IEC 61196-1-111

Edition 3.0 2024-09

INTERNATIONAL STANDARD

Coaxial communication cables –
Part 1-111: Electrical test methods – Stability of phase test methods

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COAXIAL COMMUNICATION CABLES –

Part 1-111: Electrical test methods – Stability of phase test methods

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IEC 61196-1-111 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.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) addition of the list of test methods in the Scope;
b) addition of "the number of scanning points" in every test method;
c) addition of Annex A, Phase consistency test for two or more cables;
d) addition of Annex B, Phase variation with temperature test between two cables.

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

Draft	Report on voting
46A/1666/CDV	46A/1680/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.

A list of all 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- withdrawn, or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.

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COAXIAL COMMUNICATION CABLES –

Part 1-111: Electrical test methods – Stability of phase test methods

1 Scope

This part of IEC 61196 provides test methods to determine the stability of phase of coaxial communication cables.

This document is applicable to RF coaxial cables. RF coaxial cable assemblies can also use this document for reference.

This part of IEC 61196 comprises following test methods:

a) phase variation with temperature (Clause 4);
b) phase constant variation with temperature (Clause 5);
c) phase stability with bending (Clause 6);
d) phase stability with twisting (Clause 7);
e) phase consistency test for two or more cables (Annex A);
f) phase variation with temperature test between two cables (Annex B).

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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.

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

IEC 61196-1-108:2011, *Coaxial communication cables – Part 1-108: Electrical test methods – Test for characteristic impedance, phase and group delay, electrical length and propagation velocity*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61196-1 and 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
temperature coefficient of phase
$\eta_{t,f}$
coefficient defined as at the specified frequency f, as the ratio of the phase difference $\Delta\varphi_{t,f}$ between $\varphi_{25\,°\mathrm{C},f}$ at 25 °C and $\varphi_{t,f}$ at temperature t, and the total phase $\Phi_{25\,°\mathrm{C},f}$ at 25 °C

$$\eta_{t,f} = \frac{\varphi_{25\,°\mathrm{C},f} - \varphi_{t,f}}{\Phi_{25\,°\mathrm{C},f}} = \frac{\Delta\varphi_{t,f}}{\Phi_{25\,°\mathrm{C},f}} \quad (1)$$

where:

$\varphi_{t,f}$ is the phase at temperature t and frequency f, in (°);

$\varphi_{25\,°\mathrm{C},f}$ is the phase at 25 °C and frequency f, in (°);

$\Delta\varphi_{t,f}$ is the phase difference between $\varphi_{25\,°\mathrm{C},f}$ and $\varphi_{t,f}$ at frequency f, in (°);

$\Phi_{25\,°\mathrm{C},f}$ is the total phase at 25 °C and frequency f, in (°)

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3.2
maximum variation of temperature coefficient of phase
$|\Delta\eta|_{\max}$
maximum value $\eta_{\max}$ minus the minimum value $\eta_{\min}$

$$\Delta\eta_{\max} = |\eta_{\max} - \eta_{\min}| \quad (2)$$

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3.3
ratio of relative temperature coefficient of phase *PT*
ratio of the relative temperature coefficient of phase PT, when the relationship between phase and temperature is sufficiently linear

$$PT = \frac{|\varphi_{t_1,f} - \varphi_{t_2,f}|}{\Phi_{25\,°\mathrm{C},f} \times (t_2 - t_1)} \quad (3)$$

where:

$\varphi_{t1,f}$ is the phase value at t_1 and frequency f, in (°);

$\varphi_{t2,f}$ is the phase value at t_2 and frequency f, in (°);

$\Phi_{25°\mathrm{C},f}$ is the total phase at 25 °C and frequency f, in (°);

t_1 and t_2 are any two temperatures within a specified temperature range in which the relationship between phase and temperature is sufficiently linear ($t_2 > t_1$), in °C

3.4
total relative variation of phase constant
total relative variation of the phase constant

$$\delta\beta = \frac{\beta_2 - \beta_1}{\beta_{\text{nom}}} \quad (4)$$

$$\delta\beta = \frac{l_{e,2} - l_{e,1}}{l_{\text{mech}}} \times v_{r,\text{nom}} = \left(\tau_{p,2} - \tau_{p,1}\right) \times c \times v_{r,\text{nom}} \quad (5)$$

where:

β_1 is the phase constant at temperature t_1, in radians/m;

β_2 is the phase constant at temperature $t_2 > t_1$, in radians/m;

β_{nom} is the nominal phase constant, in radians/m;

$\tau_{p,1}$ is the phase delay at temperature t_1, in s/m;

$\tau_{p,2}$ is the phase delay at temperature $t_2 > t_1$, in s/m;

c is the propagation velocity in free space (3×10^8 m/s);

$l_{e,1}$ is the electrical length at temperature t_1, in m;

$l_{e,2}$ is the electrical length at temperature $t_2 > t_1$, in m;

l_{mech} is the mechanical length, in m;

$v_{r,\text{nom}}$ is the nominal relative propagation velocity

Note 1 to entry: For unidirectional variation, t_1 and t_2 are the limits of a specified temperature range. In the case of changing signs of variation, t_1 and t_2 become the temperatures at which the extreme value of l_e or τ_p occur.

3.5
temperature coefficient of phase constant, *CT*
temperature coefficient of the phase constant

$$CT = \frac{\delta\beta}{t_2 - t_1} \quad (6)$$

where:

CT is the temperature coefficient of phase constant, in K^{-1};

$\delta\beta$ is the total relative variation of the phase constant;

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t_1 and t_2 are any two temperatures within a specified range in which the phase constant is approximately linear, in °C

4 Phase variation with temperature

4.1 Purpose

Phase of cable varies as a function of temperature. The temperature variation will induce the change of the dielectric constant ε_r , mechanical length, and material character which will cause its phase variation. This variation can be unidirectional or multi-directional. The phase variation is characterized by the temperature coefficient of phase $\eta_{t_i,f}$ or by the ratio of relative temperature coefficient of phase PT when the relationship between phase and temperature is sufficiently linear. This method provides a test method to determine the phase variation with temperature. The maximum variation of temperature coefficient of phase $\left|\Delta\eta\right|_{\max}$ is given in Formula (2).

A phase variation with temperature test to determine the difference of phase variation with temperature between two cables is given in Annex B.

4.2 Test equipment

Test equipment should be as follows:

a) a temperature chamber with sufficient precision within ± 2 °C;

b) a vector network analyser (VNA) with sufficient precision;

c) test clamp for fixation (if needed).

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4.3 Preparation of test sample (TS)

The cable under test shall be terminated with suitable connectors at each end to make a cable assembly as a test sample (TS), as shown in Figure 1. It is suggested that a pair of screw thread connectors which suit with the vector network analyser should be used to make a TS for convenience and higher precision. Two marks should be made at each end of the TS, as shown in Figure 1. $L_{1\text{mech}}$ shall not be less than 0,15 m and $L_{2\text{mech}}$ of the cable under test-(CUT) shall not be less than 2,70 m.

At least two TS should be made.

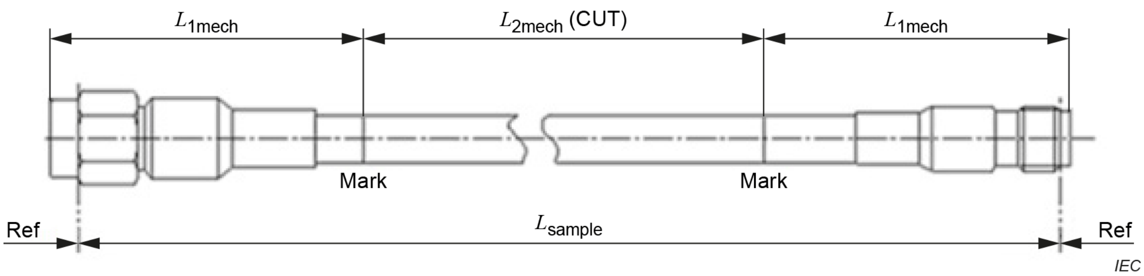

Figure 1 – Test sample (TS)

4.4 Test environment

The variation of the laboratory's ambient temperature shall be within ±2 °C. The recommended temperature is 25 °C. For a cable with PTFE dielectric, the laboratory's ambient temperature should avoid the material's sensitive temperature interval.