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colour inside

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

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FOREWORD

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International Standard IEC 61196-1-111 has been prepared by subcommittee 46A: Coaxial cables, of IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories.

The text of this standard is based on the following documents:

FDIS	Report on voting
46A/1188A/FDIS	46A/1212/RVD

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

This second edition cancels and replaces the first edition published in 2005. This edition constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

– a new Clause 4 Phase variation with temperature;
– a new Clause 6 Phase stability with bending;
– a new Clause 7 Phase stability with twisting.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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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 applies to coaxial communication cables. It specifies methods for determining the stability of phase of coaxial communication cables.

- phase variation with temperature (Clause 4);
- phase constant variation with temperature (Clause 5);
- phase stability with bending (Clause 6);
- phase stability with twisting (Clause 7).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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, as well as the following apply.

3.1
temperature coefficient of phase
$\eta_{t,f}$
coefficient defined 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

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

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 (°);

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

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

$$|\Delta\eta|_{max} = |\eta_{max} - \eta_{min}| \qquad (2)$$

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

$$PT = \frac{|\varphi_{t_1,f} - \varphi_{t_2,f}|}{\Phi_{25℃,\,f} \cdot (t_2 - t_1)} \qquad (3)$$

where

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

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

$\Phi_{25\,°C,f}$ 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

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

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

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;

$v_{r,nom}$ 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

$$CT = \frac{\delta\beta}{t_2 - t_1} \text{ in k}^{-1} \tag{6}$$

where

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

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

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, material character which will cause its phase variation. This variation can be unidirectional or multidirectional. The phase variation is characterized by the temperature coefficient of phase $\eta_{t,f}$, 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 $|\Delta\eta|_{\max}$ is given in Formula (2).

4.2 Equipment

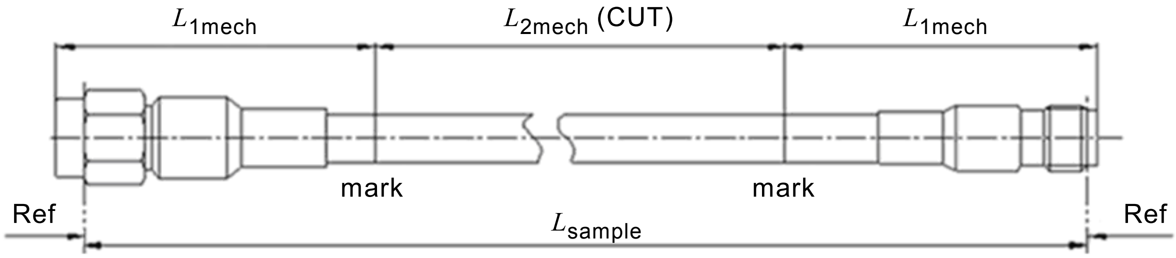
A temperature chamber with sufficient precision, temperature range and volume shall meet the requirement specified in the relevant specification (for PTFE insulated cable, the temperature should be within ±2 °C).

A vector network analyzer (VNA) capable of sufficient precision is recommended.

4.3 Test sample

The cable under test shall be terminated with suitable connectors at each end, as shown in Figure 1. It is suggested that a pair of screw thread connectors which suit with the vector network analyzer should be used to make a test sample for convenience and higher precision. Two marks should be made at each end of the test sample, 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 test samples (short named TS) should be made.



IEC 1886/14

Figure 1 – Test sample (TS)

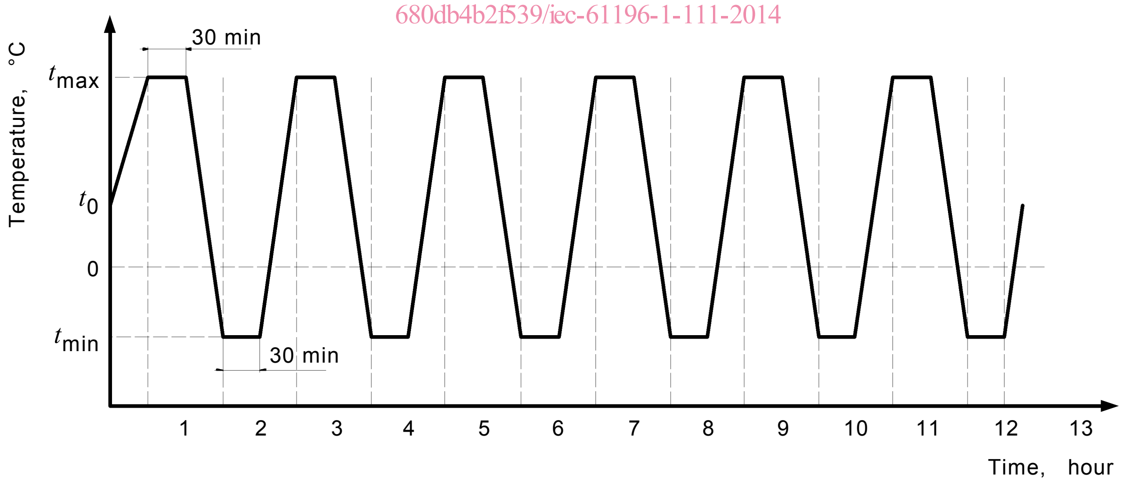
4.4 Test environment

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

4.5 Preconditioning

TS shall be put into a temperature chamber in loose coils with the diameter not less than 10 times the cable's minimum static bending radius.

Adjust temperature of the chamber for 6 cycles as shown in Figure 2 and maintain at least 30 min at each limit temperature (t_{max} and t_{min}) which shall be specified in the relevant specification to ensure temperature balance inside. Number of cycles may be agreed between the customer and the supplier.



IEC 1887/14

Key

t_0 laboratory's ambient temperature, for example 25 °C ± 2 °C

t_{max} maximum temperature specified in the relevant specification, in °C

t_{min} minimum temperature specified in the relevant specification, in °C

Figure 2 – Preconditioning

4.6 Test procedure

After preconditioning, one of the TS is picked up for calibration as a reference sample during test. The state and position of the reference sample shouldn't be changed during the test period to avoid the measurement error.