IEC 61196-1-113

Edition 1.0 2009-08

INTERNATIONAL STANDARD

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

IEC 61196-1-113:2009(E)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: 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.

- Catalogue of IEC publications: www.iec.ch/searchpub
The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub
Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv
If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 61196-1-113

Edition 1.0 2009-08

INTERNATIONAL STANDARD

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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE H

ICS 33.120.10

ISBN 978-2-88910-440-6

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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
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, 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/937/FDIS	46A/938/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 publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61196 series, 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 maintenance result 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.

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 normative references given in IEC 61196-1 (2005) constitute provisions of this part of IEC 61196.

3 Attenuation constant

The attenuation constant is defined as

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

where

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

P_1 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;

P_2 is the output power measured when the specimen is inserted into the test system, 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 metres (m).

4 Test method

4.1 Equipment

The following equipment is used:

- a vector network analyser (VNA) capable of performing S21 measurements;
- an impedance matching adapter to match the nominal characteristic impedance of the specimen to the impedance of the VNA.

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

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

where

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

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

In the above case, the reflection loss errors due to the mismatch can be neglected (≤ 0,02 dB).

4.2 Test specimen

The length of the specimen shall be such that the uncertainty of the measurement does not exceed 2 % of the attenuation of the specimen. The length of the specimen shall be determined with an uncertainty not exceeding 1 %. Thus the accumulated uncertainty of the attenuation should not exceed 3 %.

If at low frequencies the deviation between the magnitude of the complex characteristic impedance and the nominal characteristic impedance of the specimen cannot be neglected, the length of the specimen shall be such that the attenuation of the specimen at the lowest frequency to be measured is ≥ 20 dB. This will avoid the effect of multiple reflections at the ends of the specimen. Alternatively, a form fitting can be applied.

Connectors shall be fitted on each end of the test specimen. The connectors shall match directly the ports of the test equipment or test adaptors shall be used.

4.3 Procedure

4.3.1 Calibration

The attenuation of the test set-up (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.

4.3.2 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 (S21 or S12 measurement).

The ambient temperature shall be recorded.

5 Expression of test results

5.1 Expression

$$\alpha(f) = \left[a_{\text{meas}}(f) - a_{\text{cal}}(f)\right] \cdot \frac{100}{l} \text{ in dB/100 m} \qquad (3)$$

where

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

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

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

l is the physical length of the specimen in metres (m).

5.2 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:

$$\alpha_{20}(f) = \frac{\alpha_T(f)}{1 + K/100 \cdot (T - 20)} \text{ in dB/100 m} \qquad (4)$$

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;

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

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

6 Form fitting

If multiple reflections occur at low frequencies due to a mismatch between the test specimen and the test set-up, so that the attenuation curve show ripples, a form fitting may be applied which smoothes the curve. The measured attenuation shall be fitted to the following function:

$$\alpha_{fit}(f) = A \cdot \sqrt{f} + B \cdot f + \frac{C}{\sqrt{f}} \qquad (5)$$

where

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

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

f is the frequency.

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

$$\begin{vmatrix} A \\ B \\ C \end{vmatrix} = \begin{vmatrix} \sum_{i=1}^{N} f_i & \sum_{i=1}^{N} f_i^{3/2} & N \\ \sum_{i=1}^{N} f_i^{3/2} & \sum_{i=1}^{N} f_i^{2} & \sum_{i=1}^{N} f_i^{1/2} \\ N & \sum_{i=1}^{N} f_i^{1/2} & \sum_{i=1}^{N} f_i^{-1} \end{vmatrix}^{-1} x \begin{vmatrix} \sum_{i=1}^{N} \alpha_{20,i} \cdot f_i^{1/2} \\ \sum_{i=1}^{N} \alpha_{20,i} \cdot f_i \\ \sum_{i=1}^{N} \alpha_{20,i} \cdot f_i^{-1} \end{vmatrix} \qquad (6)$$

where

A, B, C	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.

7 Test report

The test report shall give the test conditions:

- temperature,
- specimen length,
- test frequency,
- number of measured frequency points,
- sweep time,
- IFBW (intermediate frequency bandwidth),

and record the values of the attenuation constant. If a form fitting has been used, the test report shall also indicate the resulting fitting.

8 Requirements

The values shall not exceed the requirements of the relevant detail specification.