IEC 61196-1-108

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INTERNATIONAL STANDARD

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

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IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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CONTENTS

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COAXIAL COMMUNICATION CABLES –

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FOREWORD

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IEC 61196-1-108 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 third edition cancels and replaces the second edition published in 2011. This edition constitutes a technical revision.

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

a) Change of title, "phase and phase constant" was added.
b) Clause 6, "Preparation of test sample (TS)" was added.

c) Clause 7, "Test procedure" was added.

d) Clause 8, "Failure criterion" was added.

e) Clause 9, "Information to be given in the relevant specification" was added.

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

Draft	Report on voting
46A/1705/FDIS	46A/1717/RVD

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.

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COAXIAL COMMUNICATION CABLES –

Part 1-108: Electrical test methods – Test for phase, phase constant, phase and group delay, propagation velocity, electrical length, and mean characteristic impedance

1 Scope

This part of IEC 61196 applies to coaxial communications cables. It specifies test methods for determining the phase, phase constant, phase and group delay, propagation velocity, electrical length, and mean characteristic impedance of coaxial cables for use in communications systems.

A procedure to measure phase dispersion of coaxial cable is included as Annex A.

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61196-1 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

4 Parameters

From the phase constant β of a cable, one can derive several parameters:

phase constant

$$\beta = \frac{\pi}{180°} \times \frac{\Phi}{l} \tag{1}$$

group delay

$$\tau_{\mathrm{g}} = \frac{d\beta}{d\omega} \approx \frac{\Delta\beta}{\Delta\omega} \tag{2}$$

phase delay

$$\tau_{\mathrm{p}} = \frac{\beta}{\omega} \tag{3}$$

propagation velocity

$$v = \frac{1}{\tau_{\mathrm{p}}} = \frac{\omega}{\beta} \tag{4}$$

relative propagation velocity

$$v_{\mathrm{r}} = \frac{v}{c} = \frac{1}{\tau_{\mathrm{p}} \times c} = \frac{\omega}{\beta \times c} \tag{5}$$

electrical length

$$l_{\mathrm{e}} = \frac{l}{v_{\mathrm{r}}} = l \times \tau_{\mathrm{p}} \times c = l \times \frac{\beta \times c}{\omega} \tag{6}$$

mean characteristic impedance

$$Z_{\mathrm{c}} = \frac{\beta}{\omega \times C} = \frac{\tau_{\mathrm{p}}}{C} \tag{7}$$

where

β	is the phase constant in radian/m;
Φ	is the expanded phase in °;
l	is the length of a cable in m;
$\Omega = 2\pi f$	is the angular frequency in radian/s;
τ_{g}	is the group delay in s/m;
τ_{p}	is the phase delay in s/m;
v	is the propagation velocity in m/s;

v_r is the relative propagation velocity;

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

l_e is the electrical length in m;

Z_c is the characteristic impedance in Ω;

C is the capacitance in F/m.

Delay and velocity parameters as well as characteristic impedance are frequency-dependent and reach an asymptotic value at high frequencies. It is usual to report them at frequencies higher than 200 MHz where the frequency is sufficiently high for the theoretical approximation always to be valid. Generally, Formula (1) to Formula (7) are limited to low dispersive cables as coaxial communications cables typically are in their specified frequency range. Methods with a wider range of application are given in Annex A.

5 Test equipment

The equipment to be used consists of

– a capacitance meter or bridge in accordance with IEC 61196-1-103, and
– a vector network analyser (VNA) capable of performing S21 measurements.

6 Preparation of test sample (TS)

6.1 General

There are two test methods. No matter method 1 or method 2, first, measure the capacitance of the cable sample according to IEC 61196-1-103; ensure that the sample length shall meet Formula (8).

$$l_{max} < \frac{500\,000}{Z_c \times C \times f} \tag{8}$$

where

l_{max} is the maximum possible sample length in m;

Z_c is the nominal characteristic impedance of the cable in Ω;

C is the measured capacitance of the cable in pF/m according to IEC 61196-1-103;

f is the lowest frequency to be measured in MHz.

6.2 Method 1 – Long cables

A cable with sufficient length l is connected to a pair of connectors to form a cable assembly as a test sample (TS) as shown in Figure 1. The phase of the pair of connectors is negligible compared with the cable under test.

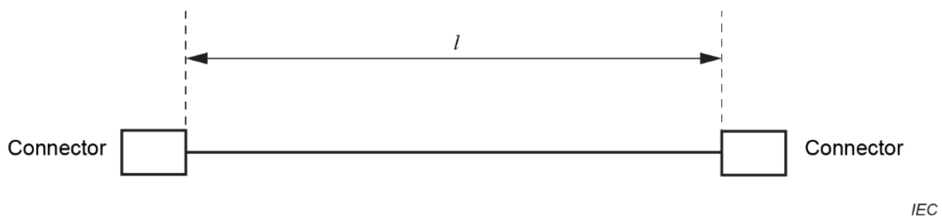
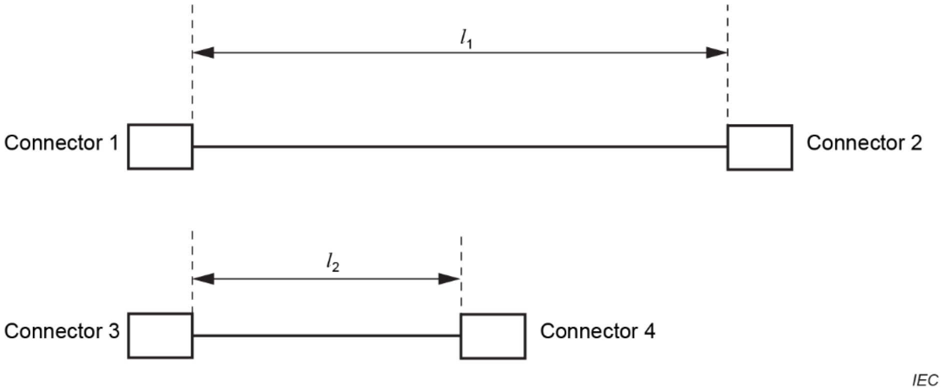


Figure 1 – Preparation of long cable

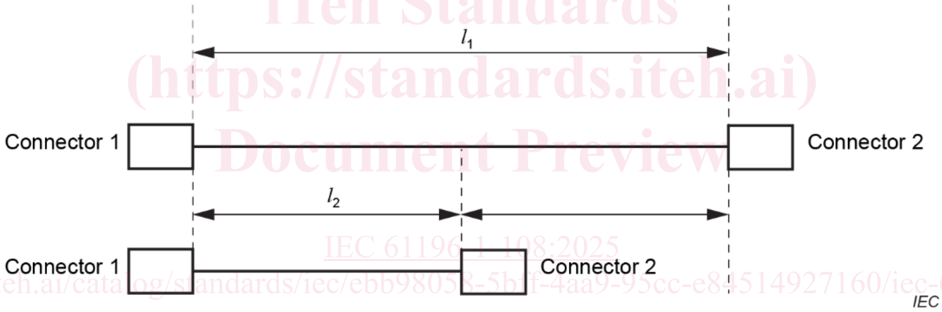
6.3 Method 2 – Short cables

Two cables with different length shall be cut from the same cable product and make two cable assemblies as two test samples (TS_1 and TS_2), terminated with two same kind and quality of connector pairs. As shown in Figure 2 a), normally, $l_1 = 2l_2$.

To improve the test precision, the shorter test sample (TS_2) can also be made by using the longer test sample (TS_1) after it has completed all the tests, as shown in Figure 2 b).



a) Two separate short test samples



b) One short test sample made by the longer sample

Figure 2 – Preparation of short cables

7 Test procedure

7.1 Phase

7.1.1 Method 1 – Long cables

Test procedure is as follows:

a) after the VNA is fully preheated, set the measurement frequency and other related parameters, and then set its test mode to measure the expand phase;

b) calibrate the test system;

c) connect the TS to the VNA, and measure and record the phase $\Phi_l(f)$ which is the phase of the length l of the cable.