

Specification for

**Capability approval of radio
frequency connector cable
assemblies and radio frequency
cable assemblies: generic
specification, test methods,
procedures, customer blank
detail specification and
guidance**

Agrément de savoir-faire pour ensembles de connecteurs et de câbles pour fréquences radioélectriques; spécification générique, méthodes d'essai, procédures, spécification particulière cadre client et guide

Anerkennung der Befähigung von Hochfrequenzstecker/ Kabelverbindern; Fachgrundspezifikation; Prüfverfahren, Durchführung der Prüfung, Vordruck für Kunden für Bauartspezifikation, und Leitfaden

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electronic Components Standards Policy Committee (ECL/-) to Technical Committee ECL/6, upon which the following bodies were represented:

British Cable Makers' Confederation
British Plastics Federation
British Telecommunications plc
EEA (the Association of Electronics, Telecommunications and Business Equipment Industries)
Ministry of Defence
Society of British Aerospace Companies Limited
Telecommunications Cables Group of BCMC

This British Standard, having been prepared under the direction of the Electronic Components Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 30 April 1991

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First published March 1986
Second edition April 1991

The following BSI references relate to the work on this standard:
Committee reference ECL/6
Draft for comment 89/25452 DC

ISBN 0 580 19027 7

Amendments issued since publication

Amd. No.	Date	Text affected

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Foreword

This British Standard has been prepared under the direction of the Electronic Components Standards Policy Committee and supersedes BS 9215 : 1986, which is withdrawn. It specifies capability approval procedures for manufacturers wishing to release radio frequency and coaxial cable assemblies under the provisions of BS 9000 : Part 6 : 1989.

Capability approval covers the design, materials, processing, inspection and test for release within a stated technology.

Under capability approval, radio frequency and coaxial cable assemblies are released to either customer detail specifications, or detail specifications for standard catalogue items.

In both cases the quality of manufacture is determined by regular assessment under the maintenance programme of capability approval. The performance of the particular radio frequency and coaxial cable assembly, and additional testing and/or quality assessment procedures, are determined by compliance with the detail specification.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Section 1. General

1.1 Scope

This British Standard specifies requirements for the capability approval of radio frequency (r.f.) and coaxial cable assemblies. It specifies the requirements for a manufacturer seeking approval of his capability to produce such assemblies within a range he defines:

The standard includes requirements for the information a manufacturer has to give to prospective customers and gives guidance on the preparation of detail specifications with those customers.

1.2 Related documents

BS 2011	Environmental testing
BS 2316	Specification for radio-frequency cables
BS 3939	Guide for graphical symbols for electrical power, telecommunications and electronics diagrams
BS 4727	Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms
BS 5775	Specification for quantities, units and symbols
BS 9000	General requirements for a system for electronic components of assessed quality
BS 9210	Specification for radio frequency connectors of assessed quality: generic data and methods of test
PD 9002	BS 9000, IECQ and BS CECC qualified products list
British Standard 3G 100	Specification for general requirements for equipment for use in aircrafts Part 2 All equipment
IEC 96-1	Radio frequency cables Part 1 General requirements and measuring methods
IEC 169-1	Radio frequency connectors Part 1 General requirements and measuring methods

1.3 Terminology

For the purposes of this British Standard, the following definitions apply. For the definitions of other terms, reference should be made to BS 4727 and clause 2 of BS 9000 : Part 1 : 1989.

1.3.1 radio frequency (r.f.) or coaxial cable assembly

A component of specified performance consisting of a length or lengths of r.f. or coaxial cable which may be either terminated or unterminated. The word 'terminated' includes fitted connectors and other forms of termination such as waveguide transitions or probes. The term 'assembly' shall be taken to mean the processing of a cable (e.g. end preparation, preforming or the fitting of sleeves) but does not necessarily include the process of termination.

1.3.2 flexible cable assembly (class 1)

A cable assembly, the cable of which is capable of repeated flexure. It usually has a braid outer conductor.

1.3.3 semi-flexible cable assembly (class 2)

A cable assembly not intended for applications requiring repeated flexure of the cable in service but bending or forming is permissible to facilitate installation.

1.3.4 semi-rigid cable assembly (class 3)

A cable assembly manufactured from semi-rigid cable which is preformed or set to shape. It is intended to be fitted into a system with a minimum of bending as any bending subsequent to manufacture may degrade the performance.

1.3.5 rigid cable assembly (class 4)

A cable assembly not intended to be bent or flexed. Any bending or flexing may degrade the performance of the cable assembly.

1.3.6 radio frequency cable

A cable intended for the transmission of r.f. energy.

1.3.7 insertion loss

The ratio of power (P_1) delivered to the load connected directly to a source and the power (P_0) delivered to a load when the cable assembly is inserted between the source and the load, expressed in decibels.

The value of the insertion loss (in dB) is given by the equation

$$\text{insertion loss} = 10 \log_{10}(P_1/P_0)$$

1.3.8 return loss

The ratio of the reflected power (P_2) measured between a source of power and the cable assembly, and the power delivered to the cable assembly by the source (P_0), expressed in decibels.

The value of the return loss (in dB) is given by the equation

$$\text{return loss} = 10 \log_{10}(P_0/P_2)$$

1.3.9 electrical length

The length of the cable assembly measured between the reference planes of the connectors and expressed in degrees or radians at a stated frequency or frequencies. It may also be expressed in millimetres, as in the following equation

$$\text{electrical length} = L_c \sqrt{E_{\text{eff}}}$$

where

L_c is the design length of the cable assembly (in mm) (see 1.3.12);

E_{eff} is the effective relative permittivity (dielectric constant) at the stated frequency for the connector/cable combination.

1.3.10 electrical delay

The propagation time between the reference planes of a cable assembly, expressed in nanoseconds.

The value of the electrical delay (in ns) is given by the equation

$$\text{electrical delay} = \frac{L_c \sqrt{E_{\text{eff}}}}{300}$$

where

L_c is the design length of the cable assembly (in mm) (see 1.3.12);

E_{eff} is the effective relative permittivity (dielectric constant) at the stated frequency for the connector/cable combination.

1.3.11 phase difference

The difference in phase between the outputs of two cable assemblies having the same input. It is expressed in either degrees or radians at a stated frequency or frequencies.

1.3.12 design length

The distance between the reference planes of the connectors of the cable assembly when the cable is in a straight line. For semi-rigid cable assemblies, it is the length of the assembly prior to bending.

1.3.13 customer detail specification (CDS)

(See 2.2.7 of BS 9000 : Part 1 : 1989 for definition).

The CDS will normally be written by the customer and will be allocated a number within the customer's system.

The CDS is not a published specification in the BS 9000 series as it is a detail specification (DS) for qualification approval, and will not therefore appear in PD 9002.

After the agreement of the content of a CDS by the component manufacturer and the customer, the component manufacturer shall allocate a number (e.g. 9215/XYZ/1234) which shall consist of a unique number (1234) prefixed by the generic specification number (9215) and the manufacturer's factory identification code (XYZ). This unique number shall be included in the customer detail specification together with the relevant manufacturer's name and address.

The component manufacturer shall maintain a register of customer specifications which shall be available to the National Supervising Inspectorate (NSI). The manufacturer shall satisfy the NSI that the specification is within the boundaries of the manufacturer's capability approval.

1.3.14 detail specification (DS)

(See 2.5.5 of BS 9000 : Part 1 : 1989 for definition). A DS covers and describes a particular component or a recognized range of components.

NOTE. The DS also gives inspection requirements, either directly or by references to the generic or sectional specification. The ratings, characteristics and limiting values of the components, including the environmental conditions, are given in the ratings and characteristics section of the DS and are in accordance with the capabilities of the component.

For each combination of capabilities of a component, i.e. electrical, mechanical and environmental, there can be a series of DSs, each individual specification covering one of the levels of quality assessment defined in 2.2.9 of BS 9000 : Part 1 : 1989.

For CDSs for capability approval (CA) see 9.3 of BS 9000 : Part 6 : 1989.

1.4 Letter symbols, signs and abbreviations

The letter symbols, signs and abbreviations used in documents for cable assemblies shall be in accordance with BS 5775.

1.5 Graphical symbols

All graphical symbols used in documents for radio frequency and coaxial cable assemblies shall be in accordance with BS 3939.

1.6 Marking of the cable assembly and package

Each cable assembly shall be marked with as many of the following items as space permits, in the order of precedence given in items (a) to (e):

- (a) type number (see note);
- (b) lot identification and/or date code;
- (c) factory identification code;
- (d) DS number (see 9.3 and 9.4 of BS 9000 : Part 6 : 1989);
- (e) any additional marking required by the DS.

All this information shall be marked on the primary package of the cable assembly.

NOTE. For cable assemblies supplied against CDS, the type number will be that required by the customer. For cable assemblies supplied against a DS for standard catalogue items, the type number will be the manufacturer's number.

1.7 Primary stage of manufacture

The primary stage of manufacture shall be the first process subsequent to the inspection of piece parts.

1.8 Subcontracting

Under CA, and from the primary stage of manufacture onwards, all the manufacturing processes involved in the production of r.f. and coaxial cable assemblies, together with the approval for use and verification of bought-in piece parts and materials, shall be under the direct surveillance of the approved manufacturer's approved person.

NOTE. See 2.4.8 of BS 9000 : Part 1 : 1989 for definition.

Subcontracting of specialized processes is permitted as specified in 3.2.2 of BS 9000 : Part 6 : 1989.

The specialized processes permitted are as follows:

- Painting
- Electroplating
- Anodizing
- Printing
- Injection moulding
- Braiding
- Irradiation
- Encapsulation
- Cable forming
- Etching
- Welding
- Brazing
- Passivation
- Jacketing
- Potting
- Environmental conditioning

1.9 Choice of components

1.9.1 Use of components of assessed quality

Wherever possible incorporated components shall be covered by and procured against BS 9000 or CECC approval. Under these conditions no other assessment of the components is normally required.

1.9.2 Use of unapproved components

For the incorporation of components other than those covered by 1.9.1, the approved manufacturer's approved person shall:

- (a) be satisfied that the quality and performance of the component is adequate for its purpose;
- (b) ensure the existence of a component specification covering all the aspects necessary to ensure its satisfactory performance as part of the cable assembly;
- (c) establish a quality programme to verify that the component continues to be supplied in conformity with the specification referred to in 1.9.2(b).

Appendix A gives the recommended minimum inspection requirements for unapproved components.

1.10 Re-verification period for maintenance of capability approval

Capability approval to the specified limits of capability is normally granted initially for three years and is to be re-verified at intervals of three years. See clause 4 of BS 9000 : Part 6 : 1989.

1.11 Rework

The conditions under which incomplete or otherwise unsatisfactory processing may be reworked shall be covered in the manufacturer's capability manual (CM) and any limitations to rework shall be stated. It is essential that all reworked material is of the same standard of quality as non-reworked satisfactory material. Subcontracting specifically for rework is not permitted; see clause 13 of BS 9000 : Part 6 : 1989.

1.12 Screening procedures

Screening procedures, as defined in 2.6.9 of BS 9000 : Part 1 : 1989, are not applicable to r.f. or coaxial cable assemblies.

Section 2. Test methods

2.1 General

In accordance with BS 9000 : Part 6 : 1989, where methods of test are given in this standard they shall be the preferred methods and shall be used where there is any doubt or dispute. Alternative methods of test are permitted (see clause 11 of BS 9000 : Part 6 : 1989) as are additional methods of test, provided that they are acceptable to the NSI.

Where a variation in a test method is specified in a DS, the variation shall take precedence over the method in this section for the cable assembly concerned.

2.2 Measurement conditions

Unless otherwise specified all tests shall be carried out under standard atmospheric conditions for testing as given in BS 2011 : Part 1.1 : 1989. Prior to the measurement, the cable assemblies shall be conditioned under the standard atmospheric conditions for testing for a time sufficient to allow the entire assembly to reach thermal stability.

When 'mounting' is specified in a test, the connector shall be securely mounted on a rigid metal plate 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.

Where the cable assembly is terminated with a connector at either or both ends, connections for testing shall be made via suitable mated connectors. These shall be fully engaged and screw couplings shall be tightened to the normal coupling torque.

When specified in the DS, testing may be conducted on a specimen cable assembly rather than on a finished cable assembly. The specimen cable assembly shall be identical to the finished cable assembly except for length or shape.

2.3 Recovery conditions

The recovery conditions for the interval after a conditioning test shall be as given in BS 2011 : Part 1.1 : 1989.

2.4 Visual inspection

The cable assembly shall be visually examined to ensure that:

- (a) the condition, workmanship and finish are satisfactory;
- (b) the marking complies with 1.6 and is legible and durable;
- (c) there is no mechanical damage, movement or displacement of parts;
- (d) no pitting or flaking of materials or finishes is apparent.

NOTE. Generally, examination may be carried out using a magnification of up to $\times 3$.

2.5 Dimensions

The dimensions of the cable assembly and connector interfaces shall be verified for conformity with the DS.

2.6 Electrical test methods

2.6.1 General

The following electrical test methods may be appropriate to either a capability qualifying component (CQC) or CDS for cable assemblies.

2.6.2 Return loss

2.6.2.1 Purpose

To measure the return loss of an r.f. cable assembly.

2.6.2.2 Circuit

See figure 1.

2.6.2.3 Procedure

With a short and then an open circuit connected to the main line of the SWR autotester bridge, an average reference level A/R is established over the required frequency range. The assembly is then connected to the main line of the SWR autotester bridge. The change measured on the test system in decibels is the indicated return loss of the cable assembly.

2.6.2.4 Specified conditions

The frequency range and, if appropriate, the frequency intervals or number of measurement points shall where appropriate be as given in the DS.

2.6.3 Insertion loss

2.6.3.1 Purpose

To measure the insertion loss of an r.f. cable assembly.

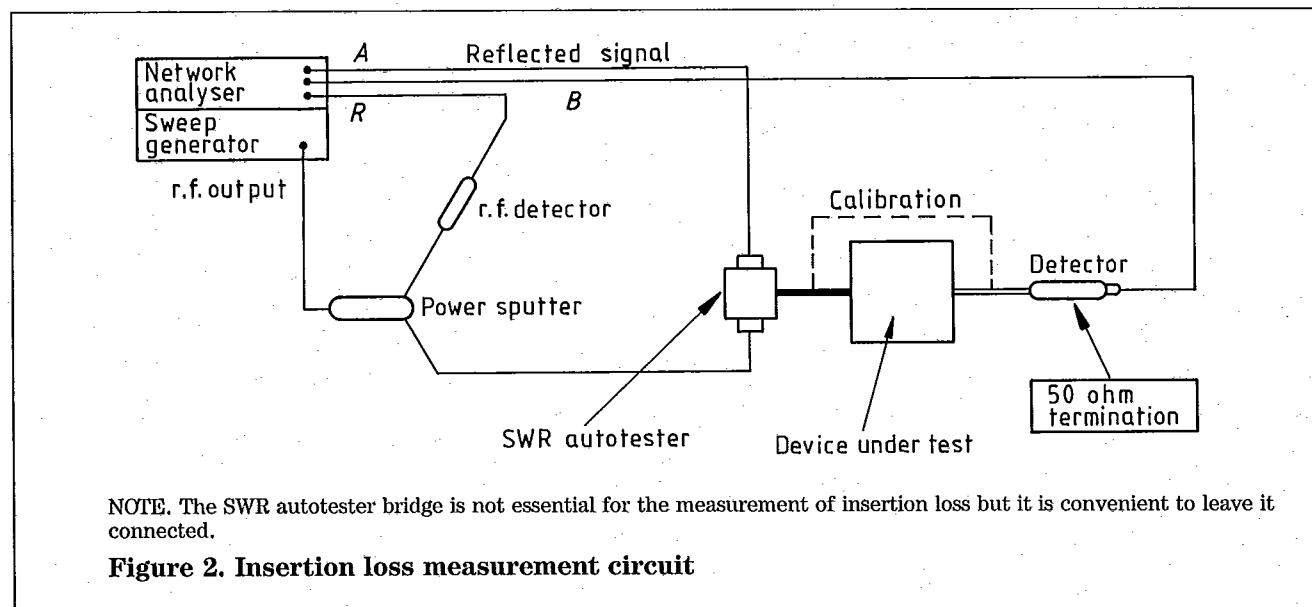
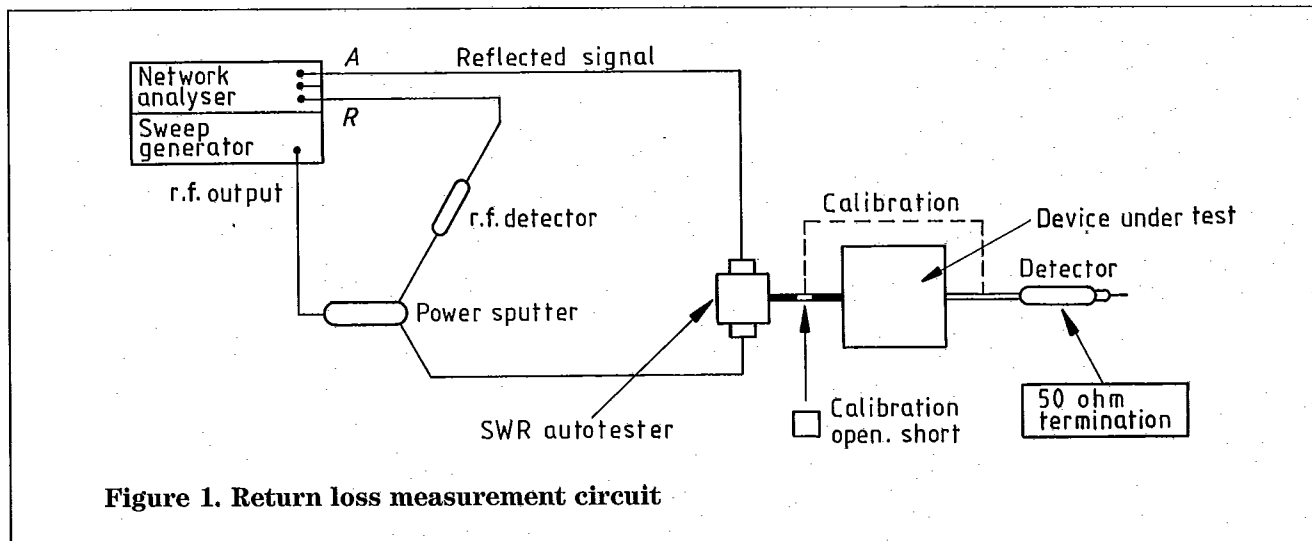
2.6.3.2 Circuit

See figure 2.

2.6.3.3 Procedure

Detector B is connected to the output of the bridge (autotester) through any necessary adaptors. Detected output B is calibrated against reference output R to provide a 0 dB reference level. The cable assembly, with any necessary adaptors is then inserted between the output of the bridge (autotester) and detector B. The insertion loss is then determined on the swept amplitude analyser. In analogue-swept systems, the frequency scan rate of the sweep oscillator shall be sufficiently slow in relation to the amplitude analyser response for the determination of the insertion loss to be accurate. In particular it shall be slow enough for cable assemblies in which there are:

- (a) resonances, which can be very sharp, associated with the structural return loss of the cable forming the cable assembly;
- (b) multiple reflections between the ends of the cable assembly or the test ports.



With non-insertable cable assemblies adaptors could be required between the test equipment and the cable assemblies under test. These shall be regarded as part of the test equipment and shall be left in circuit when the cable assemblies under test are removed from the test circuit. However, when the cable assemblies have connectors such that the circuit cannot then be reconnected, one or more adaptors may be left on the cable assemblies. In these cases, any correction made to allow for insertion loss of the adaptors shall be given in the DS.

2.6.3.4 Requirements

The values of insertion loss shall be not greater than allowed by the DS over the indicated frequency range, and if appropriate, the frequency intervals or measurement points specified.

2.6.4 Insertion loss stability with flexure

2.6.4.1 Purpose

To measure the insertion loss variation of an r.f. cable assembly following flexure.

2.6.4.2 Circuit

See figure 3.

2.6.4.3 Procedure

With the cable assembly in the position shown by figure 3, the response of the r.f. insertion loss versus frequency is normalized as 0 dB. The cable assembly is then wound around the mandrel as prescribed by the DS. The change in insertion loss is determined by means of the network analyser. Should a finished cable assembly be too short to allow the above procedure to be followed, measurement may be performed on a longer length of cable of the same type and from the same production batch.

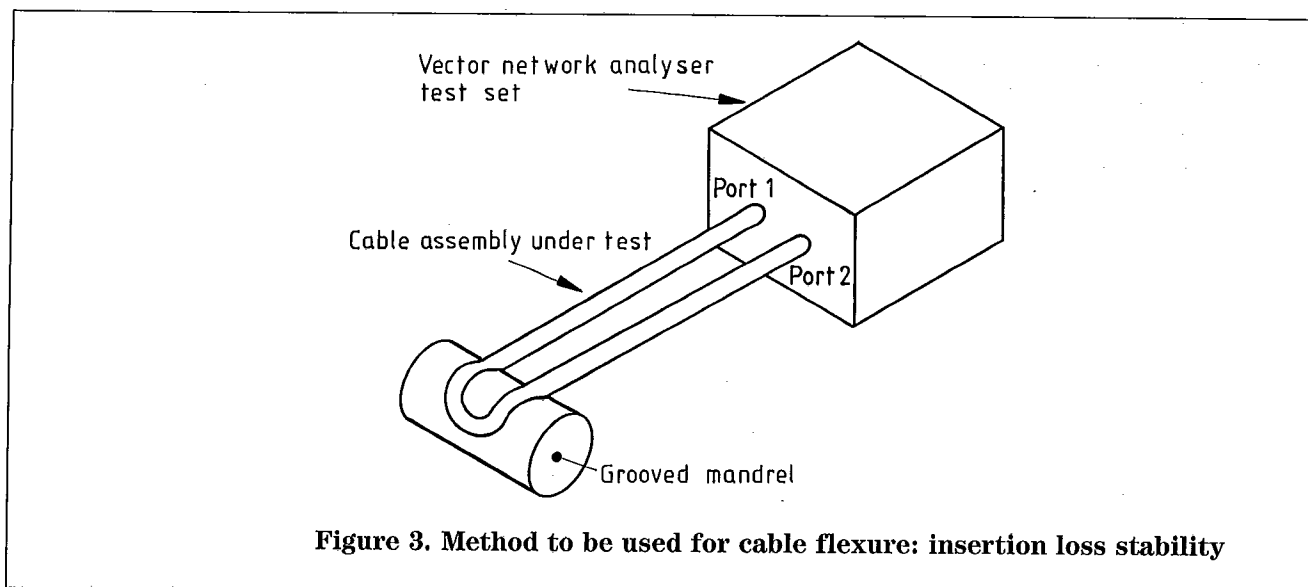


Figure 3. Method to be used for cable flexure: insertion loss stability

2.6.4.4 Requirements

The change in the insertion loss shall be not greater than allowed by the DS over the specified frequency range or at frequency intervals or measurement frequencies specified in the DS.

2.6.4.5 Information to be given in the DS

In addition to that indicated in 2.6.4.3 and 2.6.4.4 the DS shall specify:

- (a) mandrel specification (diameter and groove details);
- (b) bend radius of cable assembly;
- (c) number of turns around the mandrel;
- (d) period between completion of winding and measurement.

2.6.5 Electrical length

2.6.5.1 Purpose

To measure the absolute electrical length of a cable assembly at defined frequencies.

2.6.5.2 Circuit

See figure 4.

2.6.5.3 Procedure

Using a suitable calibrated vector network analyser the instantaneous insertion phase of a cable assembly is displayed as a function of frequency. If θ_1 is the phase change at frequency F_1 and θ_2 is the phase change at frequency F_2 then the electrical length θ_l , expressed as phase change at frequency F , is given by the equation:

$$\text{electrical length} = \frac{(\theta_2 - \theta_1) F}{F_2 - F_1}$$

2.6.5.4 Precautions

The frequencies F_1 and F_2 may need to be chosen with care.

For best accuracy the difference, $F_2 - F_1$, needs to be large but it should be pointed out that a large difference may obscure cable dispersion.

2.6.5.5 Specified conditions

The measurement frequency, or frequencies, and ambient temperature for measurement or correction factor to be applied shall be as specified in the DS.

2.6.6 Electrical length change following flexure

2.6.6.1 Purpose

To measure the phase variation of an r.f. cable assembly following flexure.

NOTE. The electrical length stability or phase stability of a cable assembly determines the small scale phase variation at a given frequency and/or over a frequency range both during and following flexure of the cable assembly.

2.6.6.2 Circuit

See figure 5.

2.6.6.3 Procedure

With the cable assembly in the position shown by figure 5, the phase or electrical length is normalized at each of the specified test frequencies. The cable assembly is then wound around the mandrel as prescribed by the DS. The change in phase or electrical length is determined by means of the vector network analyser.

Should a finished cable assembly be too short to allow the above procedure to be followed, measurements may be performed on a longer length of cable of the same type and from the same production batch.

2.6.6.4 Requirements

The stability of the electrical length, or phase variation, due to flexure shall be specified in the DS over the indicated frequency range and, if appropriate, the frequency intervals or measurement points specified.