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Coaxial communication cables – Part 13: Sectional specification for semi-rigid cables with silicon dioxide dielectric

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Part 13: Sectional specification for semi-rigid cables with silicon dioxide dielectric

FOREWORD

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IEC 61196-13 has been prepared by subcommittee 46A: Coaxial cables, of IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories. It is an International Standard.

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

Draft	Report on voting
46A/1623/CDV	46A/1637/RVC

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

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

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

This document is to be read in conjunction with IEC 61196-1:2005.

A list of all the parts in the IEC 61196 series published under the general title *Coaxial communication cables* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

COAXIAL COMMUNICATION CABLES –

Part 13: Sectional specification for semi-rigid cables with silicon dioxide dielectric

1 Scope

This part of IEC 61196 specifies the materials and cable construction for semi-rigid coaxial communication cables with silicon dioxide dielectric, IEC type designation, identification, marking and labelling, standard rating and characteristics, requirements of finished cables, quality assessment, delivery and storage, etc.

This part of IEC 61196 applies to semi-rigid coaxial communication cables with silicon dioxide dielectric and tubular outer conductor. These cables are intended for use in applications requiring extreme environments as well as in nuclear power plants, oil rigs and aircraft engines.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-3-4, *Environmental testing – Part 3-4: Supporting documentation and guidance – Damp heat tests*

IEC 60793-1-54, *Optical fibres – Part 1-54: Measurement methods and test procedures – Gamma irradiation*

IEC 61196-1:2005, *Coaxial communication cables – Part 1: Generic specification – General, definitions and requirements*

IEC 61196-1-1, *Coaxial communication cables – Part 1-1: Capability approval for coaxial cables*

IEC 61196-1-101, *Coaxial communication cables – Part 1-101: Electrical test methods – Test for conductor d.c. resistance of cable*

IEC 61196-1-102, *Coaxial communication cables – Part 1-102: Electrical test methods – Test for insulation resistance of cable dielectric*

IEC 61196-1-103, *Coaxial communication cables – Part 1-103: Electrical test methods – Test for capacitance of cable*

IEC 61196-1-105, *Coaxial communication cables – Part 1-105: Electrical test methods – Test for withstand voltage of cable dielectric*

IEC 61196-1-108, *Coaxial communication cables – Part 1-108: Electrical test methods – Test for characteristic impedance, phase and group delay, electrical length and propagation velocity*

IEC 61196-1-110, *Coaxial communication cables – Part 1-110: Electrical test methods – Test for continuity*

IEC 61196-1-111, *Coaxial communication cables – Part 1-111: Electrical test methods – Stability of phase test methods*

IEC 61196-1-112, *Coaxial communication cables – Part 1-112: Electrical test methods – Test for return loss (uniformity of impedance)*

IEC 61196-1-113, *Coaxial communication cables – Part 1-113: Electrical test methods – Test for attenuation constant*

IEC 61196-1-116, *Coaxial communication cables – Part 1-116: Electrical test methods – Test for impedance with time domain reflectometry (TDR)*

IEC 61196-1-119, *Coaxial communication cables – Part 1-119: Electrical test methods – RF average power rating*

IEC 61196-1-301, *Coaxial communication cables – Part 1-301: Mechanical test methods – Test for ovality*

IEC 61196-1-302, *Coaxial communication cables – Part 1-302: Mechanical test methods – Test for eccentricity*

IEC 61196-1-305, *Coaxial communication cables – Part 1-305: Mechanical test methods – Solderability and resistance to soldering*

IEC 61196-1-314:2015, *Coaxial communication cables – Part 1-314: Mechanical test methods – Test for bending*

IEC 61196-1-316, *Coaxial communication cables – Part 1-316: Mechanical test methods – Test of maximum pulling force of cable*

IEC 61196-1-318, *Coaxial communication cables – Part 1-318: Mechanical test methods – Heat performance tests*

IEC 62153-4-4, *Metallic communication cable test methods – Part 4-4: Electromagnetic compatibility (EMC) – Test method for measuring of the screening attenuation as up to and above 3 GHz, triaxial method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61196-1 as well as the following apply.

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

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

3.1
semi-rigid coaxial communication cable
coaxial line with smooth or corrugated tube outer conductor, not intended to be bent or flexed in service or not intended to be flexed after initial forming

4 Materials and cable construction

4.1 General

The cable construction is composed of inner conductor, insulation, outer conductor and sheath.

4.2 Inner conductor

4.2.1 Conductor material

IEC 61196-1:2005, 4.4.1 applies.

The inner conductor material shall be as stated in the relevant cable detail specification.

4.2.2 Conductor construction

The conductor shall consist of a solid wire.

In addition, IEC 61196-1:2005, 4.4.4 applies.

The diameter of the inner conductor shall be stated in the detail specification.

The tolerance of the inner conductor shall be specified in the detail specification.

4.3 Dielectric

The dielectric shall be one of the following:

- foamed silica;
- any other structure forms of silicon dioxide materials as stated in the relevant detail specification.

4.4 Outer conductor

The outer conductor shall be a copper or other metal material smooth tube with or without coating or as stated in the relevant cable detail specification.

The coating material and thickness, if any, shall be stated in the relevant detail specification.

In addition, the requirements of IEC 61196-1:2005, 4.6.1 apply.

For cables with smooth tube outer conductor, the diameter and tolerance shall be stated in the detail specification. The recommended outer diameter ratings of outer conductor (approximate the rounded value) are as follows:

1 mm (0,047"), 2 mm (0,086"), 3,5 mm (0,141"), 7 mm (0,275") or as specified in the detail specification.

The tolerance of the outer conductor shall be specified in the detail specification.

4.5 Sheath (when applicable)

When applicable, the sheath of the cable shall be in accordance with the following requirements.

a) The material of the cable sheath shall be stainless steel or as specified in the detail specification.

b) Diameter and minimum thickness and tolerance of the sheath shall be as stated in the detail specification.

5 Type name and identification of cable

5.1 Type

The type name of the cable consists of the nominal characteristic impedance and the outer diameter rating of the outer conductor. The specific names are as follows:

a) The nominal characteristic impedance, giving the nominal characteristic impedance of the cable in ohms, e.g. 50.

b) The outer diameter ratings (the approximate outer diameter) of the outer conductor in mm; when needed, the outer diameter ratings of the outer conductor in inches can be given in brackets.

E.g. 50-3,5 (0,141") is the cable type with nominal characteristic impedance of 50 Ω and the outer diameter rating of outer conductor is 3,58 mm (0,141").

5.2 Variants

The variant of cables shall be identified by the following:

a) Type name.

b) Inner conductor material:

SC – Smooth copper wire;

P – Platinum wire.

E.g. 50-3,5 (0,141")-SC is one variant of type 50-3,5 (0,141") cable, and its inner conductor is smooth copper wire.

5.3 Cable marking

The cable marking consists of cable type name, variants and IEC standard number, as shown in Figure 1.

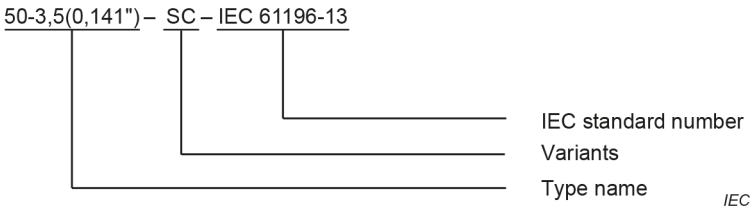

Figure 1 – Cable marking

E.g. 50-3,5(0,141")-SC-IEC 61196-13 indicates a cable, its characteristic impedance is 50 Ω, the outer diameter rating of outer conductor is 3,5 mm (0,141"), and its inner conductor is a smooth copper wire; it complies with IEC 61196-13.

Cable marking shall be applied as an interval separated by a hyphen.

6 Identification, marking and labelling

6.1 Cable identification

IEC 61196-1:2005, 6.1 applies.

6.2 Cable marking (when required)

The cable marking shall be specified in the detail specification.

6.3 Labelling

Labelling shall be provided in accordance with IEC 61196-1:2005, 6.3 and the detail specification.

7 Standard rating and characteristics

7.1 Nominal characteristic impedance

The nominal characteristic impedance shall be 50 Ω or as specified in the detail specification.

7.2 Rated temperature and humidity range

The rated temperature and humidity range shall be as specified in Table 1 or specified in the detail specification.

Table 1 – Rated temperature and humidity

Parameter	No sheath		304/316L stainless steel sheath	
	Temperature °C	Relative humidity %	Temperature °C	Relative humidity %
Operational temperature range	−273 to +800	For further study	−273 to +1 000	For further study
Storage temperature range	−55 to +110	For further study	−55 to +110	For further study
Installation temperature range	−10 to +40	For further study	−10 to +40	For further study

7.3 Operating frequency

The operating frequency range is specified in the detailed specification. For the maximum operating frequency of typical cables, see Annex A.

7.4 Average and peak power

Average and peak power shall be specified in the detail specification.

7.5 Bending radius

The minimum bending radius shall be specified in the detail specification. For the minimum bending radius of typical cables, see Annex A.

8 Requirements for finished cables

8.1 General

For finished cables, the requirements given below shall apply when they are tested in accordance with the IEC 61196-1 series or Clause 8.

Unless otherwise specified, all measurements shall be carried out under standard atmospheric conditions for testing in accordance with IEC 60068-1:2013, Clause 4.

Applicable test methods shall be in accordance with the IEC 61196-1-X series and other test methods specified herein.

8.2 Electrical requirements

Electrical measurements are given in Table 2.

Table 2 – Electrical requirements

Sub-clause	Test methods	Parameter	Requirements/Remarks
8.2.1	IEC 61196-1-101	Inner conductor DC resistance	Value in accordance with the detail specification.
8.2.2	IEC 61196-1-102	Insulation resistance	≥ 104 MΩ · km
8.2.3	IEC 61196-1-103	Capacitance	Value in accordance with the relevant detail specification. Performance requirements of typical cables are given in Annex A.
8.2.4	IEC 61196-1-105	Withstand voltage of dielectric	Value in accordance with the detail specification.
8.2.5	IEC 61196-1-108	Propagation velocity	When applicable, value in accordance with the relevant detail specification. Performance requirements of typical cables are given in Annex A.
8.2.6	IEC 61196-1-110	Continuity	Inner and outer conductor shall be continuous.
8.2.7	IEC 61196-1-111	Phase stability vs temperature	When applicable, value in accordance with the relevant detail specification. A graph should be used to depict phase versus temperature change.
8.2.8	IEC 61196-1-112	Return loss	The length of the specimen should be greater than 2 m, and the return loss should be greater than 15,6 dB (5 MHz to 3 000 MHz), or according to the relevant detailed specification. NOTE 1 The value of return loss in other working frequency band is under consideration. NOTE 2 The test method of return loss for the cable under extreme temperature is for further study and the value of return loss can be determined between the manufacturer and the user.
8.2.9	IEC 61196-1-113	Attenuation constant	Value in accordance with the detail specification. Performance requirements of typical cables are given in Annex A. NOTE 3 The test method of attenuation for the cable under extreme temperature is for further study, and the value of attenuation can be determined between the manufacturer and the user.

Sub-clause	Test methods	Parameter	Requirements/Remarks
8.2.10	IEC 61196-1-116	Characteristic impedance	Value in accordance with the relevant detail specification.
8.2.11	IEC 61196-1-119	RF average power	When required, value in accordance with the relevant detail specification.
8.2.12	IEC 62153-4-4	Screening attenuation	When required, greater than 110 dB (0,1 GHz to 3 GHz) or value in accordance with the relevant detail specification.

8.3 Environmental requirements

Environmental requirements are given in Table 3.

Table 3 – Environmental requirements

Sub-clause	Test methods	Parameter	Requirements/remarks
8.3.1	IEC 61196-1-318	Heat behaviour	Sample preparation: both ends of the specimen should be attached with suitable RF connectors. Temperature of the heating should be 1 000 °C or specified in the detail specification. Requirements: After the test, the attenuation and return loss changes shall be in accordance with the relevant detail specification.
8.3.2	IEC 60068-3-4	Damp heat	Sample preparation: both ends of the specimen should be attached with suitable RF connectors. Relative humidity: 90 % to 95 %, Temperature: 25 °C. Requirements: Attenuation change shall be in accordance with the relevant detail specification.
8.3.3	Annex B	Gamma irradiation	The test procedure and condition refer to IEC 60793-1-54, with the necessary modifications for coaxial cables. Requirements: Attenuation change shall be in accordance with the relevant detail specification.
8.3.4	Annex C	Thermal shock	The test temperature is specified in the detail specification. Duration: See Annex C or as specified in the detail specification. Cycles: 5 or as specified in the detail specification. Requirements: a) The return loss shall remain within the specified limits in 8.2.8. b) The attenuation change shall be in accordance with the relevant detail specification. c) No cracks, flaws or other damage in the cable surface.

8.4 Mechanical requirements

Mechanical requirements are given in Table 4.

Table 4 – Mechanical requirements

Sub-clause	Test methods	Parameter	Requirements/remarks
8.4.1	IEC 61196-1:2005	Visual examination	The sheath or outer conductor (when the cable is without sheath) shall be free of rust or cracks.
8.4.2	IEC 61196-1:2005	Dimensional examination	Value in accordance with the detail specification.
8.4.3	IEC 61196-1-301	Ovality of inner conductor	When applicable, ≤ 7 %, or value in accordance with the relevant detail specification.
8.4.4	IEC 61196-1-301	Ovality of sheath	When applicable, ≤ 7 %, or value in accordance with the relevant detail specification.
8.4.5	IEC 61196-1-302	Eccentricity of dielectric	When applicable, ≤ 10 %, or value in accordance with the relevant detail specification.
8.4.6	IEC 61196-1-305	Solderability	When applicable, value in accordance with the relevant detail specification.
8.4.7	IEC 61196-1-314	Cable bending	According to IEC 61196-1-314:2015, 4.3.2 procedure 1, 1 cycle, bending radius in accordance with the relevant detail specification. Requirements: a) Attenuation change shall be in accordance with the relevant detail specification. b) The return loss shall remain within the specified limits in 8.2.8. c) No physical damage in the cable.
8.4.8	IEC 61196-1-316	Tensile strength of cable (longitudinal pull)	When required, the maximum tension applied shall be greater than or equal to the cable weight of 100 m or be specified in the detail specification. Requirements: a) The characteristic impedance shall remain within the specified limits in 8.2.10. b) No physical damage in the cable.

9 Quality assessment

Quality assessment shall be in accordance with IEC 61196-1-1 or Annex D.

10 Delivery and storage

Delivery of cables shall be in accordance with IEC 61196-1:2005, Clause 9.

Unless otherwise specified in the detail specification, both ends of the cable should be well sealed to protect it from humidity.

Annex A
(normative)

Performance requirements of typical cables

A.1 Performance requirements

Performance requirements of typical cables are given in Table A.1. The attenuation values are specified in Clause A.2.

Table A.1 – Performance requirements of typical cables

Typical cable variants	Maximum operating frequency GHz[a]	Propagation velocity %	Capacitance pF/m	Bending radius mm
50-1 (0,047")	40	≥ 73	≤ 95	5,0
50-2 (0,086")	18	≥ 73	≤ 90	10,0
50-3,5 (0,141")	18	≥ 73	≤ 88	13,0
50-7 (0,275")	12	≥ 73	≤ 87	30,0
[a] When applicable.				

A.2 Attenuation

Maximum attenuation values of the typical cables can be calculated as shown in Formula (A.1):

$$\alpha = A \times \sqrt{f} + B \times f \quad \text{(A.1)}$$

where

α is the attenuation at 20 °C, in dB/m;

A, B are given in Table A.2;

f is the frequency, in GHz.

Values at typical frequencies are given in Table A.2.

Table A.2 – Maximum attenuation

Typical cable variants	*A*	*B*	Maximum attenuation at typical frequencies dB/m							
			0,2 GHz	0,5 GHz	1 GHz	3 GHz	6 GHz	8,5 GHz	12 GHz	18 GHz
50-1 (0,047")[a]	—	—	—	—	—	—	—	—	—	—
50-2 (0,086")	0,669 9	0,026 8	0,30	0,48	0,70	1,29	1,81	2,17	2,62	3,31
50-3,5 (0,141")	0,324 5	0,032 5	0,16	0,24	0,35	0,65	0,98	1,22	1,52	1,98
50-7 (0,275")	0,151 9	0,018 2	0,08	0,11	0,16	0,32	0,47	0,59	0,75	0,99
NOTE The test method of attenuation for the cable under extreme temperature is for further study, and the value of attenuation can be determined between the manufacturer and the user.										
[a] Under consideration.										

Annex B
(normative)

Gamma irradiation

B.1 General

This annex outlines a method for measuring the steady state response of semi-rigid cables with silicon dioxide dielectric exposed to gamma radiation.

The attenuation of cable with silicon dioxide dielectric generally increases when exposed to gamma radiation. This is primarily due to the trapping of radiolytic electrons and holes at defect sites in the dielectric. This test procedure includes two kinds of test conditions as well as the low dose rate condition suitable for estimating the effect of environmental background radiation, and the high dose rate condition suitable for estimating the effect of adverse nuclear environments. The test for the effects of radiation from both backgrounds can be evaluated by the changes of cable attenuation (according to IEC 61196-1-113) before and after exposure of the test sample to gamma radiation.

B.2 Apparatus

B.2.1 General

Attention is drawn to the fact that strict regulations and suitable protective facilities are to be adopted in the laboratory for this test. Carefully selected trained personnel shall be used to perform this test. It can be extremely hazardous to test personnel if it is improperly performed or without qualified conditions.

B.2.2 Radiation source

B.2.2.1 Testing of environmental background radiation

A ^{60}Co or equivalent ionizing source shall be used to deliver gamma radiation. This environment is characterized by a relatively low total dose and dose rate.

B.2.2.2 Testing of adverse nuclear environments

A ^{60}Co or equivalent ionizing source shall be used to deliver gamma radiation. This environment is characterized by a higher total dose and dose rate.

B.2.3 Attenuation testing equipment

Test equipment for attenuation testing shall be as follows:

– a vector network analyzer (VNA) capable of performing S21 measurements and a THRU calibration kit shall be used, or

– two power meters, a power splitter and a RF CW generator shall be used.

B.2.4 Radiation dosimeter

Thermo luminescent LiF or CaF crystal detectors (TLDs) or an ion chamber detector shall be used to measure the total radiation dose received by the specimen cable.

B.2.5 Temperature-controlled container

Unless otherwise specified, the temperature-controlled container shall have the capability of maintaining the specified temperatures to within ± 2 °C.

B.2.6 Test reel

The test reel shall not act as a shield or sink for the radiation used in this test. Reels of wood, plastic or similar non-conducting materials would, in principle, act as transparent to the radiation. The additional absorption shall be taken into account for exact measurements.

An appropriate dose build-up layer of similar material shall be used.

B.3 Preparation of specimens

B.3.1 Test sample length

Unless otherwise specified in the detail specification, the length of the test sample shall be not shorter than 2 m.

B.3.2 Test reel

The test sample shall be spooled onto a reel with a diameter of more than or equal to 10 cm, or that specified in the detail specification. An alternative deployment method allows the cable to be loosely wound in a coil of specified diameter. The minimum bending radius shall be considered.

B.4 Procedure

B.4.1 General

The radiation tests differ in exposure dose, dose rate, exposure time and temperature. The tests are an environmental background radiation test and an adverse nuclear radiation test.

B.4.2 Calibration of radiation source

Calibration of the radiation source for dose uniformity and level shall be made prior to the test sample being set up in the chamber. Dose and dose rate measurements at four positions shall be made in the area of exposure where the test reel will be placed (four positions are used to get a representative average value).

B.4.3 Preparation and pre-conditioning

The test sample shall be preconditioned in the temperature chamber at 25 °C ± 5 °C for 1 h prior to the testing, or at the test temperature for a preconditioned time as specified in the detail specification.

A ^{60}Co or equivalent ionizing source(s) shall be used to deliver gamma radiation at a desired dose rate. The time required to turn the radiation source on or off shall be < 10 % of the total exposure time.

It is important that the temperature is kept constant during the tests. If the test needs to be performed at different temperatures, then the attenuation prior to irradiation shall be measured for different temperatures for each specified frequency.

B.4.4 Attenuation measurement for environmental background radiation

An attenuation measurement of the test sample shall be performed, at the specified test frequency, in accordance with IEC 61196-1-113. The attenuation α_1 of the cable to the gamma radiation source shall be recorded. The environmental temperature shall be the same as during the up-coming irradiation tests when the initial attenuation measurement is performed.

Unless otherwise specified in the detail specification, environmental background radiation effects, due to exposure to gamma radiation, shall be determined by subjecting the test sample to a nominal dose rate of 0,02 Gray/hour (Gy/h). The test sample shall be exposed to a total dose of 0,1 Gray (Gy). Different dose rates and total dose can be requested in the detail specification in order to simulate particular specific conditions.

Upon completion of 2 h of the irradiation process, an attenuation measurement of the test sample shall be performed in accordance with IEC 61196-1-113. The attenuation α_2 of the test sample after exposure to the gamma radiation source shall be recorded.

B.4.5 Attenuation measurement for adverse nuclear environment

An attenuation measurement of the test sample shall be performed, at the specified test frequency, in accordance with IEC 61196-1-113. The attenuation α_1 of the cable to the gamma radiation source shall be recorded. The environmental temperature shall be the same as during the up-coming irradiation tests when the initial attenuation measurement is performed.

Unless otherwise specified in the detail specification, adverse nuclear environmental radiation effects, due to exposure to gamma radiation, shall be determined by subjecting the test sample to a nominal dose rate of 1 000 Gy/h. The test sample shall be exposed to a total dose of 1 000 Gy. Different dose rates and total dose can be requested in the detail specification in order to simulate particular specific conditions.

Upon completion of 2 h of the irradiation process, an attenuation measurement of the test sample shall be performed in accordance with IEC 61196-1-113. The attenuation α_2 of the test sample after exposure to the gamma radiation source shall be recorded.

B.5 Calculations

The change in attenuation $\Delta\alpha$ is as given in Formula (B.1):

$$\Delta\alpha = \alpha_2 - \alpha_1 \tag{B.1}$$

where

$\Delta\alpha$ is the change in attenuation, expressed in dB;

α_1 is the attenuation of the test sample prior to exposure to gamma radiation, expressed in dB;

α_2 is the attenuation of the test sample after exposure to gamma radiation, expressed in dB.

B.6 Results

B.6.1 Information to be provided

– title of test;
– sample type;
– number of samples;
– test reel diameter;
– length of test sample exposed to radiation;
– test frequencies;
– test temperature;
– test dose and rate dose;
– change in attenuation $\Delta\alpha$;
– characteristics of test sample such as cable type, dimensions and construction.

B.6.2 Information available upon request

– description of radiation source;
– description of dosimeters;
– description of detection and recording apparatus;
– description of the characteristics of temperature chamber;
– date of latest calibration of test equipment;
– identification of operators;
– material, dimensions and design of test reel;
– failure or acceptance criteria;
– other test conditions.

Annex C
(normative)

Thermal shock

C.1 General

This test is used to evaluate the transmission and mechanical performance of coaxial cables under the effects of thermal shock.

After the test, the transmission performance, such as insertion loss, return loss, etc., and mechanical performance, such as visual examination of cable, shall be specified in the relevant detail specification.

C.2 Test samples

The cable length shall be 0,5 m to 1 m or specified in the detail specification.

At least two test samples should be used for the test as specified below.

– one test sample terminated with connectors which can be used to measure the transmission performance;
– one piece of cable with its ends cut flushed which can be used to test the mechanical performance.

If the test samples have to be coiled to fit the chamber, it should be loosely coiled at the minimum bend radius with the end of the cable being straight.

C.3 Test equipment

The following test equipment shall be used:

– Environmental chambers: A system of sufficient thermal capacity shall be used to change ambient chamber conditions to meet the test requirements;
– VNA or other suitable equipment.

C.4 Procedure

C.4.1 Initial measurements

The initial transmission and mechanical performance of the test samples shall be measured according to the relevant detail specification.

C.4.2 Thermal shock

Test samples shall be placed into the environmental chamber so that there is substantially no obstruction to the flow of air across and around the specimen. The specimen shall be subjected to the specified test condition of Table C.1. One cycle consists of step 1 to step 4. Unless otherwise specified, 5 cycles should be conducted.

Test samples shall not be subjected to forced circulating air during the test. The effective total transfer time from the low temperature to the high temperature, or the reverse, shall not exceed 5 minutes. Direct heat conduction to the specimen should be avoided.

Table C.1 – Test condition

Step	Test condition	Exposure time
1	Low temperature [b]	See Table C.2
2[a]	20^{+10}_{-5}	≤ 5 min
3	High temperature [b]	See Table C.2
4a	20^{+10}_{-5}	≤ 5 min

[a] For the environmental chambers which can transfer the temperature from low temperature to high temperature without physical moving the test samples, steps 2 and 4 are not applicable.

[b] Low temperature and high temperature shall be specified in relevant detail specifications.

Table C.2 – Exposure time at temperature extremes

Weight of specimen	Exposure time Hours
≤ 28 g	1/4
> 28 g to ≤ 136 g	1/2
> 136 g to ≤ 1,36 kg	1
> 1,36 kg to ≤ 13,6 kg	2
> 13,6 kg to ≤ 136 kg	4
> 136 kg	8

C.4.3 Final measurements

After the test, the test samples shall be removed from the chamber and allowed to stabilize at room ambient temperature. After reaching room ambient temperature, the transmission and mechanical performance shall be measured according to the relevant detail specification.

Annex D
(informative)

Quality assessment

D.1 General

Quality assessment procedures may be agreed between manufacturer and customer.

Annex D provides guidance and details of the general procedures for quality conformance inspection, qualification approval and capability approval. It includes information on related documents and procedures, standardized test methods, a basic schedule for tests relating to quality conformance inspection and qualification approval.

D.2 Qualification approval and its maintenance

D.2.1 Qualification approval

D.2.1.1 Sample

The sample of each cable type submitted for qualification inspection shall be of sufficient length to perform all the applicable tests in Table D.1.

D.2.1.2 Inspection routine

The samples shall be subjected to the inspections specified in Table D.1. The entire sample shall be subjected to the inspections of group I. The specimen length shall be cut from each sample as required, and be subjected to inspections of group II.

D.2.1.3 Failure

One or more failures shall be a cause for refusal to grant qualification approval.

D.2.1.4 Maintenance of qualification approval

This shall consist of three consecutive lots passing test groups A specified in D.2.3.1.6 and B specified in D.2.3.1.7 and followed by selection of test samples from the lots as appropriate. These test samples shall successfully pass the periodic inspection (test groups C) specified in D.2.3.2.

D.2.2 Capability approval

When specified in the relevant detail specifications, capability approval shall be in accordance with IEC 61196-1-1.

D.2.3 Quality conformance inspection

D.2.3.1 Inspection of product for delivery

D.2.3.1.1 General

Inspection of product for delivery shall consist of test groups A and B on a lot-by-lot basis.