IEC 61196-1-113

Edition 2.0 2018-01

INTERNATIONAL STANDARD

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

IEC 61196-1-113:2018-01(en)

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

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

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC 61196-1-113

Edition 2.0 2018-01

INTERNATIONAL STANDARD

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.120.10

ISBN 978-2-8322-5257-4

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

COAXIAL COMMUNICATION CABLES –

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

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

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.

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:

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

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:

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

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 (≤ 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:

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

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

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

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:

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

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 %/ °C);

T is the temperature during the measurement in °C;

$a_{\text{T}}(f)$ is the attenuation constant at the temperature during measurement;

$a_{20}(f)$ 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

$\alpha_{fit}(f)$ 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:

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

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:

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