

INTERNATIONAL STANDARD

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

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CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Attenuation constant.....	6
5 Test method	7
5.1 Equipment	7
5.2 Test specimen	7
5.3 Procedure	7
5.3.1 Calibration.....	7
5.3.2 Measurement.....	8
6 Expression of test results	8
6.1 Expression.....	8
6.2 Temperature correction.....	8
7 Form fitting	8
Bibliography.....	10

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COAXIAL COMMUNICATION CABLES –**Part 1-113: Electrical test methods –
Test for attenuation constant****FOREWORD**

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International Standard IEC 61196-1-113 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.

This second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

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

- a) diverse form fitting equations are provided.

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

FDIS	Report on voting
46A/1350/FDIS	46A/1356/RVD

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

This document 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 document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
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- replaced by a revised edition, or
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A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

The attenuation curve may show ripples owing to impedance mismatch, instrument noise or local irregularities.

In this case, a form fitting may be applied to smoothe the curve. The values on the fitting curve may be used to assess the compliance with the requirements.

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COAXIAL COMMUNICATION CABLES –

Part 1-113: Electrical test methods – Test for attenuation constant

1 Scope

This part of IEC 61196 applies to coaxial communications cables. It specifies a test method for determining the attenuation constant of coaxial cables for use in communications systems. The test is applicable preferably at frequencies ≥ 5 MHz, but also for lower frequencies if the magnitude of the complex characteristic impedance is approximately equal to the nominal characteristic impedance of the specimen or if a form fitting function is applied.

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

3 Terms and definitions

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

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

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

4 Attenuation constant

The attenuation constant is defined by:

$$\alpha = 10 \cdot \log \left(\frac{P_1}{P_2} \right) \cdot \frac{100}{l} \quad \text{in dB/100 m} \quad (1)$$

where

α is the attenuation constant in dB/100 m (frequency dependent);

P_1 is the input power of a receiver where the load impedance and the receiver impedance are equal and of the same value as the nominal value of the specimen;

P_2 is the output power of a source where the load impedance and the source impedance are equal and of the same value as the nominal value of the specimen;

l is the physical length of the specimen in m.

5 Test method

5.1 Equipment

The following equipment may be used:

- a vector network analyser (VNA) capable of performing S21 measurements;
- a scalar network analyser;
- a separate signal generator and receiver.

To avoid important reflection losses owing to a mismatch between the nominal characteristic impedances of the test equipment and specimen, impedance matching adapters shall be used. The impedances shall match such that:

$$\left| \frac{Z_{\text{sample}} - Z_{\text{adapter}}}{Z_{\text{sample}} + Z_{\text{adapter}}} \right| \leq 0,05 \quad (2)$$

where

Z_{sample} is the nominal characteristic impedance of the specimen;

Z_{adapter} is the nominal characteristic impedance of the matching adapter at the second side.

In the above case, the reflection loss errors owing to the mismatch can be neglected ($\leq 0,02$ dB).

5.2 Test specimen

The length of the specimen shall be determined with an uncertainty not exceeding 1 %.

A round-trip loss of 40 dB over the whole frequency range is sufficient to avoid multiple reflections. This will avoid the effect of multiple reflections at the ends of the specimen. Alternatively, a form fitting can be applied.

NOTE Further information on impedance matching is given in IEC TR 62152:2009.

On the ends of the test specimen, suitable matched connectors shall be mounted.

5.3 Procedure

5.3.1 Calibration

The attenuation of the test setup (including the impedance matching devices and connectors) shall be measured over the whole specified frequency range. The calibration data shall be recorded to enable the test results to be corrected to an attenuation measurement.

In the case of simultaneous measurement of phase delay (see IEC 61196-1-108), a minimum number of measurement points shall be determined using the following formula:

$$N \geq [(f_2 - f_1) / 40] \cdot L \quad (3)$$

where

f is the frequency in MHz, and

L is the length in m.

5.3.2 Measurement

The cable under test (CUT) shall be connected to the test ports of the measuring devices. The attenuation shall be measured over the whole specified frequency range and at the same frequency points as for the calibration procedure within the specified frequency range.

The CUT shall be allowed to stabilize to the ambient temperature for a minimum period of 4 h.

The ambient temperature shall be recorded.

6 Expression of test results

6.1 Expression

$$\alpha(f) = [a_{\text{meas}}(f) - a_{\text{cal}}(f)] \cdot \frac{100}{l} \text{ in dB/100 m} \quad (4)$$

where

$\alpha(f)$ is the attenuation constant in dB/100 m;

$a_{\text{meas}}(f)$ is the attenuation obtained at measurement in dB;

$a_{\text{cal}}(f)$ is the attenuation obtained at calibration in dB;

l is the physical length of the specimen in m.

6.2 Temperature correction

When a temperature correction is necessary, the attenuation constant shall be corrected to the reference temperature of 20 °C with the following formula:

$$\alpha_{20}(f) = \frac{\alpha_T(f)}{1 + \frac{K}{100} \cdot (T - 20)} \text{ in dB/100 m} \quad (5)$$

where

K is the correction factor. Correction factor K shall be defined in the relevant cable specification (e.g. for copper, coaxial with non-polar insulation $K = 0,2 \text{ \% / } ^\circ\text{C}$);

T is the temperature during the measurement in °C;

$\alpha_T(f)$ is the attenuation constant at the temperature during measurement;

$\alpha_{20}(f)$ is the attenuation constant at 20 °C by temperature correction.

7 Form fitting

If multiple reflections occur at low frequencies due to a mismatch between the test specimen and the test set-up or a measurement noise at high frequency affect the measured values, so that the attenuation curve shows ripples, a form fitting may be applied that smoothes the curve.

The attenuation of a cable as a function of frequency can be expressed as shown in the following equation:

$$\alpha_{\text{fit}}(f) = A \cdot \sqrt{f} + B \cdot f + C + \frac{D}{\sqrt{f}} \quad (6)$$

where

$\alpha_{\text{fit}}(f)$ is the fitted attenuation of the temperature corrected attenuation $\alpha_{20}(f)$;

A is the coefficient for the losses in the inner and outer conductors due to the skin effect;

B is the coefficient for dielectric loss;

C is the constant component;

D is the optional coefficient for the losses in copper clad conductors.

The form fitting shall be a least square fitting done on corrected attenuation values (α_{20}). The least square fit coefficients are calculated using the equation below:

$$\begin{bmatrix} A \\ B \\ C \\ D \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^N f_i & \sum_{i=1}^N f_i^{3/2} & \sum_{i=1}^N f_i^{1/2} & N \\ \sum_{i=1}^N f_i^{3/2} & \sum_{i=1}^N f_i^2 & \sum_{i=1}^N f_i & \sum_{i=1}^N f_i^{1/2} \\ \sum_{i=1}^N f_i^{1/2} & \sum_{i=1}^N f_i & N & \sum_{i=1}^N f_i^{-1/2} \\ N & \sum_{i=1}^N f_i^{1/2} & \sum_{i=1}^N f_i^{-1/2} & \sum_{i=1}^N f_i^{-1} \end{bmatrix}^{-1} \begin{bmatrix} \sum_{i=1}^N \alpha_{20,i} \cdot f_i^{1/2} \\ \sum_{i=1}^N \alpha_{20,i} \cdot f_i \\ \sum_{i=1}^N \alpha_{20,i} \\ \sum_{i=1}^N \alpha_{20,i} \cdot f_i^{-1/2} \end{bmatrix} \quad (7)$$

where

A, B, C, D are the least square fit coefficients;

f_i is the frequency at measurement point i ;

N is the number of measured frequency points;

$\alpha_{20,i}$ is the temperature corrected attenuation at measurement point i .

If no copper clad conductors are present ($D = 0$), the least square fit coefficients are calculated using the equation below:

$$\begin{bmatrix} A \\ B \\ C \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^N f_i & \sum_{i=1}^N f_i^{3/2} & \sum_{i=1}^N f_i^{1/2} \\ \sum_{i=1}^N f_i^{3/2} & \sum_{i=1}^N f_i^2 & \sum_{i=1}^N f_i \\ \sum_{i=1}^N f_i^{1/2} & \sum_{i=1}^N f_i & N \end{bmatrix}^{-1} \begin{bmatrix} \sum_{i=1}^N \alpha_{20,i} \cdot f_i^{1/2} \\ \sum_{i=1}^N \alpha_{20,i} \cdot f_i \\ \sum_{i=1}^N \alpha_{20,i} \end{bmatrix} \quad (8)$$