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colour inside

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

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**Part 1-108: Electrical test methods –
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FOREWORD

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International Standard IEC 61196-1-108 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.

This second edition replaces the first edition published in 2005. The main changes to the previous edition is the enclosing of Annex A describing the measurement of phase dispersion.

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

FDIS	Report on voting
46A/1039/FDIS	46A/1057/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 standard is intended to be read in conjunction with IEC 61196-1. It is based on the second edition (2005) of that standard.

A list of all parts of 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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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

COAXIAL COMMUNICATION CABLES –

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

1 Scope

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

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

2 Normative references

The following referenced documents are indispensable for the application 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.

4 Parameters

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

group delay

$$\tau_{g} = \frac{d\beta}{d\omega} \approx \frac{\Delta\beta}{\Delta\omega} \tag{1}$$

phase delay

$$\tau_{p} = \frac{\beta}{\omega} \tag{2}$$

propagation velocity

$$v = \frac{1}{\tau_{p}} = \frac{\omega}{\beta} \tag{3}$$

relative propagation velocity

$$v_{r} = \frac{v}{c} = \frac{1}{\tau_{p} \cdot c} = \frac{l_{mech}}{l_{e}} \tag{4}$$

electrical length

$$l_{e} = l_{mech} \cdot \tau_{p} \cdot c \tag{5}$$

characteristic impedance

$$Z_c = \frac{\beta}{\omega C} = \frac{\tau_p}{C} \qquad (6)$$

where

β	is the phase constant in radian/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;
C	is the capacitance in pF/m;
c	is the propagation velocity in free space ($3 \cdot 10^8$ m/s);
l_e	is the electrical length in m;
l_{mech}	is the mechanical length in m;
v	is the propagation velocity in m/s;
v_r	is the relative propagation velocity;
Z_c	is the characteristic impedance in Ω.

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, the above-given formulas 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 method

5.1 Equipment

The equipment to be used consists of:

– a capacitance metre or bridge in accordance with IEC 61196-1-103.

– a vector network analyser (VNA) capable of performing S_{21} measurements.

5.2 Test sample

Due to the cyclic behaviour of exp(-jβl), a VNA can measure the phase constant β only in the range of –180 ° to +180 ° respectively from $-\pi$ to $+\pi$ and doesn't give an information how many phase turns have already been at the lowest frequency. To avoid hidden phase turns, the maximum length of the sample should be:

$$l_{max} < \frac{500\,000}{Z_c \cdot C \cdot f} \qquad (7)$$

where

C	is the capacitance of the cable in pF/m according to IEC 61196-1-103;
f	is the lowest frequency to be measured in MHz;
l_{max}	is the maximum possible sample length in m;
Z_c	is the nominal characteristic impedance of the cable.

This restriction is not applicable if solely group delay is to be measured as then only the derivative of the phase is important.

5.3 Procedure

The S_{21} or S_{12} parameter of the sample shall be measured with the VNA. The phase constant obtained from this measurement is used to calculate the above-defined parameter.

It has to be assured that the number of measurement point is high enough to detect every phase turn.

The ambient temperature shall be recorded.

6 Expression of test results

6.1 Phase constant β

For the evaluation of the phase velocity, it is necessary to have full phase shift information. Normally, a VNA measures the phase in the range of $-\pi$ and $+\pi$. In this case, the phase shift has to be transformed into a monotonic decreasing function of frequency in the range of 0 and $-\infty$ (see Figure 1). Some network analysers provide this function.

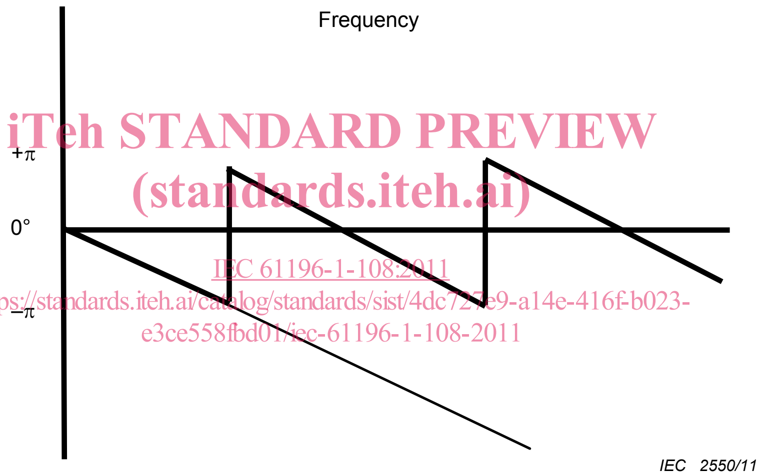

Figure 1 – Phase shift expanded

As an example for computation, the following source code may be used.

```
For I = 2 to number of frequency points
        K=0
        WHILE Phase (I) > Phase (I -1)
                K = K +1
                Phase (I) = Phase (I)- K ·2π
        END While
NEXT I
```

The phase constant β is then calculated by:

$$\beta(f) = \frac{\varphi_{\text{exp}}(f)}{l_{\text{sample}}} \tag{8}$$

where

$\beta(f)$ is the phase constant at frequency f in radians/m;