</i>
EN 60068-2-29:1993 (IEC 68-2-29:1987)	BS EN 60068-2-29:1993 <i>Test Eb and guidance: Bump</i>
EN 60068-2-47:1993 (IEC 68-2-47:1982)	BS EN 60068-2-47:1993 <i>Mounting of components, equipment and other articles for dynamic tests including shock (Ea), bump (Eb), vibration (Fc and Fd) and steady state acceleration (Ga) and guidance</i> BS 2011 <i>Environmental testing</i>
HD 323.2.3 S2:1987 (IEC 68-2-3:1969)	Part 2.1 Ca:1977 <i>Test Ca. Damp heat, steady state</i>
HD 323.2.11 S1:1988 (IEC 68-2-11:1981)	Part 2.1 Ka:1982 <i>Test Ka. Salt mist</i>
HD 323 2.13 S1:1987 (IEC 68-2-13:1983)	Part 2.1 M:1984 <i>Test M. Low air pressure</i>
HD 323.2.14 S2:1987 (IEC 68-2-14:1984)	Part 2.1 N:1985 <i>Test N. Change of temperature</i>
HD 323.2.20 S3:1988 (IEC 68-2-20:1979)	Part 2.1 T:1981 <i>Test T. Soldering</i>

HD 323.2.30 S3:1988 (IEC 68-2-30:1980)	Part 2.1 Db:1981 <i>Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle)</i>
HD 323.2.54 S1:1987 (IEC 68-2-54:1985)	Part 2.1 Ta:1989 <i>Test Ta. Soldering, Solderability testing by the wetting balance method</i>
ISO 1000:1992 ^b	BS 5555:1993 <i>Specification for SI units and recommendations for the use of their multiples and of certain other units</i>

^a EN 60068-1:1995 supersedes HD 323.1 S2:1988.

^b ISO 1000:1992 supersedes ISO 1000:1981.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, the EN title page, pages 2 to 76, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Radio-frequency connectors

Part 1: Generic specification — General requirements and measuring methods

(includes amendments A1:1996 and A2:1997)
(IEC 1169-1:1992 + A1:1996 + A2:1997)

Connecteurs pour fréquences radioélectriques
Partie 1: Spécification générique —
Prescriptions générales et méthodes de mesure
(inclut les amendements A1:1996
et A2:1997)
(CEI 1169-1:1992 + A1:1996 + A2:1997)

Hochfrequenz-Steckverbinder
Teil 1: Fachgrundspezifikation Allgemeine
Anforderungen und Meßverfahren
(enthält Änderungen A1:1996 und A2:1997)
(IEC 1169-1:1992 + A1:1996 + A2:1997)

This European Standard was approved by CENELEC on 1994-03-08; amendment A1 was approved by CENELEC on 1996-07-02 and amendment A2 was approved by CENELEC on 1997-03-11. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The CENELEC questionnaire procedure, performed for finding out whether or not the International Standard IEC 1169-1:1992 could be accepted without textural changes, has shown that no common modifications were necessary for the acceptance as European Standard.

The reference document was submitted to the CENELEC members for formal vote and was approved by CENELEC as EN 61169-1 on 8 March 1994.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1995-03-15
- latest date of withdrawal of conflicting national standards (dow) 1995-03-15

Annexes designated “normative” are part of the body of the standard. Annexes designated “informative” are given for information. In this standard, Annex A and Annex B are informative and Annex ZA is normative.

Foreword of amendment A1

The text of document 46D/245/FDIS, future amendment 1 to IEC 1169-1:1992, prepared by SC 46D, RF connectors, of IEC TC 46, Cables, wires, waveguides, RF connectors, and accessories for communication and signalling, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 61169-1:1994 on 1996-07-02.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-04-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1997-04-01

Foreword of amendment A2

The text of document 46D/279/FDIS, future amendment 2 to IEC 61169-1:1992, prepared by SC 46D, RF connectors, of IEC TC 46, Cables, wires, waveguides, R.F. connectors, and accessories for communication and signalling, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A2 to EN 61169-1:1994 on 1997-03-11.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-01-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1998-01-01

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Cross-reference table of corresponding clauses in IEC Publications 169-1 and 1169-1

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1 Scope

This standard relates to connectors for r.f. transmission lines for use in telecommunications, electronic and similar equipment.

2 Object

This standard serves as a generic specification providing 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 and mechanical properties;
- classification of connectors with regard to environmental testing procedures involving temperature, humidity and vibration.

The test methods and procedures of the standard are intended and acceptance for type approval testing. They may also be adopted, by agreement between manufacturer and customer, to serve as a basis for acceptance tests.

3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 1169. At the time of publication of this standard, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 1169 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 27, *Letter Symbols to be Used in Electrical Technology*.

IEC 50, *International Electrotechnical Vocabulary*.

IEC 50(151):1978, *Electrical and Magnetic Devices*.

IEC 68-1:1988, *Environmental testing — Part 1: General and guidance*.

IEC 68-2-1:1990, *Environmental testing — Part 2: Tests — Test A: Cold*.

IEC 68-2-2:1974, *Environmental testing — Test B: Dry heat*.

IEC 68-2-3:1969, *Environmental testing — Test Ca: Damp heat, steady state*.

IEC 68-2-6:1982, *Environmental testing — Test Fc and guidance: Vibration (sinusoidal)*.

IEC 68-2-11:1981, *Environmental testing — Test Ka: Salt mist*.

IEC 68-2-13:1983, *Environmental testing — Test M: Low air pressure*.

IEC 68-2-14:1984, *Environmental testing — Test N: Change of temperature*.

IEC 68-2-17:1978, *Environmental testing — Test Q: Sealing*.

IEC 68-2-20:1979, *Environmental testing — Test T: Soldering*.

IEC 68-2-27:1987, *Environmental testing — Test Ea and guidance: Shock*.

IEC 68-2-29:1987, *Environmental testing — Test Eb and guidance: Bump*.

IEC 68-2-30:1980, *Environmental testing — Test Db and guidance: Damp heat, cyclic: (12 + 12 hour cycle)*.

IEC 68-2-42:1980, *Environmental testing — Test Kc: Sulphur dioxide test for contacts and connections*.

IEC 68-2-47:1982, *Environmental testing — Mounting of components, equipment and other articles for dynamic tests*.

IEC 68-2-54:1985, *Environmental testing — Test Ta: Solderability testing by the wetting balance method*.

IEC 457-1:1974, *Rigid precision coaxial lines and their associated precision connectors. Part 1: General requirements and measuring methods*.

IEC 617, *Graphical symbols for diagrams*.

ISO 370:1975, *Toleranced dimensions — Conversion from inches into millimetres and vice versa*.

ISO 1000:1981, *SI units and recommendations for the use of their multiples and of certain other units*.

4 Definitions

For the purpose of this standard, the following definitions apply:

4.1 General, parts of connectors

4.1.1 (electrical) contact

the 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

4.1.2 contact

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

4.1.3 male contact

pin contact

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

4.1.4 female contact

socket contact

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

4.1.5 hermaphroditic contact

a contact which is intended to mate with an identical contact

4.1.6 resilient contact

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

4.2 Basic connector terms

4.2.1 connector

a 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

4.2.2 connector pair

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

4.2.3 type

series

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

NOTE 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.

4.2.4 style

a particular form or shape of connector, as well as a combination of connectors of the same type. Examples are: free and fixed connectors, both straight and right angle, within-type adaptors straight and right angle

NOTE For “adaptor”, see 4.5.1 to 4.5.5: a “within-type adaptor” may also be considered as a particular style of a given type.

4.2.5**variant**

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

4.2.6**grade**

a qualification of a connector with regard to mechanical and electrical precision in particular with respect to a defined reflection factor

4.2.7**general purpose connector: Grade 2**

a connector making use of the widest permitted dimensional deviations (tolerances) so as still to guarantee minimum stated performance and intermateability

NOTE A requirement for the reflection factor may or may not be specified.

4.2.8**high performance connector: Grade 1**

a connector for which limits of reflection factor are specified as a function of frequency. 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 reflection factor requirements are met

4.2.9**standard test connector: Grade 0**

a precisely made connector of a particular type used to carry out reflection factor measurements on Grade 1 and Grade 2 connectors, contributing only negligible errors to the measuring result

NOTE 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.

4.2.10**precision connector**

a 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. 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 457-1: Rigid precision coaxial lines and their associated precision connectors, Part 1: General requirements and measuring methods

4.2.11**laboratory precision connector (LPC)**

a precision connector without dielectric support for the centre conductor

4.2.12**general precision connector (GPC)**

a precision connector with self-contained dielectric support capable of supporting the unsupported centre conductor of an LPC and standard air-line with which it is mated

4.3 Constructional terms**4.3.1****male connector**

pin connector

a connector containing a male (pin) centre contact

4.3.2**female connector**

socket connector

a connector containing a female (socket) centre contact

4.3.3

plug connector

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

NOTE Depending on the particular type, a plug may be a male or female connector.

4.3.4

socket

a connector complementary to the plug

4.3.5

hermaphroditic connector

a connector which mates with an identical connector

NOTE The coupling (locking) means need not be hermaphroditic.

4.3.6

free connector

a connector for attachment to a free end of a cable. It is normally a plug

NOTE If not specified as fixed, a connector is assumed to be free.

4.3.7

fixed connector

a connector with provision for attachment to a mounting surface. It is normally a socket

4.3.8

triaxial

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

4.4 Sealing

4.4.1

sealed connector

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

4.4.2

barrier seal

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

4.4.3

panel seal

a 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 The sealing member is often provided as a discrete item.

4.4.4

mating face seal

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

4.4.5

hermetic seal

a seal meeting the requirements specified on application of Test Qk of IEC 68-2-17: Environmental testing, Part 2: Tests, Test Q: Sealing

4.5 Miscellaneous terms and terms concerning measuring equipment

4.5.1

adaptor

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

4.5.2**fixed adaptor**

an adaptor with provision for attachment to a mounting surface

NOTE If not specified as fixed, an adaptor is assumed to be free.

4.5.3**within-type adaptor**

an adaptor for use between two or more connectors all of the same type

4.5.4**inter-type adaptor**

an adaptor for use between two or more connectors of different types

4.5.5**standard test adaptor**

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

4.5.6**standard air line**

a 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

4.5.7**reference line**

an air line similar to the standard air line but with dielectric support of the inner conductor, and with a design such that the internal reflection factor is kept at a minimum within the frequency range made use of for measurements

4.5.8**cable simulator**

a section of precise transmission line with accurate characteristic impedance, in general a precision cable, to which the connector under test is attached in such a way that the transition from line to connector simulates as precisely as possible the normal state of the connector attached to an appropriate cable (in particular with regard to reflection factor and reactive disturbances)

4.5.9**proof coupling torque**

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

4.5.10**normal coupling torque**

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

4.5.11**engagement and separation torque**

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

4.6 General electrotechnical terms

NOTE The following terms and definitions are taken from IEC 50(151): International Electrotechnical Vocabulary (IEV), Chapter 151: Electrical and Magnetic Devices, where they are numbered 151-04-01, 151-04-02 and 151-04-03, respectively. The note added to 3.6.1, nominal value, is for the purpose of this standard.

4.6.1

nominal value

a suitable approximate quantity value used to designate or identify a component, device or equipment

NOTE It follows from the definition that a nominal value is not subject to tolerances.

4.6.2

limiting value

in a specification, the greatest or smallest admissible value of one of the quantities

4.6.3

rated value

a quantity value assigned, generally by a manufacturer, for a specified operating condition of a component, device or equipment

5 Units, symbols and dimensions

5.1 Units and symbols

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

IEC publications:

27: *Letter symbols to be used in electrical technology.*

50: *International Electrotechnical Vocabulary (IEV).*

617: *Graphical symbols for diagrams.*

Other publication:

ISO Standard 1000 (1981): *SI units and recommendations for the use of their multiples and of certain other units.*

5.2 Dimensions

5.2.1 Details to be provided in relevant specifications

Each relevant specification shall provide:

- i) sufficient dimensional information on the mating faces of general purpose and standard test connectors as to ensure intermateability and compliance with performance requirements: crimping dies, when used, shall be in accordance with the dimensions shown in IEC 803;
- ii) information on the connector envelope maximum dimensions to enable the user to accommodate the connectors in his equipment.

The essential purpose of the drawings is to ensure mechanical interchangeability and adequate electrical performance: they are not, however, intended to restrict details of construction which do not affect interchangeability or performance, nor are they to be used as manufacturing drawings.

NOTE Equipment designers should work to the limits stated in the outline drawings and not to the dimensions of individual specimens.

5.2.2 Dimensional units to be used in specifications

The dimensions and tolerances shall be given in both millimetres and inches. The original system of units shall be stated.

Independent of the system of units, the highest accuracy required by the dimensions shall be such that the values, the first digit of which is 1 or 2, shall not comprise more than five digits, those with the first digit being 3 to 9 shall not have more than four significant digits. In any case, the precision shall be limited to 1 μm or 0,00005 in.

5.2.3 Conversion of dimensions given in inches into millimetres and vice versa

During the conversion of the dimensions, in principle they shall be rounded to the nearest 0,001 mm or 0,00005 in. Where, however, mechanical and electrical considerations permit, the rounding shall usually be to the nearest 0,01 mm or 0,0005 in. This also holds for the conversion between the systems of units after having made the exact calculation according to ISO Standard 370: Toleranced dimensions, conversion from inches to millimetres and vice versa.

A note shall be added to each specification reading:

“The values for the dimensions in...¹⁾...derived from these in...¹⁾.... are not necessarily exact according to ISO Standard 370: Toleranced dimensions — Conversion from inches into millimetres and vice versa. They are, however, to be considered as acceptable rounded values with regard to accuracy.

NOTE For more details, see 9.1.3 of IEC 1169-1.”

6 Standard 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 short description of the connector construction stating in particular the inner diameter of the outer conductor and, if applicable, the cable types preferable to be used with the connector;
- the reflection factor as a function of frequency for the different grades (if applicable) together with the conditions for which it is valid;
- the working voltage at different altitudes (pressures);
- the climatic categories;
- any other rating or characteristic applicable.

7 Classification into climatic categories

The classification of connectors with regard to climatic conditions is based on IEC 68-1: Part 1: General and Guidance, 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 to be prescribed by the relevant specification shall preferably, but not necessarily, be selected from the following preferred values:

Low temperature	– 40 °C, – 55 °C
High temperature	85 °C (category 085), 125 °C and 155 °C
Duration of damp heat, steady state	4 days (category 04), 21 and 56 days

The following two groups are recommended as preferred climatic categories for r.f. connectors:

40/085/21

55/155/21

8 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. The IEC as a body cannot accept responsibility in this matter.

¹⁾ Millimetres or inches to be entered as applicable.

9 Test Methods

9.1 General

This section comprises the description of electrical and mechanical measuring methods, environmental conditionings and testing procedures to be used and acceptance for type testing, but which are also applicable to other testing purposes. In general no requirements are directly specified. However, where appropriate, one or more preferred severities are given.

The relevant specification shall prescribe those tests, measuring methods and procedures, taken from the library of tests as contained in this chapter, needed for a specific product, together with the appropriate severities and requirements.

For technical reasons some of the tests have to be carried out in a definite sequence on the same specimens. Separate specimens may be required for different sequences. Since, for some tests the specimens undergo a treatment which excludes them from being sold, it is an economic measure to form appropriate test groups.

A schedule of test groups taking into account the above is shown in Annex A. This schedule is expected to be applicable, in principle, to all types of connectors, deleting those tests or sequences not required for a particular type or style.

According to the schedule, all specimens of a test sample should be submitted to the first group of tests. The sample is then split up into the required number of equal sub-samples of not less than four pairs of connectors, unless otherwise specified.

9.1.1 *Standard conditions for testing*

Unless otherwise specified, the following conditions shall apply:

- tests shall be carried out under standard atmospheric conditions for testing as specified in IEC 68-1;
- 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.
- recovery conditions for the interval after a conditioning and the next measurement or test shall be in accordance with IEC 68-1.

The test schedule is shown in **10.3** and details of conditioning in **9.4**.

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 (normally supplied with the connectors).

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.

When mounting is required in a test, the connector shall be securely mounted on a rigid plate of suitable material, using a clamp for free connectors or the normal fixing for fixed connectors. The dimensions of the mounting plate shall be such that the contour of the specimen is exceeded.

Mounting and arrangement of cables/wires for dynamic tests such as bump, vibration and shock, shall be in accordance with IEC 68-2-47. Unless otherwise specified in the relevant specification cables/wires shall be clamped to the test table in axial alignment at a distance of $90\text{ mm} \pm 10\text{ mm}$ from each cable outlet. The free end of the cable shall be restrained from rotation by clamping to a rigid support.

Unless otherwise indicated in the relevant specification the effects of gravitational force and the direction and level of the prevailing magnetic field may be disregarded when carrying out dynamic tests.

In the case of mounted connectors subjected to environmental conditioning, care shall be taken to ensure that the surface finish of the mounting plate is compatible with that of the connector body so that electrolytic corrosion due to contact of dissimilar metals is avoided. For sealed connectors the mounting shall take the form of a suitable test jig so that without disturbance of the panel seals, the leakage rate may be measured at the conclusion of the recovery period after the environmental conditioning.

The back-of-panel portion of such fixed connectors, when appropriate, shall be protected. The free ends of cable shall be protected against the ingress of moisture.

For tests involving exposure to high temperature — usually the upper temperature category as in the climatic sequence, rapid change of temperature and high temperature endurance, a cable with an appropriate temperature capability should be used. The upper temperature limit of the cable specified may, however, be less than of the connector.

9.1.2 *Visual inspection*

Visual inspection shall include a check on:

a) The marking:

it shall be correct in accordance with 11.2 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 11.2.

9.1.3 *Dimensions*

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.

9.1.3.1 *Outline dimensions*

The outline dimensions shall comply with those specified in the relevant specification. When specified as a lot-by-lot inspection, this requirement may be demonstrated prior to final assembly.

9.1.3.2 *Piece-parts-with-materials*

One set of piece-parts supplied to the requirements of the relevant specification shall be checked with compliance with the drawings quoted on the qualification approval application or certificate.

9.1.3.3 *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 *Reflection factor*

9.2.1.1 *General considerations*

The reflection factor of r.f. 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 0). 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.

Alternatively the use of a cable simulator is permitted.

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.

The reflection factor shall be expressed as a function of frequency. Measurements shall usually be made in the frequency domain, preferably by using a swept-frequency generator. Measuring in the time domain and converting to frequency domain may be suitable up to frequencies of approximately 1 GHz and has the particular advantage of permitting the separation of reflections arising from the connector under test from other reflections in the system. This is more difficult to achieve, in particular at low frequencies, when measuring in the frequency domain.

If spot frequency, as distinguished from sweep-frequency, techniques are used, appropriately small frequency increments shall be employed. Spot-frequency techniques are not satisfactory for error recognition methods, unless the generator (normally automatically controlled) permits very small increments of frequency.

Examples of appropriate equipment for measuring the reflection factor as a function of frequency include radio-frequency bridges, directional couplers and slotted lines. Measuring set-ups using this equipment without special provisions for recognition of errors originating from different defects are, in general, only satisfactory for reflection factors greater than 0,05 (considering that the measuring uncertainty should not be greater than 10 % of the quantity measured).

For testing connectors with specified reflection factor limits lower than 0,05 the use of a set-up permitting the recognition of error contributions, and thus permitting the evaluation of the relevant reflection, will in general be necessary.

There are some computer controlled automated measurement systems having enhancement routines with error correction models that reduce the measurement uncertainty in reflection factor to the point where further recognition methods are not required.

9.2.1.2 *Information to be given in the relevant specification*

- a) limits for the reflection factor as a function of frequency 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.

9.2.1.3 *Normal measuring methods*

9.2.1.4 *Ordinary measuring set-up*

Figure 1 shows a simple set-up, using either a bridge, a directional coupler or a slotted line, with which the recognition of errors from different sources is not normally possible. In this figure, the principle locations where reflections may occur are marked with B, C and D, together with the associated reflection factors r_b , r_c and r_d . The reflection factor due to the connector under test is r_x .

The measuring port error r_b represents not only the reflection at that location but incorporates also bridge, coupler or slotted line residual errors.

Since the phases of the several reflected waves depend on the electrical lengths between the locations and, therefore, on the frequency, their contributions to the apparent total reflection factor are random. The root mean square value obtained, therefore, is:

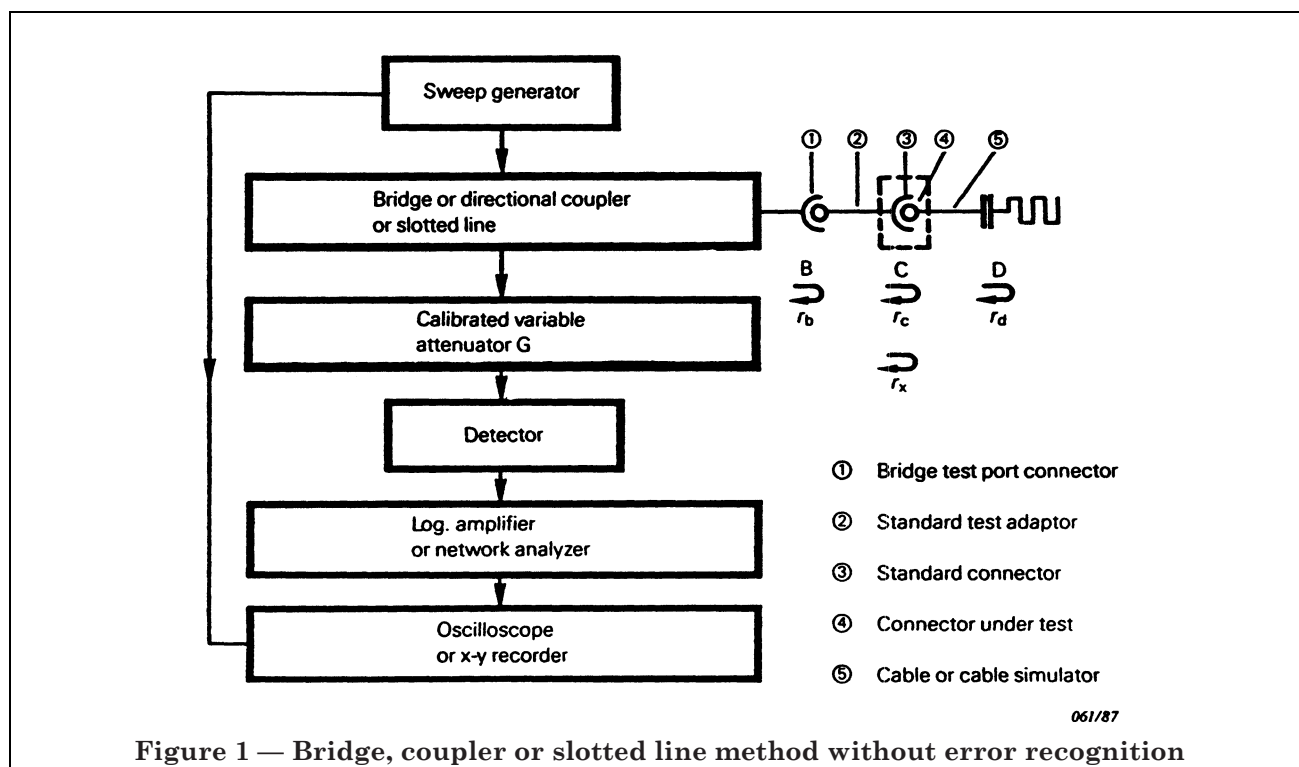
$$r_{\text{total}} = \sqrt{r_x^2 + (r_b^2 + r_c^2 + r_d^2)}$$

As an example, typical values may be $r_b = 0,018$, $r_c = r_d = 0,01$. Assuming $r_x = 0,05$ this leads to:

$$\frac{r_{\text{total}}}{r_x} = 1,1$$

This represents an inaccuracy of 10 %. Single values at individual frequencies may, of course, be affected by much greater or smaller errors.

Although a swept-frequency generator is indicated in Figure 1, this is not intended to preclude the use of spot-frequency techniques, taking into due account the warning expressed in 9.2.1.1.



9.2.1.5 Two-connector procedure

A special procedure, called the two-connector procedure, uses as test set-up two, as far as possible identical, test specimens interconnected back to back by a section of cable previously selected for accuracy and uniformity of characteristic impedance. While not permitting the recognition of errors, this procedure allows identification with good probability whether appreciable disturbances are present.

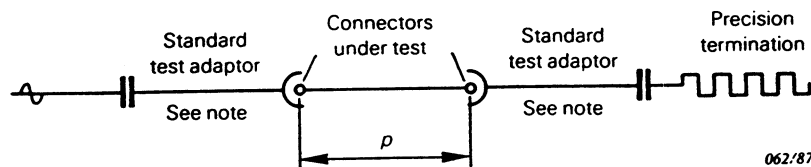
The procedure is illustrated in Figure 2. It makes use of the phenomena that for two identical test specimens, which have also equal reflection factors as a function of frequency, the reflections from the two connectors cancel each other each time the distance p between them corresponds to an odd number of quarter wavelengths, and they add numerically to double their individual value if p equals an even number of quarter wavelengths of the wave in the interconnecting section p . Complete cancellation is a fairly reliable criterion for both the exact equality of the reflections from the two connectors and the absence of spurious reflections in the system.

In practical applications, the loss in the cable section p prevents the backward waves, resulting from equal reflection factors, from producing complete cancellation at the nodes. Unequal reflections manifest themselves as unequal minima when the connector assembly is reversed. In general, low maximum values (low reflection factor) with minimum values that do not change with reversal of the assembly, are acceptable. However, maximum values corresponding to reflection factors in excess of specified data, or considerable change in minimum values when the assembly is reversed should result in both connectors and cable being inspected before further tests are resumed.

The interconnecting cable of the connectors shall consist either of a prescribed cable of verified performance or an adequate cable simulator. The cable shall be no longer than is necessary with regard to the lowest frequency at which the reflection factor is to be measured. Several lengths p may be advisable for a wide frequency range and also if results are required at frequencies not covered by the series of anti-nodes.

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 two-connector procedure may be used in conjunction with bridge, directional coupler or slotted line measuring methods. In the following, the latter method is described in some detail.



NOTE Instead of using standard test adaptors, standard test connectors may be directly used on the generator port and the precision termination.

Figure 2 — Measuring set-up for two connector procedure

Figure 3 shows the x-y-plot of the voltage on the slotted line, preferably using a logarithmic scale graded in decibels, as a function of frequency with the probe position as a parameter (the probe is simply moved by an appropriate amount after each frequency sweep). The display of the curves permits the envelopes to be drawn. Thus, the minimum widths of the display may be judged. The maximum widths of the envelope correspond to the voltage standing wave ratio (VSWR) from which the reflection factor at the particular frequency is derived.

The numerical value of the reflection factor r corresponding to the maximum is given by the formula:

$$\text{for a single connector: } r = \frac{1}{2} \frac{\text{VSWR} - 1}{\text{VSWR} + 1}$$

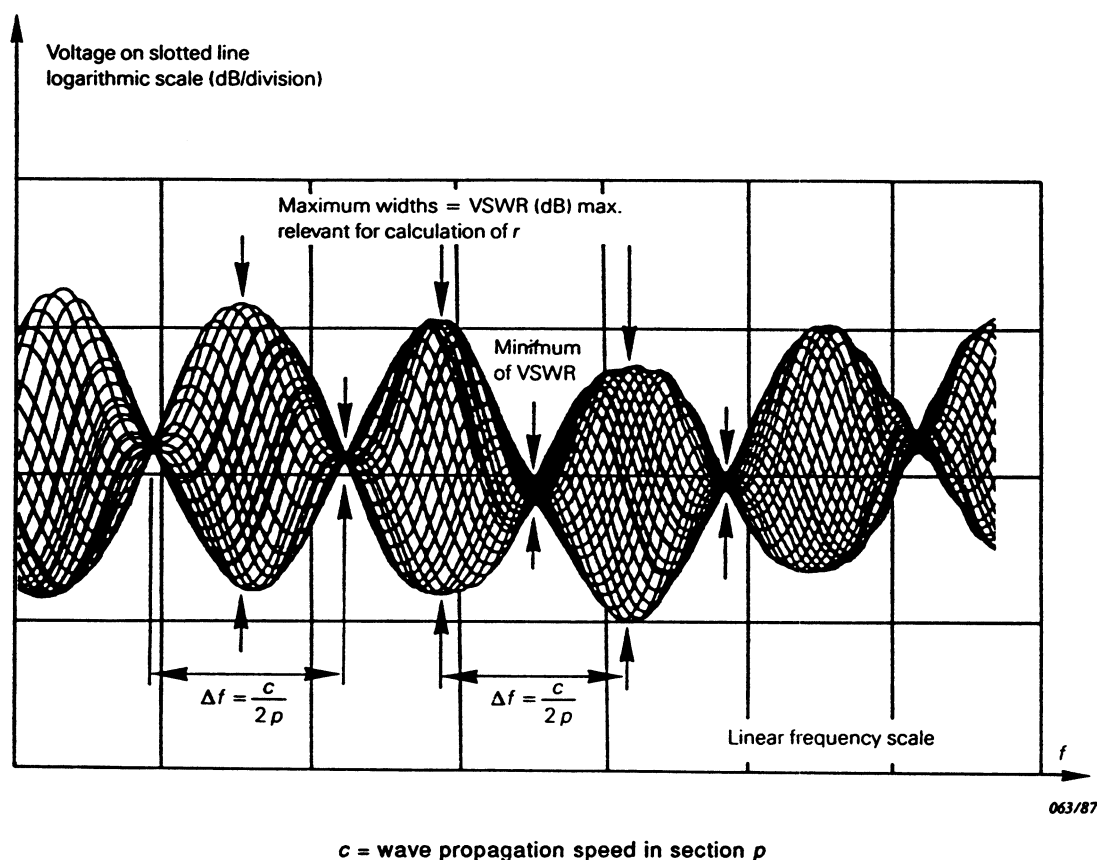
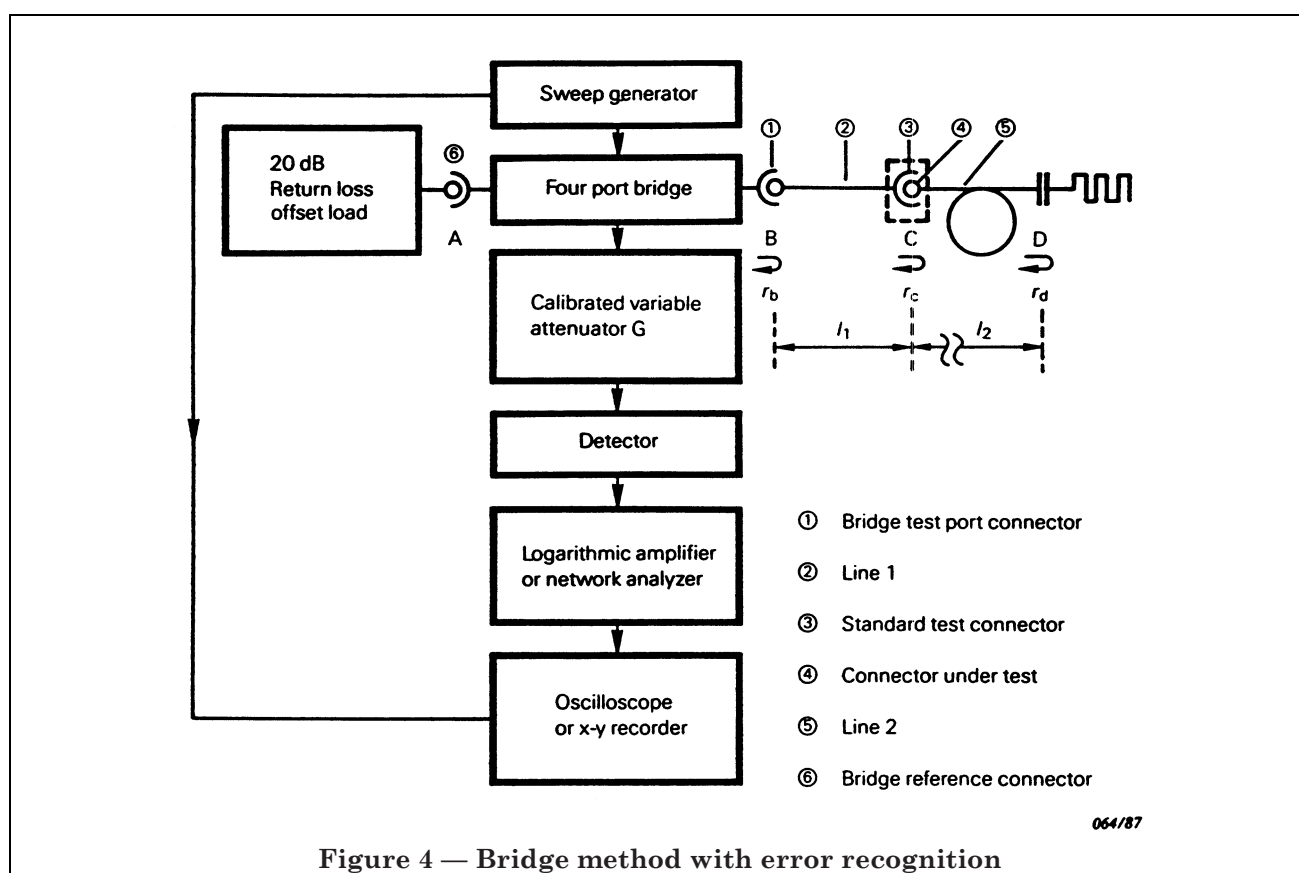


Figure 3 — Voltage on slotted line as a function of frequency with probe position as parameter

9.2.1.6 Measuring methods providing error recognition

9.2.1.6.1 Using a bridge

In order to achieve the possibility of error recognition, two modifications are applied to the normal measuring set-up in Figure 1. These include providing adequate lengths of the lines from the bridge port B to the test assembly at C, and from the test assembly to the matched load at D. Furthermore, the termination at the reference port A of the bridge is given a value such that, assuming the test port is terminated by the exact nominal characteristic impedance, a known reflection factor r_b of, for example, 0,1 (return loss 20 dB) would result. The set-up is shown in Figure 4. The length l_2 should be made at least five times l_1 .



This method produces a plot of the total (resulting) reflection factor as a function of frequency illustrated in Figure 5. At point B, the summation of the three complexors (phasors), representing the reflection factors, is given by:

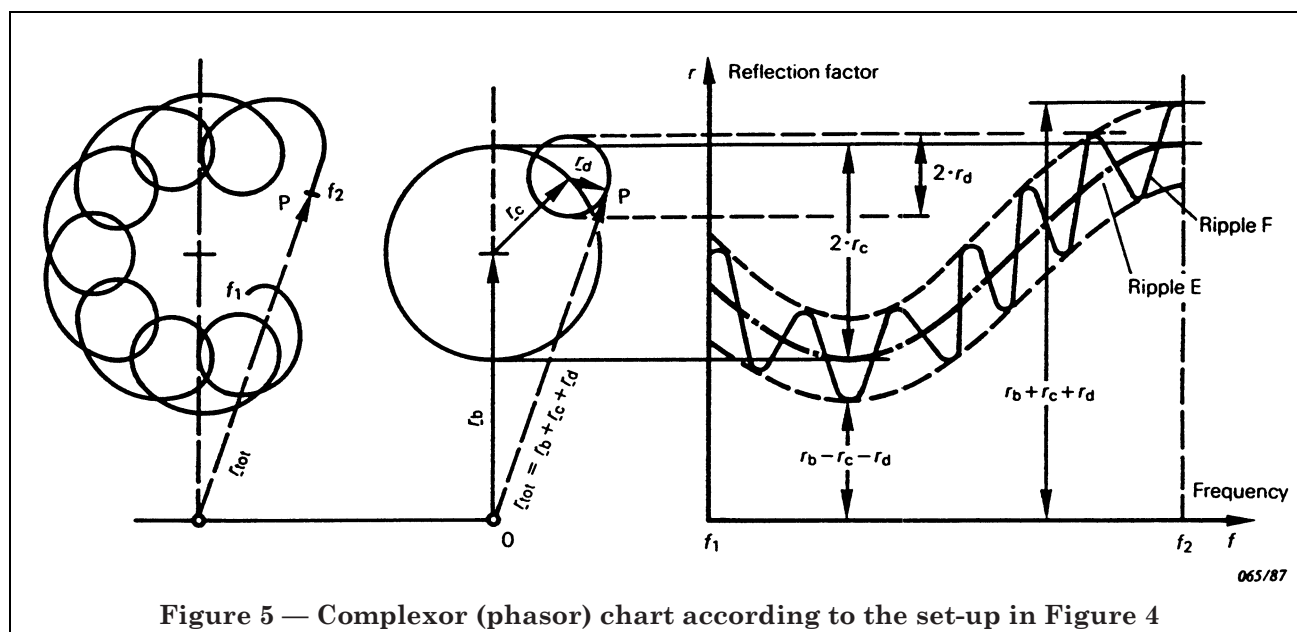
$$L_{\text{tot}} = L_b + L_c + L_d$$

where

L_b is due to the intentional and known mismatch of the bridge at the port B and is more or less constant in amplitude. Slight deviations are caused by internal bridge errors and by the influence of non-zero line lengths between the bridge-elements and the test and reference ports B and A.

L_c includes the reflection factor L_x of the connector under test and that of the standard test connector. By its rotation relative to the complexor L_b it causes the ripple E, as shown in Figure 5 and Figure 6b.

L_d is the reflection of the termination at the end of line 2 and is responsible for the ripple F which is five times faster than the ripple E if the electrical lengths correspond exactly to $l_2 = 5 l_1$.



When using logarithmic detection, the display of the curve on an x-y-plotter will show the resulting return loss in decibels as ordinate, frequency as abscissa. An example is represented in Figure 6a. The conversion into reflection factor may be carried out by using an overlay scale as shown on the right of Figure 6a, or by other suitable means. The extraction of $r_c(r_x)$ is done by calculation, for which Figure 6b and Figure 6c, are given as guidance.

The offset reflection factor r_b must be greater than the sum $r_c + r_d$ to prevent ambiguity of the total reflection curve.

The swept-frequency range and the electrical lengths of both lines should be chosen such that there is a sufficient number of ripples to determine the reflection factor curve. With a 200 mm air line l_1 between bridge test port at B and the standard test connector at C, one r_c -ripple (E) period corresponds to a 750 MHz variation in the frequency axis of the display.

