BRITISH STANDARD

BS EN 60966-1:1999
IEC 60966-1: 1999
QC 140000: 1999

Radio frequency and coaxial cable assemblies —

Part 1: Generic specification — General requirements and test methods

The European Standard EN 60966-1:1999 has the status of a British Standard

ICS 33.120.10

National foreword

This British Standard is the English language version of EN 60966-1:1999. It is identical with IEC 60966-1:1999. It supersedes BS EN 60966-1:1993 which will be withdrawn on 2002-02-01. This standard is a harmonized specification within the IEC quality assessment system for electronic components (IECQ). In the IECQ system, this specification is numbered QC 140000.

The UK participation in its preparation was entrusted by Technical Committee EPL/46, Cables, wires, waveguides, RF connectors and accessories for comms and signalling, to Subcommittee EPL/46/1, Communication cables, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

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.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 38 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.

This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 October 1999

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60966-1

June 1999

ICS 33.120.10

Supersedes EN 60966-1:1993

English version

Radio frequency and coaxial cable assemblies Part 1: Generic specification — General requirements and test methods

(IEC 60966-1:1999)

Ensembles de cordons coaxiaux et de cordons pour fréquences radioélectriques
Partie 1: Spécification générique
Généralités et méthodes d'essai
(CEI 60966-1:1999)

Konfektionierte Koaxial- und Hochfrequenzkabel
Teil 1: Fachgrundspezifikation
Allgemeine Anforderungen und Prüfverfahren
(IEC 60966-1:1999)

This European Standard was approved by CENELEC on 1999-05-01. 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, Czech Republic, 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

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Foreword

The text of document 46A/343/FDIS, future edition 2 of IEC 60966-1, prepared by SC 46A, Coaxial cables, 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 EN 60966-1 on 1999-05-01.

This European Standard supersedes EN 60966-1:1993.

The following dates were fixed:

— latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2000-02-01

— latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2002-05-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, Annex A, Annex E and Annex ZA are normative and Annex B, Annex C and Annex D are informative. Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60966-1:1999 was approved by CENELEC as a European Standard without any modification.

Contents

1 Scope

This International Standard specifies requirements for radio frequency coaxial cable assemblies operating in the transverse electromagnetic mode (TEM) and establishes general requirements for testing the electrical, mechanical and environmental properties of radio frequency coaxial cable assemblies composed of cables and connectors. Additional requirements relating to specific families of cable assemblies are given in the relevant sectional specifications.

NOTE 1 The design of the cables and connectors used should preferably conform to the applicable parts of IEC 61196 and IEC 61169 respectively.

NOTE 2 This specification does not include tests which are normally performed on the cables and connectors separately. These tests are described in IEC 61196-1 and IEC 61169-1 respectively.

NOTE 3 Wherever possible, cables and connectors used in cable assemblies, even if they are not described in the IEC 61196 or IEC 61169 series are tested separately according to the tests given in the relevant generic specification.

NOTE 4 Where additional protection is applied to a cable assembly, the mechanical and environmental tests described in this standard are applicable.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60966. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60966 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 60068-2-3:1969, *Environmental testing — Part 2: Tests — Test Ca: Damp heat, steady state.*

IEC 60068-2-6:1995, *Environmental testing — Part 2: Tests — Test Fc: Vibration (sinusoidal).*

IEC 60068-2-11:1981, *Environmental testing — Part 2: Tests — Test Ka: Salt mist.*

IEC 60068-2-14:1984, *Environmental testing — Part 2: Tests — Test N: Change of temperature.*

IEC 60068-2-27:1987, *Environmental testing — Part 2: Tests — Test Ea and guidance: Shock.*

IEC 60068-2-29:1987, *Environmental testing — Part 2: Tests — Test Eb and guidance: Bump.*

IEC 60068-2-42:1982, *Environmental testing — Part 2: Tests — Test Kc: Sulphur dioxide test for contacts and connections.*

IEC 60068-2-68:1994, *Environmental testing — Part 2: Tests — Test L: Dust and sand.*

IEC 60096-1:1986, *Radio frequency cables — Part 1: General requirements and measuring methods.*

IEC 60332-1:1993, *Tests on electric cables under fire conditions — Part 1: Test on a single vertical insulated wire or cable.*

IEC 60339 (all parts), *General purpose rigid coaxial transmission lines and their associated flange connectors.*

IEC 60512-5:1992, *Electromechanical components for electronic equipment, basic testing procedures and measuring methods — Part 5: Impact tests (free components), static load tests (fixed components), endurance tests and overload tests.*

IEC 61169-1:1992, *Radio-frequency connectors — Part 1: Generic specification — General requirements and measuring methods.*

IEC 61196-1:1995, *Radio-frequency cables — Part 1: Generic specification — General definitions, requirements and test methods.*

IEC 61726:1995, *Cable assemblies, cables, connectors and passive microwave components — Screening attenuation measurement by the reverberation chamber method.*

IEC QC 001002:1986, *Rules of procedure of the IEC quality assessment system for electronic components (IECQ).*

ISO 9000, *Quality management and quality assurance standards.*

ISO 9001:1994, *Quality systems — Model for quality assurance in design, development, production, installation and servicing.*

ISO 9002:1994, *Quality systems — Model for quality assurance in production, installation and servicing.*

3 Definitions

For the purpose of this part of IEC 60966, the following definitions apply.

3.1 cable assembly

a combination of cable(s) and connector(s) with or without any additional protection and with specified performance, used as a single unit

3.1.1
flexible cable assembly

a cable assembly where the cable is capable of repeated flexure. The cable usually has a braid outer conductor

3.1.2
semi-flexible cable assembly

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

3.1.3
semi-rigid cable assembly

a cable assembly not intended to be bent or flexed after manufacture. Any bending or flexing during installation or use may degrade the performance of the cable assembly

3.2
insertion loss

the loss introduced by inserting a cable assembly into a system. In this standard, it is the ratio, expressed in decibels, of the power (P_1) delivered to a load connected directly to a source and the power (P_2) delivered to a load when the cable assembly is inserted between the source and the load

$$\textit{Insertion loss} = 10 \times \log\left(\frac{P_1}{P_2}\right)$$

3.3
reflection factor

the ratio of the complex wave amplitude of the reflected wave to the complex wave amplitude of the incident wave at a port or transverse cross-section of a transmission line

3.4
electrical length

the equivalent free-space length of the cable assembly

3.5
electrical length difference

the difference in electrical length between cable assemblies

3.6
phase difference

the difference in phase between a transverse electromagnetic mode (TEM) wave which has traversed the cable assembly and an identical wave which has traversed another cable assembly

3.7
propagation time

the time taken for the propagation of a TEM wave between the reference planes of the two connectors

3.8
minimum static bending radius

the radius used in climatic tests. It is the minimum permissible radius for fixed installation of the cable

3.9
dynamic bending radius

the bending radius is used for the insertion loss stability, stability of electrical length and flexing endurance tests, and is the minimum bending radius for applications where the cable assembly is flexed. Larger bending radii will allow the increase of the maximum number of flexures

3.10 screening effectiveness

3.10.1
transfer impedance

the quotient of the induced voltage on the inside of the cable assembly and the inducing current outside the assembly. In practice, this is between defined points on connectors mated to the connectors of the cable assembly

3.10.2
screening attenuation

the ratio of the signal power inside the cable assembly to the total power that radiates outside the cable assembly

3.11
power rating

the input power which may be handled continuously by the cable assembly when terminated by its characteristic impedance

NOTE 1 For practical application, the maximum power that may be handled is dependent upon the return loss.

NOTE 2 Power rating is dependent on mounting details, ambient temperature, air pressure and circulation. It is normally specified at an ambient temperature of 40 °C.

3.12
artificial ageing

a process used to improve the stability of phase attenuation and expansion with temperature. This process normally consists of submitting the complete cable assembly to a number of temperature cycles. Unless otherwise specified in the relevant detail specification, submitting the complete cable assembly to artificial ageing is optional, at the discretion of the supplier

4 Design and manufacturing requirements

4.1 Cable design and construction

Cables in accordance with, or conforming to, IEC 61196 shall be specified wherever possible, Where cable designs deviating from IEC 61196 are required, these cables shall comply with the requirements of the relevant detail specification.

4.2 Connector design and construction

Connector types conforming to the relevant part of IEC 61169 shall be specified wherever possible, but where a special connector design is required, the interface shall conform to the relevant part of IEC 61169, where available, and the connector construction shall comply with the requirements of the relevant detail specification.

4.3 Outline and interface dimensions

a) Outline dimensions shall be in accordance with the relevant detail specification of the cable assembly.

b) Interface dimensions shall be in accordance with the relevant detail specification.

5 Workmanship, marking and packaging

5.1 Workmanship

There shall be no observable defects in the cable assembly; it shall be clean and in good condition.

5.2 Marking

Marking shall be legible and in accordance with the relevant detail specification; it shall identify the manufacturer of the cable assembly.

5.3 End caps

Unless otherwise specified in the relevant detail specification, disposable end caps of suitable material for transport and storage shall be fitted to the connectors to protect at least each interface from damage and dirt.

5.4 Packaging and labelling

Packaging and labelling shall be in accordance with the relevant detail specification, unless otherwise specified.

6 Quality assessment

A guide for quality assurance including capability approval as well as qualification approval is given in Annex E.

7 Test methods — General

7.1 Standard atmospheric conditions for testing

Unless otherwise specified, all tests shall be carried out under the conditions specified in IEC 60068.

Before the measurements are made, the cable assemblies shall be stored at the measuring temperature for a time sufficient to allow the entire cable assembly to reach this temperature. When measurements are made at a temperature other than the standard temperature, the result shall, where necessary, be corrected to the standard temperature.

NOTE Where it is impracticable to carry out tests under the standard atmospheric conditions for testing, a note to this effect, stating the actual conditions of tests, should be added to the test report.

7.2 Visual inspection

The specimen shall be visually examined to ensure that:

a) the condition, workmanship and finish are satisfactory;

b) the marking is in accordance with **5.2** of this specification;

c) there is no mechanical damage, undesired movement or displacement of parts;

d) no pitting or flaking of materials or finishes is apparent.

Examination may generally be carried out using an instrument with up to three times magnification.

7.3 Dimensions inspection

7.3.1 *Interface dimensions*

The interface dimensions shall be tested for compliance with the relevant detail specification with the appropriate test equipment.

Where connectors conforming to IEC 61169 are used, inspection of interface dimensions may be limited to those features likely to vary as a result of incorrect assembly, for example the axial dimensions from reference plane to dielectric, and to inner contact features.

Where other connectors are used or where special requirements exist, details shall be given in the relevant detail specification.

7.3.2 *Outline dimensions*

Any special requirements for the measurement of cable assembly outline dimensions shall be given in the relevant detail specification.

8 Electrical tests

8.1 Reflection properties

8.1.1 *Object*

To determine the amount of signal that is reflected back to the signal source by the cable assembly under test in a matched system. The reflection behaviour is preferably expressed in terms of “dB return loss”.

8.1.2 *Procedure*

The return loss of a cable assembly should be measured with a suitable network analyser.

For the measurement of the reflection characteristics of cable assemblies, special care must be given to the following:

— ensure that the sweep speed is slow enough for the reflected signal to remain in the centre of the IF-filter of the receiver system. The longer the cable, the slower the sweep speed that must be chosen;

— cable assemblies might have narrow return loss spikes. For continuous network analyser-systems, the sweep rate shall be low enough and for digital network analyser-systems, the number of measurement points shall be high enough for resolving eventual return loss spikes.

For example, for digital systems, the number of points should be:

n □ $3(f_2 - f_1)\ L/(120)$

where

n	is the number of sampling points in the frequency range f_1 to f_2 forming the response curve;
f_1	is the lowest frequency in the range, in MHz;
f_2	is the highest frequency in the range, in MHz;
L	is the physical length of the test specimen, in m.

Failing to apply these criteria may result in too wide a distance between the frequency sampling points, thus leading to considerable measuring failures.

The return loss of cable assemblies is not necessarily symmetrical for both sides, and measurements from both sides might be required. Unless otherwise stated in the relevant detail specification, the worse case has to be within the specification.

The system has to be calibrated with the appropriate connector types. If these are not available, then adapters have to be used. The adapters will give a deterioration in the measured return loss, but, the result shall not be corrected for the adapters. The combined return loss, including the adapters, shall be within the specification.

Other techniques for measuring the reflection characteristics of a cable assembly may be used if agreed by the customer.

8.1.3 *Requirements*

The measured return loss values shall be within the specified limits.

8.1.4 *Information to be given in the detail specification*

a) Minimum return loss, as a function of frequency, if appropriate.

b) Frequency range.

c) Required frequency resolution.

Measurements to be made from one or both ends.

8.2 Uniformity of impedance

8.2.1 *Object*

To determine the variation of local characteristic impedance of the cable assembly.

8.2.2 *Procedure*

Measurement is made using a time domain reflectometer (TDR) with input step applied to the cable assembly through an air line acting as an impedance reference. Impedance variation along the assembly shall be observed.

Alternatively, a system using frequency domain to time domain conversion may be used.

8.2.3 *Requirements*

To be as specified in the relevant detail specification.

8.2.4 *Information to be given in the detail specification*

a) Rise time of the TDR system.

b) Limits of impedance variation.

8.3 Insertion loss

8.3.1 *Procedure*

The insertion loss shall be inspected in accordance with Annex A.

8.3.2 *Requirements*

The insertion loss shall not exceed the specified limits at any frequency within the frequency band indicated in the relevant detail specification.

8.3.3 *Information to be given in the detail specification*

a) Maximum insertion loss, if appropriate, as a function of frequency.

b) Frequency range.

8.4 Insertion loss stability

8.4.1 *Object*

To determine the change of attenuation at a given frequency when the cable assembly is subjected to dynamic bending.

8.4.2 ***Procedure***

During insertion loss measurement according to **8.3**, the cable is wound on a mandrel of radius equal to the dynamic bending radius and using the number of turns indicated in the relevant detail specification.

8.4.3 ***Requirements***

During and after the test, the specified change of insertion loss given in the relevant detail specification shall not be exceeded.

8.4.4 ***Information to be given in the detail specification***

a) Dynamic bending radius of the cable (radius of the mandrel).

b) Number of turns and portion of the cable assembly on the mandrel.

c) Test frequencies.

d) Maximum change of insertion loss.

8.5 Propagation time

8.5.1 ***Procedure***

The propagation time is inspected in accordance with Annex B.

8.5.2 ***Requirements***

The propagation time shall not exceed the limits indicated in the relevant detail specification.

8.5.3 ***Information to be given in the detail specification***

a) Frequency band in which the measurement is carried out (see clause **B.1**) or rise time of the system (see clause **B.2**).

b) Propagation time and tolerance.

8.6 Stability of electrical length

8.6.1 ***Object***

To determine the change of phase caused by the change in electrical length when the cable assembly is subjected either to bending or twisting.

8.6.2 ***Procedures***

8.6.2.1 *Bending*

Method 1

A cable assembly which is of a U shape has to be connected to a suitable network analyser (NWA), (see Figure 1a). During recording of the phase of the transmitting signal, the cable is wound around the mandrel for 180° (see Figure 1b), unwound to the starting position, wound counter-clockwise for 180° around the mandrel (see Figure 1c) and again unwound to its starting position. The initial position of the mandrel shall be chosen so that only the straight parts of the U will be bent during the test.

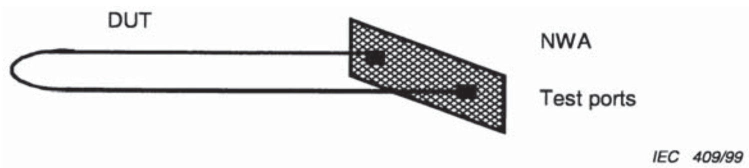


Figure 1a — Start position

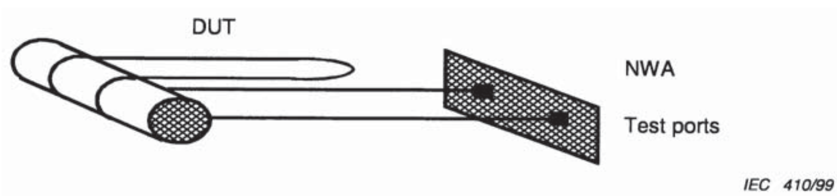


Figure 1b — First bend

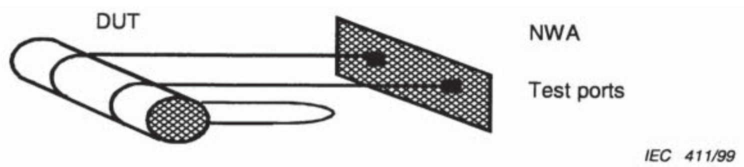


Figure 1c — Second bend

Figure 1 — Bending test: U shape assembly

Method 2

A cable assembly which is of a straight shape (see Figure 2a) has to be terminated by a short at one end and connected to a suitable network analyser at the other end. During the recording of the phase of the reflected signal, the cable is first wound clockwise around the mandrel for one half turn (see Figure 2b), released to the starting position then wound anti-clockwise around the mandrel (see Figure 2c) and again released to its starting position.

8.6.2.2 *Twisting*

A cable assembly which is of a U shape has to be connected to a suitable network analyser (see Figure 3a). During the recording of the phase of the transmitting signal the mandrel in the middle of the cable is first twisted in a clockwise direction for 180° (see Figure 3b) then released to the starting position, twisted counter-clockwise for 180° (see Figure 3c) and again released to its starting position.

NOTE Depending on the torsional rigidity and the maximum permissible torque at the cable connectors interface, the maximum twist angle may have to be restricted.

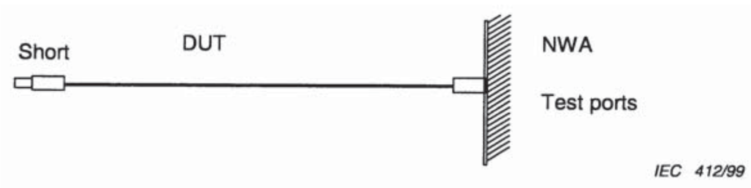


Figure 2a — Start position

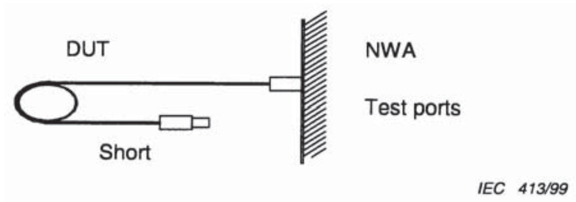


Figure 2b — First bend

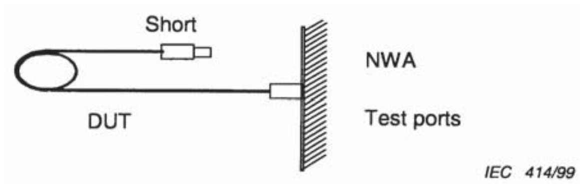


Figure 2c — Second bend

Figure 2 — Bending test: straight assembly

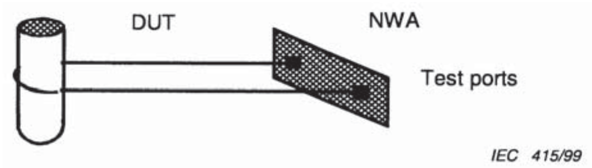


Figure 3a — Start position

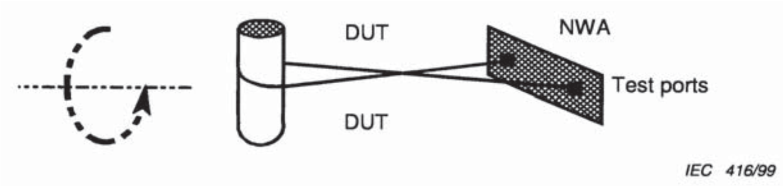


Figure 3b — First twist

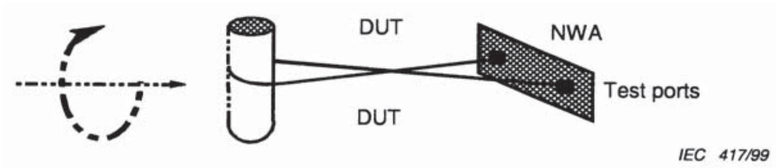


Figure 3c — Second twist

Figure 3 — Twisting test: U shape assembly

8.6.3 ***Requirements***

The phase difference shall not exceed the limits specified in the relevant detail specification.

8.6.4 ***Information to be given in the detail specification***

a) Radius of mandrel (usually dynamic bending radius of the cable).

b) Test frequency.

c) Maximum change of phase.

8.7 Phase difference

8.7.1 ***Object***

To measure the phase difference between two or more cable assemblies.

8.7.2 ***Procedure***

Measurements shall be made using a suitable network analyser of appropriate resolution. Alternatively, a slotted line may be used where frequency and accuracy requirements permit.

8.7.3 ***Requirements***

The phase difference shall not exceed the limits specified in the relevant detail specification.

8.7.4 ***Information to be given in the detail specification***

a) Maximum phase difference or nominal phase difference with tolerances.

b) Frequency.

8.8 Phase variation with temperature

8.8.1 ***Object***

To determine the changes of phase caused by the change in the electrical length when the cable assembly is subjected to various temperatures within its operating temperature range.

When specified in the relevant detail specification this test may be conducted on a specimen cable assembly rather than a finished cable assembly. The specimen cable assembly shall be identical to the finished cable assembly except for its length and its shape.

8.8.2 ***Procedure***

Measurements shall be made using a suitable network analyser with the cable assembly, including its connectors, in a controlled temperature chamber. Details of any cable supports shall be given in the relevant detail specification.

Where tests are made on a specimen cable assembly, the cable shall form one or more unsupported loops of a diameter at least ten or more times the minimum static bending radius.

Six temperature cycles shall be used. Alternatively, a slotted line can be used where frequency and accuracy requirements permit.

8.8.3 *Requirements*

During the test, the phase variation shall not exceed the limits specified in the relevant detail specification.

8.8.4 *Information to be given in the detail specification*

a) Temperature range and temperature against time cycle.

b) Measurement frequency.

c) Method of presenting the results for example □el/□C.

d) Admissible phase variation.

e) Configuration of substitute specimen cable assembly, when allowed.

8.9 Screening effectiveness

The screening effectiveness shall be tested. Applicable tests are given in Annex C or in IEC 61726. The relevant detail specification shall identify the applicable test, the frequency range and the minimum value of screening effectiveness.

8.10 Voltage proof

8.10.1 *Procedure*

Each cable assembly shall withstand, without breakdown or flashover, the voltage specified by the relevant detail specification. The minimum value of the test voltage derived from the rated working voltage U of the cable assembly and the test voltage E (both expressed as d.c. or a.c. peak) is given by:

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

or

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

The peak a.c. voltage stated in the relevant detail specification, at a frequency between 40 Hz and 60 Hz, shall be applied between the inner and outer conductors of the cable assembly using a mated connector as an interface.

Alternatively, a d.c. voltage equal to the peak a.c. voltage may be applied.

The voltage shall be applied for a period of 1 min, unless otherwise stated in the relevant detail specification.

8.10.2 *Requirements*

There shall be no breakdown or flashover.

8.10.3 *Information to be given in the detail specification*

a) Test voltage.

b) Any special requirements.

8.11 Insulation resistance

8.11.1 *Procedure*

The insulation resistance shall be measured between the inner and outer conductor of the cable assembly with a direct voltage of 500 V ± 50 V or with the rated voltage of the cable assembly, whichever is less.

The insulation resistance shall be measured after a stabilisation time of 60 s ± 5 s, unless otherwise specified in the relevant detail specification.

8.11.2 *Requirements*

The value of the insulation resistance shall not be less than that indicated in the detail specification.

8.11.3 *Information to be given in the detail specification*

a) Test voltage.

b) Stabilization time.

c) Resistance value.

8.12 Inner and outer conductor continuity

8.12.1 *Object*

To ensure the d.c. and low frequency continuity of the inner and outer conductors.

8.12.2 *Procedure*

Any appropriate method may be used.

8.12.3 *Requirements*

There shall be no undesired d.c. or low frequency discontinuity of the inner or outer conductor.

8.12.4 *Information to be given in the detail specification*

a) Test voltage.

b) Test current.

c) Frequency.

8.13 Void

8.14 Power rating

8.14.1 *Object*

The power rating of a cable assembly is defined as the input power at any specified frequency, temperature and pressure, which can be handled continuously when the cable assembly is terminated by a load corresponding to the characteristic impedance.

A limitation may be either the maximum permissible operating voltage or the maximum inner conductor temperature of either the cable or the connector.

Thus, the power handling capability test is divided into two categories:

a) continuous power handling capability;

b) peak or pulsed power handling capability.

8.14.2 *Procedure*

The test shall be performed in accordance with **11.19** of IEC 61196-1 taking into account any evidence of arcing and mechanical displacement of the solder or mechanical joint.

8.14.3 *Requirements*

There shall be no evidence of breakdown due to overheating, arcing or flashover throughout the application of the specified power related to the environmental conditions as stated in the relevant detail specification. After the test, the cable assembly shall show no visual damage and the electrical requirements shall be satisfied.

8.14.4 *Information to be given in the detail specification*

a) Temperature.

b) Pressure.

c) Relative humidity.

Peak power test

d) Power level.

e) Frequency.

f) Pulse width and duty cycle.

CW power test

g) Power level.

h) Frequency.

8.15 Intermodulation level measurement

Under consideration.

9 Mechanical robustness tests

9.1 Tensile

9.1.1 *Object*

To determine the mechanical strength and, when required, electrical stability of the cable assembly when subjected to an axial force.

9.1.2 *Procedure*

A tensile force as stated in the relevant detail specification shall be applied to the two connectors along the common axis of the cable and connectors. When the length or shape of the cable makes this impossible, the force shall be applied between the cable and each connector in turn.

NOTE When the force cannot be applied between the two connectors, these tests are normally destructive to the cable.

9.1.3 *Requirements*

There shall be no visual evidence of the movement of the cable relative to the connector.

Inner contact and insulator positions shall be in accordance with interface dimensions.

Electrical test requirements shall be complied with, if stated in the relevant detail specification.

9.1.4 *Information to be given in the detail specification*

a) Value of the force.

b) Duration and method of application of the force.

c) Electrical tests required.

9.2 Flexure

9.2.1 *Object*

To determine the ability of the cable assembly to withstand bending at the junction of the cable and connector.

9.2.2 *Procedure*

The test shall be performed using a fixture as shown in Figure 4.

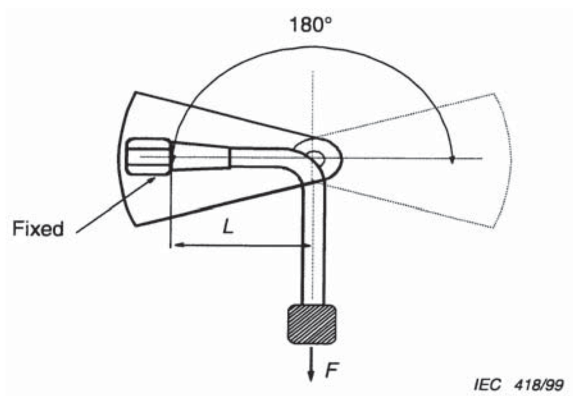


Figure 4 — Fixture for cable assembly flexure test

The length L is adjusted so that the cable is on the vertical axis and the connector in the horizontal position when the force F is applied. A flexure is a rotation of the fixture of 180°. The rate of flexure shall be 20 per minute or as stated in the relevant detail specification.

9.2.3 *Requirements*

After the test, the cable assembly interface dimensions shall be within the specified limits.

Electrical test requirements stated in the relevant detail specification shall be complied with.

9.2.4 *Information to be given in the detail specification*

a) Value of the force F.

b) Number of flexures, normally 500.

c) Electrical tests required.

d) Whether or not electrical tests shall be applied with the cable assembly still on the fixture.

9.3 Flexing endurance

9.3.1 ***Object***

To determine the acceptability of the cable assembly intended to withstand flexing in service.

9.3.2 ***Procedure***

The cable assembly shall be placed on a horizontal table in an apparatus as illustrated in Figure 5. Whilst one connector is fixed, the other connector is moved back and forth in the direction of the cable axis.

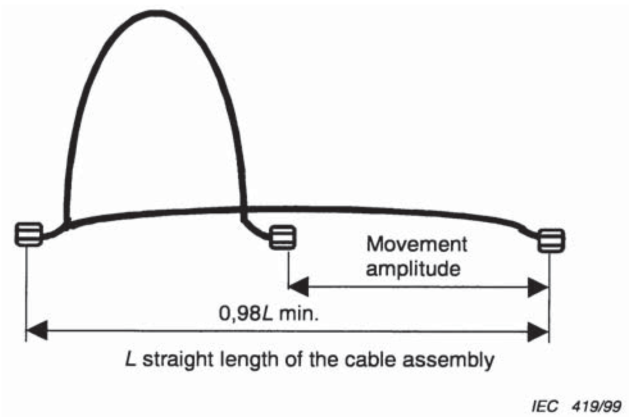


Figure 5 — Apparatus for cable assembly flexing endurance test

9.3.3 ***Requirements***

After the test, the cable assembly shall show no visible damage and the interface dimensions shall be within the specified limits. Electrical requirements stated in the relevant detail specification shall be complied with.

9.3.4 ***Information to be given in the detail specification***

a) Movement amplitude, normally half the length of the assembly.

b) Number of cycles, normally 500.

c) Electrical tests to be applied, with requirements.

9.4 Cable assembly crushing

9.4.1 ***Object***

To determine the ability of a cable assembly to withstand a transverse load (or a force) applied to any part of the cable.

9.4.2 ***Procedure***

A force F shall be applied to a test fixture as shown in Figure 6 at the rate of 0,2 F per second maximum. The force shall then be maintained for 60 s ± 10 s.

9.4.3 ***Requirements***

After the test, the reflection characteristics and insertion loss shall be within the limiting values specified in the relevant detail specification.

For some applications, the relevant detail specification shall indicate the uniformity of impedance according to **8.2**.

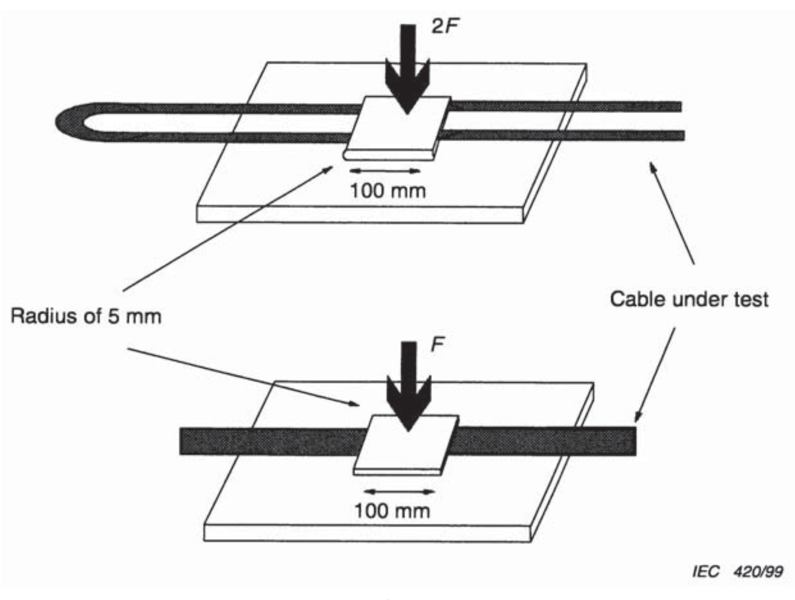


Figure 6 — Fixture for cable crushing test

9.4.4 ***Information to be given in the detail specification***

a) Value of the force *F*, normally 800 N.

b) Distance from the test region to one of the connectors, normally 1 m maximum.

c) Electrical tests and their requirements.

9.5 Torque

9.5.1 ***Procedure***

The ability of the cable to resist torsion shall be tested by the application of a specific torque strictly axially to the interface of the cable to the connector. The torque shall be applied for at least 60 s in both clockwise and counter clockwise directions.

9.5.2 ***Requirements***

After each 60 s application of the torque, the interface of the cable to the connector shall be visually examined. The cable assembly shall show no visual damage and the electrical requirements shall be satisfied. In addition, for semi-flexible and semi-rigid cables, there shall be no angular displacement between the cable and the connector.

9.5.3 ***Information to be given in the detail specification***

a) Value of the torque.

9.6 Multiple bending

9.6.1 ***Object***

To determine the ability of a cable assembly to withstand a number of reverse bends.

9.6.2 ***Procedure***

The cable assembly is subjected to a certain number of reverse bends using a pulling "go and return" arrangement over its entire length. The radius of the two pulleys shall be in accordance with the minimum dynamic bending radius of the cable. The pulleys shall be positioned so that the bending angle of the cable on each pulley is more than 90° as shown in Figure 7. The cable assembly is pulled forwards and backwards against a restraining force F_r which is set to ensure continuous contact between the cable and the pulleys.

9.6.3 ***Requirements***

After the test, the cable assembly shall show no visual damage and the electrical requirements shall be satisfied.

9.6.4 ***Information to be given in the detail specification***

a) Number of cycles (normally 20).

b) Electrical tests and their required limits to be applied.

9.7 Abrasion test of cable assembly

9.7.1 ***Object***

To determine the resistance to abrasion of the cable assembly sheath.

9.7.2 ***Procedure***

The cable assembly is subjected to test **10.10** of IEC 61196-1.

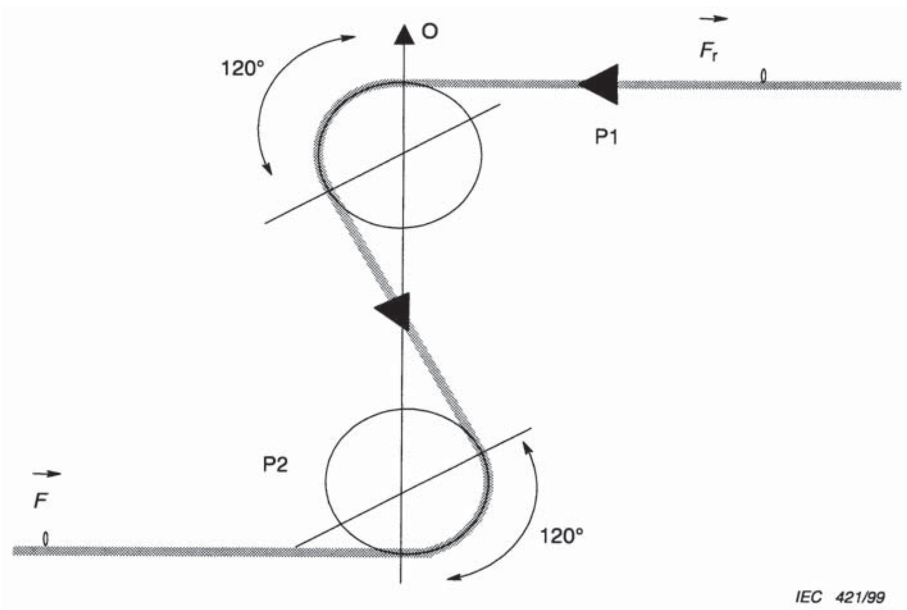


Figure 7 — Multiple bending test

9.8 Vibrations, shocks and impact

If required the test for vibrations and shocks shall be selected as defined in **10.2**.

9.8.1 *Impact test*

This test shall be conducted in accordance with test 7B of IEC 60512-5.

9.9 Mechanical endurance

When this test is not performed on the connectors separately it will be conducted in accordance with **9.5** of IEC 61169-1.

10 Environmental tests

10.1 Recommended severities

For the recommended severities of environmental tests, see Annex D.

10.2 Vibration, bumps and shock

When these tests are required, they shall be selected from IEC 60068 (see Annex D).

10.3 Climatic sequence

10.3.1 *Procedure*

The test shall be performed in accordance with **9.4.2** of IEC 61169-1. Flexible cable assemblies shall be wound on a mandrel of minimum static bending radius. The number of full turns shall be three, unless otherwise stated in the relevant detail specification.

10.3.2 *Requirements*

At the conclusion of the recovery period, the cable assembly shall comply with the requirements of the following tests, unless otherwise stated in the relevant detail specification.

a) Insulation resistance.

b) Voltage proof.

c) Insertion loss.

d) Visual inspection.

The insulation resistance measurement and the voltage proof shall be carried out within 30 min of the end of the recovery period.

10.3.3 *Information to be given in the detail specification*

a) Severity of each step of the climatic sequence.

b) Number of turns on the mandrel if other than three.

c) Electrical tests made during and after the sequence and their requirements.

d) Whether connectors are unmated or protected.

10.4 Damp heat, steady state

10.4.1 *Procedure*

The flexible cable assembly shall be wound on a mandrel of minimum static bending radius. The number of full turns shall be three, unless otherwise stated in the relevant detail specification. The test shall be performed in accordance with **9.4.3** of IEC 61169-1.

10.4.2 *Requirements*

At the conclusion of the recovery period the cable assembly shall comply with the requirements of the following tests, unless otherwise stated in the relevant detail specification.

a) Insulation resistance.

b) Voltage proof.

c) Insertion loss.

d) Visual inspection.

The insulation resistance and the voltage proof measurements shall be carried out within 30 min of the end of the recovery period.

10.4.3 *Information to be given in the detail specification*

a) Severity of the test.

b) Number of turns on the mandrel if other than three.

c) Electrical checks made immediately after conditioning and after recovery period and their requirements.

d) Whether connectors are mated or unmated.

10.5 Rapid change of temperature

10.5.1 *Procedure*

The test shall be performed in accordance with **9.4.4** of IEC 61169-1. Flexible cable assemblies shall be wound on a mandrel of minimum static bending radius. The number of full turns shall be three, unless otherwise stated in the relevant detail specification.

10.5.2 *Requirements*

At the conclusion of the recovery period, the cable assembly shall comply with the requirements of the following tests, unless otherwise stated in the relevant detail specification.

a) Insulation resistance.

b) Voltage proof

c) Insertion loss.

d) Visual inspection.

Centre contact and insulator positions shall be in accordance with the interface dimensions.

10.5.3 ***Information to be given in the detail specification***

a) Minimum and maximum temperature.

b) Number of turns on the mandrel if other than three.

c) Final tests and measurements and their requirements.

10.6 Solvents and contaminating fluids

10.6.1 ***Procedure***

The test shall be performed in accordance with **9.7** of IEC 61169-1.

10.6.2 ***Requirements***

At the conclusion of the recovery period, the cable assembly shall comply with the requirements of the following tests, unless otherwise stated in the relevant detail specification.

a) Insulation resistance.

b) Visual inspection.

c) Insertion loss.

10.6.3 ***Information to be given in the detail specification***

a) Conditioning fluids.

b) Drying temperature, if different from 70 °C.

c) Requirements for insulation resistance and insertion loss.

d) Whether the connectors are mated or unmated.

10.7 Water immersion

10.7.1 ***Procedure***

Details of the method shall be given in the relevant detail specification and shall be generally in accordance with **9.2.7** of IEC 61169-1.

10.7.2 ***Requirements***

At the conclusion of the test duration, the cable assembly shall comply with the requirements of the following tests, unless otherwise specified in the relevant detail specification.

a) Insulation resistance.

b) Insertion loss.

10.7.3 ***Information to be given in the detail specification***

a) Requirements for insulation resistance and insertion loss.

b) Whether the connectors are mated or unmated.

10.8 Salt mist and sulphur dioxide tests

10.8.1 ***Procedure***

When these tests are required, they shall be selected from IEC 60068. Severities are to be given in the relevant detail specification.

10.8.2 ***Requirements***

At the conclusion of the recovery period, the cable assembly shall comply with the requirements of the following tests, unless otherwise stated in the relevant detail specification:

a) Insulation resistance.

b) Visual inspection.

c) Insertion loss.

10.8.3 ***Information to be given in the detail specification***

a) Requirements for insulation resistance and insertion loss.

b) Whether the connectors are mated or unmated.

10.9 Dust tests

10.9.1 ***Object***

To determine whether the effects of exposure to dust impair the operational performance of the cable assembly and in particular the function of the coupling mechanism.

10.9.2 ***Procedure***

Details of a typical test cabinet for carrying out this test are given in **10.9.5**. The dust medium shall be fine powdered silica as detailed in **10.9.5**.

The dry specimen(s) with connectors mated and with back-of-panel portion of fixed connectors and free ends of cable protected, when appropriate, against ingress of dust shall be placed in the cabinet simulating the normal operational altitude. (If the normal operational altitude is indefinite, the specimen(s) shall be positioned in the altitude most likely to prove adverse).

No relevant part of any specimen shall be closer than 150 mm to the sides, top or bottom of the cabinet or part of another specimen during the test.

Each test cycle shall be of 15 min duration, during which the air blast shall be operated for the first 2 s only.

The number of test cycles to which the specimens will be exposed will be dependent upon the severity of exposure to dust likely to be met in service. The following are the preferred test severities:

a) Severe dust conditions: 20 cycles.

b) Moderate dust conditions: 10 cycles.

c) Slight dust conditions: 2 cycles.

10.9.3 ***Requirements***

At the conclusion of the last cycle, the specimen(s) shall be carefully removed from the chamber and any surplus dust removed by a light shaking or blowing. Before uncoupling the connector, any measurements required by the detail specification to check for deterioration in performance shall be made.

10.9.4 ***Information to be given in the detail specification***

a) Duration of test cycle if other than 15 min.

b) The equivalent altitude if other than that covered by the standard atmospheric conditions for testing.

c) Number of test cycles.

d) Details of visual, mechanical and electric inspection and tests required at the conclusion of the conditioning including whether a special tool may be used to assist uncoupling of mated connector.

e) Size of particles to be chosen from **6.1.4.2** of IEC 60068-2-68.

10.9.5 ***Test chamber***

The cabinet used shall be based on the typical details given below. The essential features are:

a) A dense diffusion of the dust shall be achieved within 2 s.

b) A glass observation panel incorporated in an opening door (with externally hand-operated wiper).

c) Means for holding the specimens in the cabinet in accordance with the requirements of this specification and the detail specification.

d) There shall be no increase in air pressure within the cabinet during the test and especially during the first 2 s of each cycle.

e) The test chamber temperature shall be capable of being raised to and maintained at a temperature of 35 °C ± 2 °C with a relative humidity not exceeding 60 %. It shall be adjustable so as to produce a dust concentration sufficient to deposit 25 g ± 5 g in the measuring device (see Figure 8) over a period of 5 min.

f) Materials used for the construction of the cabinet shall be such that there shall be no contamination of the dust by foreign matter.

g) Details of the powdered medium to be as follows: dry silica with grains 2,5 μm to 50 μm and grains of 50 μm to 150 μm (fifty/fifty).

10.10 Flammability

10.10.1 ***Procedure***

The test shall normally be carried out in accordance with IEC 60332-1 on a finished cable assembly. Unless otherwise specified in the detail specification, the duration of flame application shall be derived from the formula given in clause **7** of IEC 60332-1. In case of plastic components other than the cable itself, each one shall satisfy the requirements of the relevant specification.

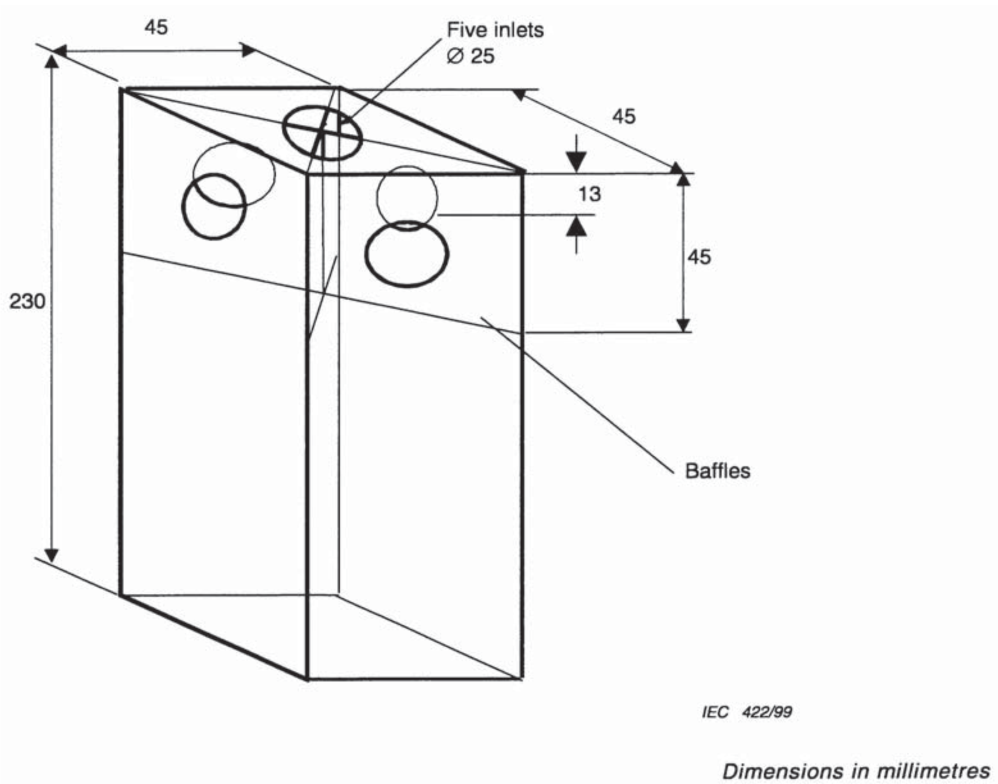


Figure 8 — Dust measuring device

10.10.2 ***Requirements***

a) If ignition occurs, the cable shall not continue to burn for more than 15 s after removal from the flame.

b) At no time during the test shall burning particles become detached from the cable.

10.10.3 ***Information to be given in the detail specification***

Any deviation from the standard procedure.

11 Specialized test methods

Specialized test methods, applicable to a specific group of cable assemblies only, shall be specified in the relevant sectional specification.

12 Test schedules

Testing schedules shall be defined in sectional and relevant detail specifications.

NOTE Typical sub-families consist of RF cable assemblies manufactured from a specific type of cable, for example, flexible or semi-rigid, RF-connectors of an IEC standardized or proprietary design, and having specific characteristics, for example precision or super-screened.

Annex A (normative)
Test methods for insertion loss determination

A.1 Purpose

To determine the insertion loss of an RF cable assembly.

A.2 Test methods

Three test methods for the determination of the insertion loss of an RF cable assembly are described in this annex. The test equipment should have the same nominal characteristic impedance as the cable assembly under test. If this is not possible, test methods 1 and 2, given in **A.2.1** and **A.2.2**, may only be used with the application of the correction formula and procedures given in clause **A.3**.

Test method 3 is only suitable for RF cable assemblies having an insertion loss smaller than their return loss.

Adapters may be required between the test equipment and the cable assembly under test. These shall be regarded as part of the test equipment and shall be left in the circuit when the cable assembly is removed as part of the test procedure. However, should a cable assembly have connectors such that the adapters cannot be coupled together when the cable assembly is removed, one or more of the adapters may be left on the cable assembly. In this case, an allowance for the adapter(s) shall be made in the relevant detail specification.

A.2.1 *Test method 1*

A.2.1.1 *Procedure for inspection*

The cable assembly is tested in the test equipment circuit as shown in Figure A.1.

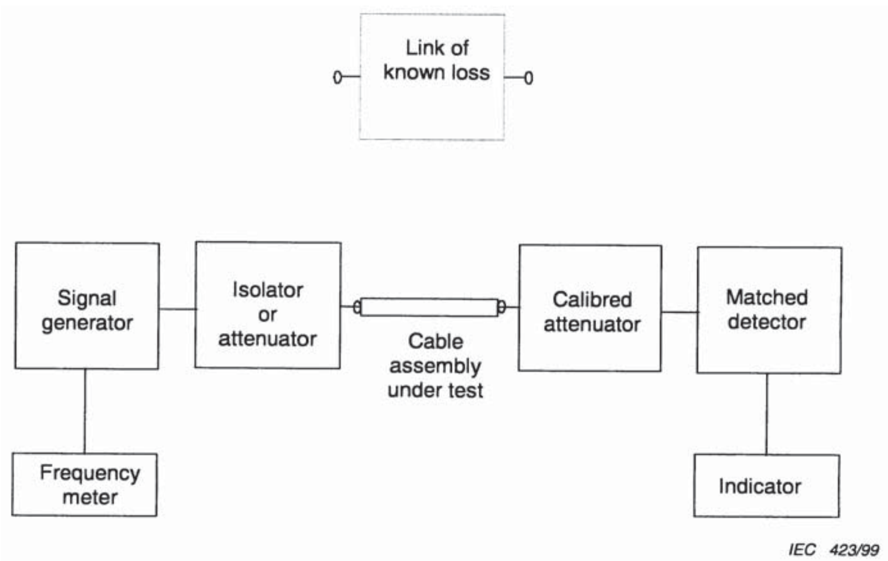


Figure A.1 — Circuit for the determination of insertion loss

First the cable assembly is either replaced by the link of known loss or the two test ports are coupled together and the indicator set to a suitable value (i.e. less than the maximum). The cable assembly is inserted between the test ports and the calibrated attenuator is then backed off by an amount equal to the cable assembly limit, less the known loss of the link if used. The indicator reading shall not be less than the set value. This ensures that the insertion loss of the cable assembly is not more than the specified value.

A.2.1.2 *Procedure for measurement*

The cable assembly is tested in the test equipment circuit as shown in Figure A.1. The indicator is set to a suitable value (i.e. less than the maximum). The cable assembly is then removed and the indicator reading is returned to the set value using the calibrated attenuator and if necessary the link of known loss.

A.2.1.3 *Acceptance*

The insertion loss of the cable assembly shall be no greater than the specified value.

A.2.1.4 *Precautions*

a) The return losses at the two test ports may impair measurement and shall be taken into account (see clause **A.3**).

b) Care shall be taken to ensure that too much power does not damage the detector.

c) The oscillator shall be sufficiently pure or filtered, to ensure that neither harmonics nor spurious signals compromise the tests.

d) See clause **A.2** regarding the use of adapters.

A.2.2 ***Test method 2***

This test method may be used for cable assemblies having the same nominal characteristic impedance as the test equipment (i.e. for high return loss cases) as well as for cable assemblies having different nominal characteristic impedances (i.e. for low return loss cases).

A.2.2.1 *Procedure*

The test circuit is shown in Figure A.2 whereby the detector V is connected to the output of the directional coupler or bridge through adapters as necessary.

Depending upon the test port return losses, calibration is made either by amplitude or by amplitude and phase (high return loss requires amplitude calibration only, while low return loss requires amplitude and phase calibration in accordance with clause **A.3**). The cable assembly is inserted between the output of the directional coupler or bridge and the detector V, using adapters if necessary. The attenuation is determined on the swept amplitude analyzer.

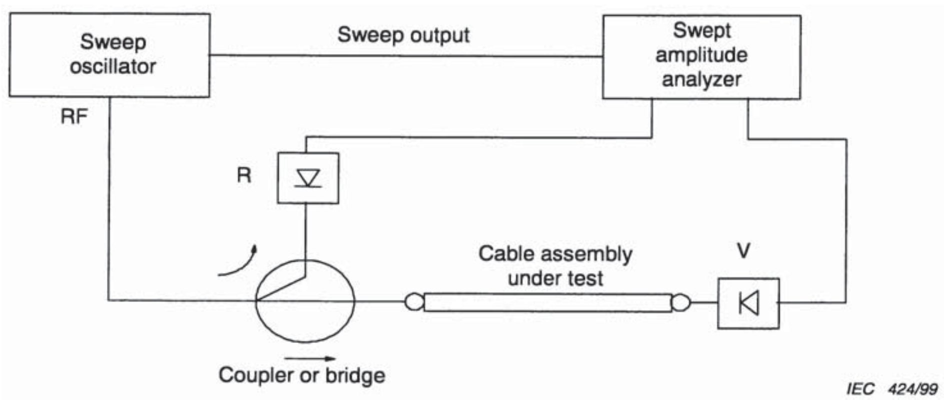


Figure A.2 — Circuit for the determination of insertion loss

If sufficient power is available or if there is sufficient sensitivity in the systems, the alternative circuit shown in Figure A.3 may be used.

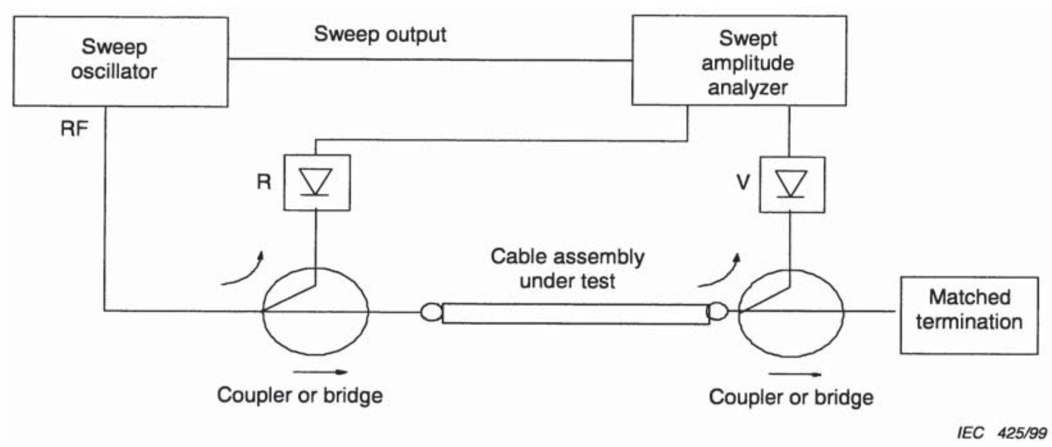


Figure A.3 — Alternative circuit for the determination of insertion loss

A.2.2.2 *Acceptance*

The insertion loss of the cable assembly shall be no greater than that specified.

A.2.2.3 *Precautions*

a) The return losses at the two test ports may impair measurement and shall be taken into account (see clause **A.3**). In particular, an attenuator having a low reflection may be required in front of the detector V.

b) The calibration of the system shall take into account the power dependence of the coupler.

c) The oscillator shall be sufficiently pure or filtered, to ensure that neither harmonics nor spurious signals compromise the tests.

d) In analogue-swept systems the frequency scan rate of the sweep oscillator shall be sufficiently slow in relation to the amplitude analyzer response to obtain an accurate determination of the insertion loss. In particular, it shall be slow enough for cable assemblies in which there are:

1) resonances, which can be very sharp, associated with structural return loss in the cable assembly;

2) multiple reflections between the ends of the cable assembly or the test ports.

e) In digitally stepped frequency systems, the steps shall be sufficiently fine for an accurate determination of the insertion loss. In particular, they shall be fine enough for the cases described in item d).

f) See clause **A.2** regarding the use of adapters.

A.2.3 ***Test method 3***

A double-pass method of test may be used if the insertion loss of the cable assembly is smaller than its return loss and the test bandwidth is sufficient. This requirement precludes the testing of unmatched cable assemblies.

A.2.3.1 *Procedure*

The layout of the test circuit is shown in Figure A.4.

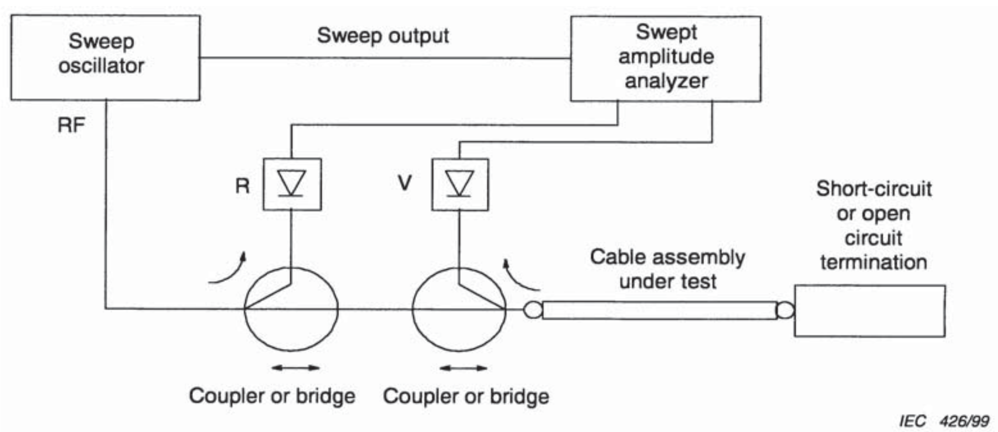


Figure A.4 — Double-pass circuit for the determination of insertion loss

Levels for V/R at 0 dB and for any other required attenuation are established over the required frequency range with terminations on the directional coupler port or adapters as follows:

a) short-circuit;

b) open-circuit.

The decibel average of these two levels a) and b) shall be deemed the reference level.

The cable assembly is then coupled to the directional coupler using adapters as necessary and attenuation levels are obtained with the short- and open-circuit terminations. The decibel average of the two plots obtained with the different terminations is twice the insertion loss of the cable assembly under test.

A.2.3.2 *Acceptance*

The insertion loss of the cable assembly shall be no greater than the specified value.

A.2.3.3 *Precautions*

a) The return loss at the test port and the directivity of the directional coupler or the apparent directivity of the bridge impair the measurement and shall be taken into account (see clause **A.3**).

b) The test bandwidth shall be sufficient to provide confidence in averaging plots.

c) The calibration of the system shall take into account the power dependence of the coupler.

d) The oscillator shall be sufficiently pure or filtered, to ensure that neither harmonics nor spurious signals compromise the tests.

e) In analogue-swept systems, the frequency scan rate of the sweep oscillator shall be sufficiently slow in relation to the amplitude analyzer response to obtain an accurate determination of the insertion loss. In particular, it shall be slow enough for cable assemblies in which there are:

1) resonances, which can be very sharp, associated with structural return loss in the cable assembly;

2) multiple reflections between the ends of the cable assembly or the test ports,

f) In digitally stepped frequency systems, the steps shall be sufficiently fine for an accurate determination of the insertion loss. In particular they shall be fine enough for the cases described in item e).

g) The insertion loss of the cable assembly shall permit resolution of the reflections from the cable assembly and its terminations.

h) In open-circuit tests, radiation from the connector centre contacts shall not compromise accuracy. If necessary, precision open-circuit terminations (i.e. shielded or closed-end open-circuit terminations) shall be used.

j) See clause **A.2** regarding the use of adapters.

A.3 Correction for characteristic impedance differences

When the characteristic impedance of the test equipment and the cable assembly differ, test methods 1 and 2 may be used with the following correction formula:

$$A = A' - \left[20 \times \log \frac{(Z_g + Z_0)}{\left(2 \times \sqrt{Z_g \times Z_0}\right)}\right] - \left[20 \times \log \frac{(Z_1 + Z_0)}{\left(2 \times \sqrt{Z_g \times Z_1}\right)}\right] - \left[20 \times \log\left[1 - \left(\frac{Z_g - Z_0}{Z_g + Z_0} \times \frac{Z_1 - Z_0}{Z_1 + Z_0} \times e^{-2(\alpha + \beta)L}\right)\right]\right]$$

where

A	is the true insertion loss of the cable assembly under test (dB);
A'	is the measured insertion loss of the cable assembly (dB);
Z_g	is the nominal output impedance of the generator's isolator/attenuator (test method 1) or the coupler or bridge (test method 2) (Ω);
Z_0	is the nominal characteristic impedance of the cable assembly (Ω);
Z_1	is the nominal input impedance of the calibrated attenuator (test method 1) or the detector or coupler/bridge (test method 2) (Ω);
α	is the attenuation constant of the cable assembly (neper/m);
β	is the phase constant of the cable assembly (radian/m);
L	is the physical length of the cable assembly (m).

When the attenuation against frequency shows a consistent ripple resulting from the multiple reflections between the two test ports, β may be obtained from:

$$\beta = \frac{\pi \times f}{\Delta f \times L}$$

where

Δf	is the frequency difference between either two successive maxima or two successive minima in the attenuation ripple at approximately frequency f.

Further to this, □ is approximately equal to □′ which is obtained from:

□ = A□/8,686 L neper/m

However, for greater accuracy, this formula may be used iteratively by substituting □ for □′ in the above equation.

Annex B (informative)
Measuring methods for propagation time

Introduction

Methods for both long and short cable assemblies are needed. For long cable assemblies a method based on resonance of forward and backward waves is recommended. This resonance method is described in clause **B.1**. For short cable assemblies the time domain method described in clause **B.2** is recommended.

B.1 Resonance method for propagation time measurement

The frequencies f_i of the voltage minima at the near end of a short-circuited cable assembly and/or the frequencies f_j of the voltage maxima of an open-circuited cable assembly are measured. The frequency of the first maximum or minimum is designated as f_1, the second as f_2, etc.

A suitable equipment arrangement is given in Figure B.1.

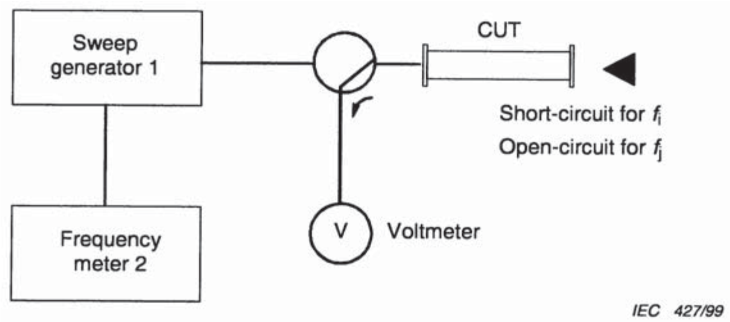


Figure B.1 — Arrangement of test equipment

The propagation time $T_{p,n}$ at frequency f_i or f_j is given by the formula:

$$T_{p,n} = \frac{n}{f_n}$$

where $n = i$ or j.

NOTE The electrical length of the coupling device and the adapter should be taken into account.

The accuracy can be improved by taking the mean values:

$$f_n = \frac{f_i + f_j}{2}$$

$$T_{pn} = \frac{T_{pi} + T_{pj}}{2}$$

where $n = i = j$.

For best accuracy the cable shall be terminated with a short-circuited or open-circuited connector of the same electrical length.

At other than the above resonance frequencies, the following formula may be used. The coefficients are determined from measurement at several resonance frequencies f_n.

$$T_p = B_o + B_{1f}^{-1/2} + B_{2f}^{-1/4} + ...$$

B.2 Time domain method for propagation time measurement

For a short or very short cable assembly the propagation time can be determined by the time delay of an echo through the cable.

A time domain reflectometer (TDR) or a pulse echo test set can be used. The rise time of the system and the width of the pulse should be in accordance with the resolution needed.

The measured echo delay time should be divided by a factor of 2 to obtain the propagation time of the cable assembly. Allowance should be made for the electrical length of the short-circuit or open-circuit.

Annex C (informative)
Measurement method for screening effectiveness

C.1 Introduction

The screening effectiveness of a coaxial cable assembly is determined by the screening properties of its cable, its connectors and the joints between them. The transfer impedance may be measured by the line injection method depicted in Figure C.1.

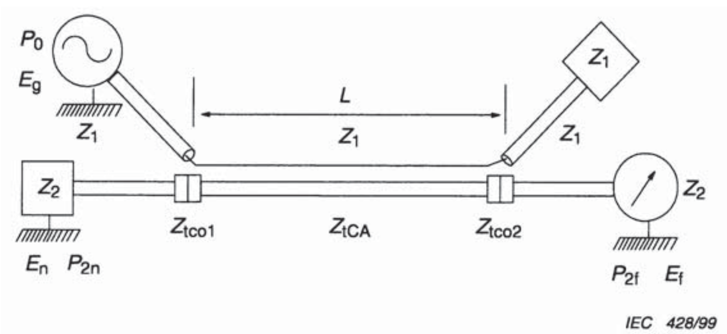


Figure C.1 — Line injection test circuit for coaxial cable assemblies

$$T_n = \sqrt{\frac{P_{2n}}{P_0}} \qquad T_j = \sqrt{\frac{P_{2j}}{P_0}}$$

In these formulae, P_o is the power input to the cable assembly; P_{2n} and P_{2f} are the measured powers from the near and far ends of the cable assembly, respectively.

When $Z_f = 0$, the measured coupling transfer functions are:

$$T_j = \left[\left(\frac{Z_{tCA}}{2 \times Z_{12}} \times S_j(f)\right) + \left(\frac{Z_{tco1} + Z_{tco2}}{2 \times Z_{12}}\right)\right]$$

where $Z_{12} = \sqrt{Z_1 \times Z_2}$

In Figure C.2, the cable is electrically long above frequency f_{cn}. The connectors are considered electrically short over the whole frequency range and the sum of their transfer impedances is assumed to be smaller than that of the cable. The transfer impedances of the joints are included in the transfer impedances of the connectors.

In spite of the fact that the cable is electrically long at higher frequencies, the transfer impedances can be added together without taking into account the phase shift of the cable.

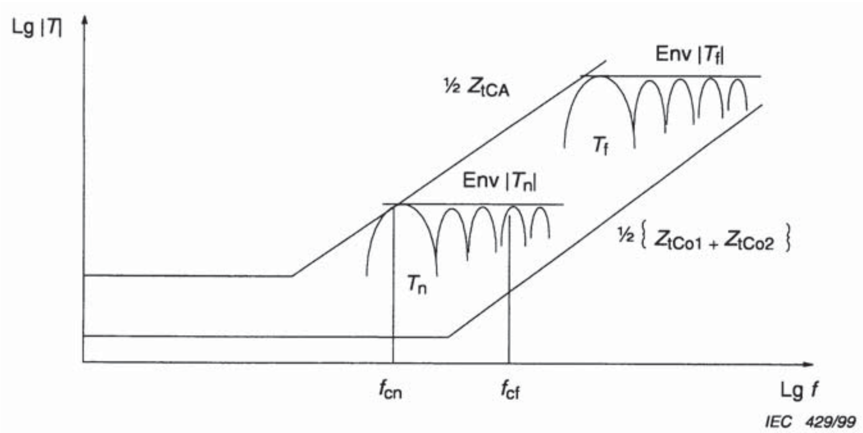


Figure C.2 — Schematic transfer functions of a coaxial cable assembly

In practice, the magnitude of the transfer impedances of the connectors and cable create difficulties in both describing and measuring the screening effectiveness of the complete cable assembly if:

a) the transfer impedances of the connectors dominate, the transfer function and transfer impedance of a cable assembly will normally increase linearly with the frequency; or

b) the transfer impedance of the cable dominates, the linearly increasing transfer function has a cut off frequency f_c above which resonances occur. The cut off frequencies for the near and far end transfer functions are different as shown in Figure C.2.

When the transfer impedance of the cable dominates, the envelopes (Env) of the transfer functions are:

$$\mathrm{Env}(|T_j|) \approx \frac{|Z_f + Z_t|}{2 \times Z_{12} \times \left(1 + \dfrac{1}{f_{cf}^{n}}\right)}$$

where

$$f_{cf}^{n} = \frac{C}{\left|\sqrt{\varepsilon_{r2}} \pm \sqrt{\varepsilon_{r1}}\right| \times \pi L} = \frac{v\pm}{\pi \times L} \quad \text{and} \quad v\pm = \frac{C}{\left|\dfrac{1}{v_{r2}} \pm \dfrac{1}{v_{r1}}\right|}$$

It should be noted that both the effective transfer impedance and the screening attenuation include the effect of the cable length.

In the formulae above, it is assumed that the transfer impedance of the cable is always dominant.

C.2 Test method

The line injection method, which is satisfactory for coaxial cables, can also be used for measuring the screening effectiveness of a coaxial cable assembly. The full circuit for a coaxial cable assembly is given in Figure C.3.

For measurements at frequencies above 100 MHz, the injection circuit needs to fulfil three well-defined conditions:

— constant characteristic impedance over the length of the test section;

— characteristic impedance matched to test instruments; and

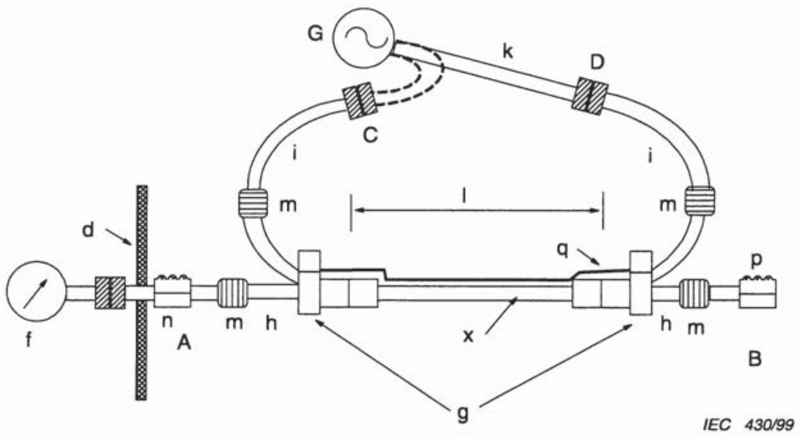
— low or measurable insertion loss.

For the construction of the injection line, one or several parallel wires may be used with both ends of all wires connected to the central conductors of the coaxial feeder cables.

The characteristic impedance of the injection line shall be equal to that of the feeder cables, the generator and the load.

With the arrangement described, the generator and matched load on the injection circuit may be exchanged to perform either near or far end measurements, i.e. no manipulation of the cable assembly under test is required.

The full details related to this test method are given in clause **12** of IEC 61196-1.



A is the cable assembly test circuit far end relative to input at D (alternatively, near end relative to input at C)
B is the cable assembly test circuit near end relative to input at D (alternatively, far end relative to input at C)
C is the injection circuit far end (alternatively, near end)
D is the injection circuit near end (alternatively, far end)
x is the cable assembly under test
d is the screened room wall with well-screened coaxial feed-through
G is the generator (synthesizer, tracking generator, etc.)
f is the test receiver (spectrum analyzer, network analyzer, etc.)
g is the connection to injection wires
h is a brass tube for additional screening of the cables fitted to the cable assembly under test
i are injection wire feeder cables (length approximately 0,5 m each, low loss)
k is the feeder cable from generator
l is the length of cable assembly
m are ferrite rings (length of each block approximately 100 mm)
n is additional screening for the connection between screened room and cable assembly under test
p is additional screening for terminating resistance of cable assembly under test
q is the injection line

Figure C.3 — Complete installation for practical screening effectiveness measurements

Annex D (informative)
Recommended severities for environmental tests

D.1 Introduction to the relationship between environmental conditions and severities of testing

D.1.1 *General*

The purpose of environmental engineering is to render the product and the environment compatible. It should take all economic and technical aspects into consideration and thereby choose the best test methods and correct severities for the evaluation of the product's ability to withstand the environment. A test program for the product is defined whereby the test sequence together with the test methods and limits are specified.

D.1.2 *Environmental conditions*

The environmental conditions shall be evaluated by measurements or by other information available so that statistically accurate characteristic values can be established corresponding to the highest possible constraints. Each situation has an environment of its own, but it is not reasonable to prescribe individual products having slightly different withstand properties for each individual situation. It is necessary to combine these environments into a class forming an envelope of related environments. It is only necessary to take into account those parameters that influence the performance of the product. The environment shall cover all the conditions that occur during the life of the product, i.e. storage, transportation, use and handling.

D.1.3 *Environmental testing*

The purpose of an environmental test is to demonstrate that a product under defined environmental conditions can survive without permanent failure and continue to function according to specification. The severity of the test to be selected will depend on the characteristic values obtained for the parameters, the failure mechanism, the ageing factor if known, and the consequences of failure. The latter will have been studied by the utilization of the particular product and depends on its application. This means that the severity of the test can be raised or lowered according to the criticality of the product. If the sampling of the product suggests wide variations in its ability to withstand the specified environment, the level of testing should be increased. If the distributions of environmental constraints and the resistance to the environment of a lot tested are suspected to partially overlap, the test levels can be raised to clarify this weakness.

The performance requirements should also be considered. Normal performance is usually specified for all primary functions but, for secondary functions, requirements may be relaxed during extreme conditions to avoid unnecessary over-specification.

An environmental test may be performed for many purposes. In this generic specification, the environmental tests are one part of the qualification approval tests. In this case, a test of resistance to the environment demonstrates the ability of the product to function under constraints or withstand stated constraints. There are, however, inherent limitations due to the fact that the tests are usually carried out on a few samples.

The results give protection to a particular design, but not to an individual product. The successful test will ensure that the product, as a type, is capable of withstanding the expected environments. Different kinds of tests and severity levels are necessary for product reliability and endurance.

An outline of the action needed for the preparation of an environmental test specification is given in Figure D.1.

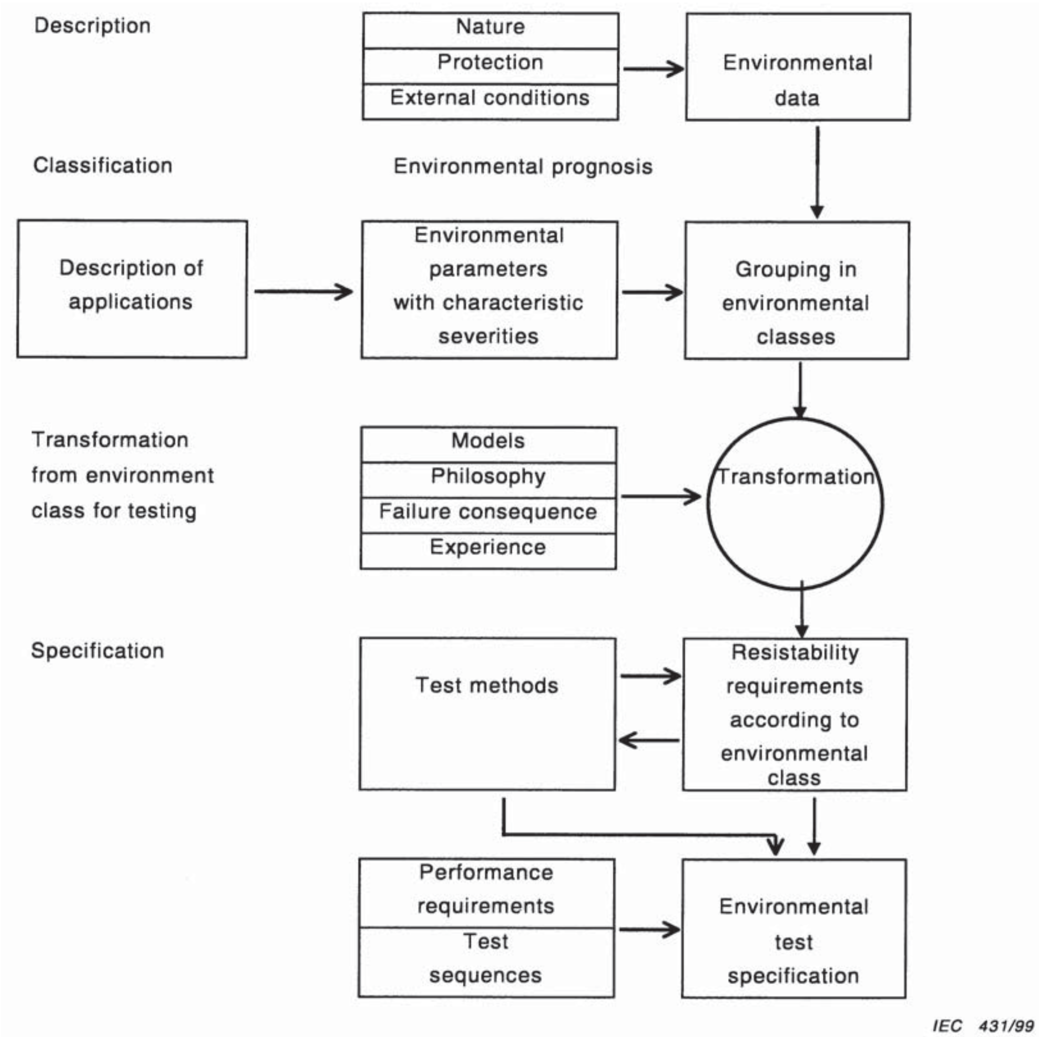


Figure D.1 — Description of action needed for the preparation of the environmental test specification

D.2 Severities for environmental tests

D.2.1 ***Vibration***

This test shall be carried out in accordance with test Fc of IEC 60068-2-6, as specified in **9.3.3** of IEC 61169-1, which includes details on continuity monitoring and on the information which should be given in the relevant sectional and detail specifications.

The vibration severity shall be defined by a combination of three parameters: range of frequency, vibration amplitude and duration in terms of the number of cycles. The relevant specification shall select the appropriate requirement for each parameter from the following recommended values:

Swept frequency range:	10 Hz to 150 Hz
	10 Hz to 500 Hz
	10 Hz to 2 000 Hz
Vibration amplitude:	. . . . . .

Vibration amplitude shall be specified below 57 Hz to 62 Hz and at frequencies higher than acceleration amplitude.

Table D.1 — Relationship between displacement and acceleration

Displacement amplitude	Acceleration amplitude	
mm	m/s²	g
0,75	98	10
1,0	147	15
1,5	196	20

Duration: . . . . . .

Number of swept cycles in each axis: 2, 5, 10 or 20.

D.2.2 *Bump*

This test shall be carried out in accordance with test Eb of IEC 60068-2-29. Unless otherwise required in the sectional or relevant detail specification, one of the following recommended severities shall be selected:

Number of bumps: 1 000 ± 10

D.2.3 *Shock*

This test shall be carried out in accordance with test Ea of IEC 60068-2-27.

Unless otherwise required in the sectional or relevant detail specification, one of the recommended pulse shapes given in the table below shall be selected. The shock severity is given by a combination of the peak acceleration and the duration of the nominal pulse.

Table D.2 — Relationship between peak acceleration and velocity change

Peak acceleration		Corresponding duration of pulse	Corresponding velocity change		
			Final peak saw tooth	Half sine	Trapezoidal
m/s²	g	ms	m/s	m/s	m/s
147	15	11	0,81	1,03	1,46
294	30	18	2,65	3,37	4,77
490	50	11	2,69	3,43	4,86
981	100	6	2,94	3,74	5,30
4 900	500	1	2,45	3,12	4,42
14 700	1 500	0,5	3,68	4,68	6,62

D.2.4 *Climatic sequence*

Unless otherwise required in the sectional or relevant detail specification, one of the following recommended severities shall be selected:

Low temperature:	– 40 °C to – 55 °C
High temperature:	+ 70 °C, + 85 °C, + 125 °C, + 155 °C, + 200 °C
Duration:	4, 10, 21 or 56 days

D.2.5 *Damp heat, steady state*

This test shall be carried out in accordance with test Ca of IEC 60068-2-3.

Unless otherwise required in the sectional or relevant detail specification, one of the following recommended severities shall be selected:

Duration: 4, 10, 21 or 56 days

D.2.6 ***Rapid change of temperature***

This test shall be carried out in accordance with test Nc of IEC 60068-2-14. The range of temperatures shall be selected in accordance with the test of climatic sequence.

Velocity of change:	1 °C ± 0,2 °C/min
Number of cycles:	2, unless otherwise specified

D.2.7 ***Salt mist***

This test shall be carried out in accordance with test Ka of IEC 60068-2-11. The duration of the test shall be either 96 h or 168 h.

D.2.8 ***Sulphur dioxide test***

This test shall be carried out in accordance with test Kc of IEC 60068-2-42. The duration of the test shall be of four days.

D.2.9 ***Dust test***

Under consideration.

Annex E (normative) Quality assessment

Introduction

The purpose is to give general procedures on how to achieve a quality assessment for RF cable assemblies.

According to **3.1** of IEC 60096-1 an RF cable assembly is a combination of a cable and connectors with specified performance, used as a single unit.

The cables should be preferably chosen from IEC 61196 and the connectors from IEC 61169, (see clause **1**, note 1), in many cases they will be customer-built products.

Quality assurance for connectors and cables is described in IEC 61169 and IEC 61196 respectively and does not form part of this specification.

E.1 Object

This part of the generic specification for radio frequency coaxial cable assemblies specifies qualification approval and capability approval procedures.

E.2 General

E.2.1 ***Related documents***

See clause **2**.

E.2.2 ***Standards and preferred values***

Whenever possible, standards and preferred values according to this generic specification and the relevant sectional specification shall be used.

E.2.3 ***Marking of the cable assembly and packaging*** (see **5.2**)

Unless otherwise specified in the detail specification (DS) or customer detail specification (CDS) each cable assembly shall be marked with as many of the following items, as space permits, given in the order of preference:

— type number;

— lot identification and/or date code and/or serial number;

— factory identification code;

— detail specification number.

All this information shall be marked on the primary package of the cable assemblies, all markings shall be legible and indelible.

E.2.4 ***Terminology***

E.2.4.1 *Capability manual (CM)*

The capability manual (CM) of a manufacturer is a complete description of design rules, manufacturer processes and test procedures including the limits and the verification procedures. The capability manual is the basic document for granting a capability approval.

E.2.4.2 *Quality manual (QM)*

The quality manual (QM) describes either directly or by reference to the manufacturer's internal documents, the procedures used by the manufacturer to ensure conformity of his products with the applicable specifications. It is needed for both qualification and capability approval.

E.2.4.3 *Capability qualifying components (CQCs)*

CQCs are test specimens specially designed or taken from production, used for verifying capability limits in accordance with the capability manual (CM).

E.2.4.4 *Primary stage of manufacture*

The primary stage of manufacture is the first activity under the control of the manufacturer, according to the capability manual.

E.3 Quality assessment procedures

E.3.1 *Procedures for qualification approval*

E.3.1.1 *Introduction*

Qualification approval is appropriate when the cable assemblies are made to standard patterns and usually in continuous production.

Qualification approval can only be achieved for existing detail specifications.

The relevant specifications state the requirements for the qualification approval of the cable assembly (test schedule, number of specimens, number of defectives permitted, etc.).

E.3.1.2 *How to obtain qualification approval*

To obtain qualification approval the following steps shall be performed:

a) Approval of the manufacturer on the basis of his ability to produce and inspect components in conformance with the specifications and the agreed rules of procedure, limited to specified organisation and facilities, verified by audits on QM by the NSI according for instance to ISO 9001 or ISO 9002.

NOTE A valid approval according to the relevant ISO 9000 is recognized.

b) Successful completion of qualification tests usually made on production items according to the relevant specification.

E.3.1.3 *How to maintain qualification approval*

To maintain a qualification approval the manufacturer shall comply with the following conditions to the satisfaction of the NSI:

a) The results of the periodic audits by the NSI at intervals no greater than one year on the quality manual shall be satisfactory.

b) The delivered products shall fulfil the quality assurance requirements.

c) An inspection of the current production is carried out in accordance with the specifications. The cable assemblies from lots which do not fulfil the specifications are not permitted to be delivered.

d) Successful completion of periodic tests according to the detail specification.

E.3.1.4 *Modifications likely to affect qualification approval*

These shall be in accordance with the requirements of rules of procedure in **11.4** of IEC QC 001002-3.

The manufacturer shall report to the NSI any technical modifications, including changes of place of manufacture, which could affect the results obtained where the qualification approval was delivered.

The NSI shall then decide whether it is necessary to repeat all or some of the qualification approval tests before any components subject to the modifications are delivered under the system.

The NSI shall, as a part of its surveillance, ensure that the reporting of modifications has taken place.

E.3.2 *Procedures for capability approval*

E.3.2.1 *Introduction*

When the total volume of cable assemblies being manufactured for a particular customer order is less than the quantity of assemblies to be tested for a capability study based on the manufacturer's capability manual, then the capability study is not required to obtain capability approval.

As capability approval is process orientated, it is appropriate when the cable assembling technologies are fully controlled and the requirements of the customers with respect to design variants change to reflect final use.

Capability approval is valid for all existing and future detail specifications within the capability limits.

The capability manual states the requirements for the capability approval of all cable assemblies within the capability limits.

E.3.2.2 *How to obtain a capability approval*

To obtain a capability approval, the following steps shall be performed:

a) Approval of the manufacturer on the basis of his ability to produce and inspect components according to the specifications and the agreed rules of procedure, limited to specified organisation and facilities checked by audit on the QM by the NSI according to ISO 9001 or ISO 9002.

NOTE A valid approval according to the relevant ISO 9000 is recognized.

b) Approval of the manufacturer on the basis of his capability manual by the NSI.

c) Successful completion of qualification tests on CQCs specified by the chief inspector according to the CM and the relevant specifications.

E.3.2.3 *How to maintain a capability approval*

To maintain the capability approval the manufacturer shall comply with the following conditions to the satisfaction of the NSI:

a) He shall give evidence that the capability limits stay valid by periodic testing of the CQCs according to the CM.

b) The results of the periodic audits on the QM led by the NSI at intervals no greater than one year shall be satisfactory.

c) The delivered products shall fulfil the quality assurance requirements.

d) The capability manual shall be continuously updated.

e) The register of the associated products shall be kept up to date.

E.3.2.4 *Procedure for reduction, extension or change of capability*

Where an approved manufacturer wishes to reduce, extend or change the domain of his capability, it is the responsibility of the chief inspector to decide whether the reduction, extension or change is significant or not.

Where the reduction, extension or change is not significant, it shall be recorded by the manufacturer who may proceed without the approval of the NSI.

Where the reduction, extension or change is significant the manufacturer shall notify the NSI in advance.

The results of the tests carried out to demonstrate the effect of the change on the products shall be made available to the NSI.

E.3.3 ***Quality conformance inspection***

After qualification approval or capability approval has been obtained, the manufacturer is responsible for ensuring that no technical changes likely to affect the approval are introduced for the products without re-approval, and that the quality conformance inspection required by the specifications is carried out with success.

The quality conformance inspection is divided into two parts:

a) A first group of tests that is carried out lot by lot and serves to accept the individual production lots that it is based on.

b) A second group of tests, containing the time consuming and more expensive tests, that are carried out on a periodic basis.

Under qualification approval, the full test programme is given in the detail specification.

Under capability approval, periodic tests shall be performed on CQCs as prescribed in the CM.

E.3.3.1 *Formation of inspection lots*

An inspection lot may be formed by the aggregation of several production lots, provided that:

a) The production lots are manufactured under essentially the same conditions, without significant interruption.

b) All the production lots are assembled with the same piece parts.

E.3.3.2 *Lot-by-lot tests*

Lot-by-lot tests are carried out on each inspection lot.

Generally, lot-by-lot tests cover the visual and dimensional inspections and the principal characteristics of the cable assemblies.

E.3.3.3 *Periodic tests*

Periodic tests are carried out at fixed intervals on samples taken from lots which have already satisfied the lot-by-lot tests or on CQCs in case of capability approval. The periodicity and the number of samples are given in DS.

Generally, the periodic tests cover structural characteristics. They are time consuming and rather expensive.

E.3.3.4 *Release or rejection of lots*

This shall be in accordance with the requirements in **12.5** of IEC QC 001002-3.

Unless otherwise stated in the relevant specification, the lots shall be released or rejected on the basis of the lot-by-lot tests. Normally the failure of the sample submitted to one of the periodic tests shall entail the rejection of the lot from which the sample came.

E.3.3.5 *Procedure in the event of failure in a periodic test*

This shall be in accordance with the requirements in **12.6** of IEC QC 001002-3.

E.4 Capability manual and approval

E.4.1 *Responsibilities*

It is the responsibility of the chief inspector to access the capability manual as well as to select and define CQCs.

To assure that the manufacturer's organization, processes and products are correctly documented in his quality and capability manuals and effectively implemented in accordance with the requirements, an audit shall be performed under the responsibility of the NSI.

The NSI shall verify the following items:

- — capability manual;
- — quality assessment;
- — organization;
- — design control;
- — manufacturing inspections;
- — control of equipment used for inspection, measuring and testing;
- — control of non-conforming parts, material, products;
- — handling, storage and delivery;
- — change control,
- — traceability.

E.4.2 *Contents of the capability manual*

E.4.2.1 *Object*

This subclause shall give the range of specifications covered by the capability approval.

E.4.2.2 *List of revisions*

The validation of an updated capability manual is part of the audit procedure.

Revisions shall be identified by an index and the date. When a revision takes place, a complete list of all changes shall be made which occurred during the preceding period.

E.4.2.3 *Related documents*

The capability manual shall make reference to all mentioned relevant documents.

E.4.2.4 *Capability domain, capability limits and their related CQCs* (see Table E.1, Table E.2 and Table E.3)

This section shall give the identification of the domain in terms of:

a) connectors;

b) cables;

c) main assembly techniques;

d) other piece parts (sleeves, caps, armours, etc.);

e) test facilities.

This subclause shall also give a reference list of the capability limits and the CQCs chosen to assess these limits from the primary stage of manufacture to the final product.

E.4.2.5 *Flow chart, including process parameters* (see Table E.4)

This section shall include:

a) General flow chart(s) giving the full sequence of manufacturing and inspection processes, from the primary stage of manufacture to the delivery and the corresponding CQCs.

b) Working instructions, and inspection procedures for all processes contained in the flow chart, generally by reference to in-house documentation.

c) Flow charts for CQCs.

E.4.2.6 *Purchased raw materials and piece parts*

This subclause shall identify purchasing specifications for the raw materials and piece parts used in the manufacturing processes.

E.4.2.7 *Design rules*

Unless covered by quality manual, the manufacturer's design rules shall be stated either directly or by reference to the manufacturer's internal documents.

E.4.2.8 *Register of associated products*

This subclause shall give the list of products which are, or can be, delivered under capability approval generally by reference to an annex.

E.4.3 ***Criteria for capability limits***

The sectional specifications shall preferably give guidance for capability limits, technology, processes, performances and their related CQCs. The CM may include one or several subfamilies from one or several sectional specifications.

Table E.1 — Example of capability limits for cable assemblies

Technology	Capability domain	Capability limits
Cable	Flexible (subfamily) Semi-rigid (subfamily) Semi-flexible (subfamily) Super-screened (subfamily)	Purchased according to IEC 61196-XX or other standards or manufactured according to processes described in the CM (see Table E.2)
Connectors	Series SMA, N, BNC, etc. Customer-built	Purchased according to IEC 61169-YY, IEC 60339 or other standards, or manufactured according to processes described in the CM (see Table E.3)
Other piece parts	Sleeves, armour, etc.	
Assembly techniques	Crimping Soldering, etc.	
Mechanical Electrical Environmental	Test group Mn Eb and/or Eh Vc and/or Vv	

Table E.2 — Example of capability limits for flexible cables

Inner conductor	Solid wire (range of diameters) Stranded wire Plated wire
Insulation	Extrusion (function of the material) Tape lapping Sintering
Outer conductor	Braid Foil plus braid Tape lapping
Jacket	Braid Extrusion (materials)

Table E.3 — Example of capability limits for connectors

Slicing
Molding
CNC machining
Electroforming
Electroerosion
Embossing
Plating, etc.

In this case, Table E.2 and Table E.3 have been combined with Table E.1 concerning environmental, mechanical and electrical requirements.

Table E.4 — Example of flow chart (see **E.4.2.5**)

Operations	Limits	CQC	Specifications
Cable manufacture	Purchased according to IEC 61196-XX	NA	Purchasing specification Incoming inspection
Connector manufacture	Purchased according to IEC 61169-YY	NA	Purchasing specification Incoming inspection
Cable preparation	Accuracy 2 mm	CQC n° 001	Procedure n° 1001
Connector crimping	For outer cable diameter 5 mm to 15 mm	CQC n° 002	Procedure n° 1002
Connector soldering	For inner cable diameter of 0,5 mm to 4 mm	CQC n° 003	Procedure n° 1003
Tests Eh, Ez, Mn, Vt	12,5 GHz; – 40/125 °C	CQC n° 004	Procedure n° 1004
Packaging			Procedure n° 1005

Annex ZA (normative) Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60068-2-3	1969	*Basic environmental testing procedures* Part 2: *Tests — Test Ca: Damp heat, steady state*	HD 323.2.3 S2[a]	1987
IEC 60068-2-6 + corr. March	1995 1995	Part 2: *Tests — Test Fc: Vibration (sinusoidal)*	EN 60068-2-6	1995
IEC 60068-2-11	1981	Part 2: *Tests — Test Ka: Salt mist*	EN 60068-2-11	1999
IEC 60068-2-14	1984	Part 2: *Tests — Test N: Change of temperature*	HD 323.2.14 S2[b]	1987
IEC 60068-2-27	1987	Part 2: *Tests — Test Ea and guidance: Shock*	EN 60068-2-27	1993
IEC 60068-2-29 + corr.	1987	Part 2: *Tests — Test Eb and guidance: Bump*	EN 60068-2-29	1993
IEC 60068-2-42	1982	Part 2: *Tests — Test Kc: Sulphur dioxide test for contacts and connections*	—	—
IEC 60068-2-68	1994	Part 2: *Tests — Test L: Dust and sand*	EN 60068-2-68	1996
IEC 60096-1	1986	*Radio-frequency cables* Part 1: *General requirements and measuring methods*	—	—
IEC 60332-1	1993[c]	*Tests on electric cables under fire conditions* Part 1: *Test on a single vertical insulated wire or cable*	—	—
IEC 60339	series	*General purpose rigid coaxial transmission lines and their associated flange connectors*	HD 350	series
IEC 60512-5	1992	*Electromechanical components for electronic equipment, basic testing procedures and measuring methods* Part 5: *Impact tests (free components), static load tests (fixed components), endurance tests and overload tests*	—	—
IEC 61169-1	1992	*Radio-frequency connectors* Part 1: *Generic specification — General requirements and measuring methods*	EN 61169-1	1994
IEC 61196-1	1995	*Radio-frequency cables* Part 1: *Generic specification — General, definitions, requirements and test methods*	—	—

[a] HD 323.2.3 S2 includes A1:1984 to IEC 60068-2-3.
[b] HD 323.2.14 S2 includes A1:1986 to IEC 60068-2-14.
[c] HD 405.1 S1 is superseded by EN 50265-1:1998 and EN 50265-2-1:1998, which are related to IEC 60332-1:1993.

Publication	Year	Title	EN/HD	Year
IEC 61726	1995	*Cable assemblies, cables, connectors and passive microwave components — Screening attenuation measurement by the reverberation chamber method*	—	—
IEC QC 001002	1986	*Rules of procedure of the IEC Quality Assessment System for Electronic Components (IECQ)*	—	—
ISO 9000	series	*Quality management and quality assurance standards*	EN ISO 9000	series
ISO 9001	1994	*Quality systems — Model for quality assurance in design/development, production, installation and servicing*	EN ISO 9001	1994
ISO 9002	1994	*Quality systems — Model for quality assurance in production, installation and servicing*	EN ISO 9002	1994

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