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INTERNATIONAL STANDARD

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

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CONTENTS

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COAXIAL COMMUNICATION CABLES –

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

FOREWORD

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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. It is an International Standard.

This third edition cancels and replaces the second edition published in 2018. This edition constitutes a technical revision.

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

a) add Clause 3 "Terms and definitions";

b) add Clause 4 "Test environment";

c) add Clause 5 "Preconditioning";

d) add Subclause 7.1 "General";

e) add detail test methods including 7.2 "long cable methods" and 7.3 "double-cable method";

f) add "Annex A Stability of attenuation constant at different temperatures";

g) add "Annex B Test examples of stability of attenuation constants at different temperature".

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

Draft	Report on voting
46A/1688/FDIS	46A/1693/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.

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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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 test sample (TS) 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: General specification – General, definitions and requirements*

3 Terms and definitions

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

3.1
attenuation constant
real part of the propagation coefficient, defined as

$$\alpha = 10 \cdot \log_{10}\left(\frac{P_1}{P_2}\right) \cdot \frac{100}{l} \tag{1}$$

where

α is the attenuation constant of the cable, dB/100 m;

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 test sample (TS), W;

P_2 is the output power measured when the test sample (TS) 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 test sample (TS), W;

l is the physical length of the test sample (TS), m.

4 Test environment

The test should be carried out at normal temperature, and the change range of ambient temperature should be kept within ±2 °C.

5 Preconditioning

The test samples (TS) should be stable at the ambient temperature for at least 4 h while recording the ambient temperature.

6 Equipment

The following equipment can be used:

a) a vector network analyser (VNA);

b) length measuring instruments with accuracy not exceeding one thousandth of the length of the test sample (TS);

c) the connectors adapted to the TS should preferably match and connect with VNA test ports;

d) if impedance matching adapters are needed, they shall be provided to match the impedance of the VNA and that of the test sample (TS). In that case, the impedance of the impedance matching adapters shall meet Formula (2).

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

where

Z_{TS} is the nominal characteristic impedance of the test sample (TS);

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).

7 Test method

7.1 General

The following three test methods can be used to test the attenuation constant of a cable.

a) Method 1: long cable method, that is, a cable with sufficient length is connected to a pair of connectors to form a cable assembly as a test sample (TS), and the insertion losses of the pair of connectors is negligible. The measured insertion loss of assembly can be used to calculate the attenuation constant of the cable directly. This method is suitable for measuring the cable attenuation constant only when the insertion loss of the pair of connectors can be ignored comparing that of the cable.

b) Method 2: double-cable method, that is, two pieces of cables with different lengths are cut from a cable under test and connected respectively to a pair of connectors with same type and specification and quality, to form two cable assemblies as test samples (TS). The measured insertion loss of two cable assemblies can be used to calculate the attenuation constant. The method is suitable for measuring the cable attenuation constant only when the difference between insertion losses of two pair of connectors can be ignored.

c) Method 3: when needed, the stability of attenuation constant of coaxial cable can be tested by testing the changing ratio of its attenuation constants at different temperatures relative to its attenuation constant at 20 °C.

The test method of stability of attenuation constant that shall be used is specified in Annex A. The example of stability of attenuation constant at different temperature is shown in Annex B.

7.2 Method 1 – Long cable method

7.2.1 Preparation of test sample (TS)

The TS shall be terminated with a pair of connectors which shall be well matched to the cable and can be connected to VNA directly. The cable shall be long enough so that the insertion loss of the connector pair can be negligible compared with that of the cable.

To improve test accuracy, it is recommended that the connectors at both ends of the TS are threaded RF coaxial connectors pair which can connect VNA directly.

If, at low frequencies, the deviation between the size of the complex characteristics of the sample impedance and the nominal characteristic impedance cannot be ignored, the sample length l should be such that the attenuation of the sample at the minimum frequency to be measured is greater than 20 dB, which will avoid the influence of multiple reflections at both ends of the sample. Alternatively, the fit function can be applied.

7.2.2 Test procedure

The test procedure shall be as follows.

a) After VNA is fully preheated, set the measurement frequency range and the test mode to S12 or S21. According to user needs, choose linear scanning or logarithmic scanning as the scanning mode. The number of scanning points shall be set according to Formula (3) and should not be less than 801 points. When the value calculated according to Formula (3) exceeds the maximum number of points of the device, the highest number of points that VNA can reach should be taken.

$$n \geq \frac{3(f_2 - f_1)l}{120} \quad (3)$$

where

n is the number of scanning points of measurement;

f_1 is the lowest point of the frequency range in MHz;

f_2 is the highest point of the frequency range in MHz;

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

b) System calibration: full two port calibration shall be performed at the ends of the test cables.

c) Connect TS to VNA and measure the insertion loss $IL(f)$ of the TS.

d) Calculate the attenuation constant according to Formula (4):

$$\alpha(f) = \mathrm{IL}(f) \cdot \frac{100}{l} \tag{4}$$

where

$\alpha(f)$	is the attenuation constant of the cable, dB/100 m;
$\mathrm{IL}(f)$	is the measured insertion loss, dB;
l	is the physical length of the TS, m.

7.3 Method 2 – Double cable method

7.3.1 Preparation of test sample (TS)

Cut two pieces of cables with different lengths from a cable under test; each piece of cable shall be connected to a pair of connectors to form a cable assembly as test sample (TS). The two pairs of connectors shall be the same type, same specification, and quality. The length difference ($l_1 - l_2$) of the two pieces of cables shall be at least 3 m. Both TS shall be made by the same methods.

To improve test accuracy, it is recommended that the connectors at both ends of the TS are threaded RF coaxial connectors pair which can connect VNA directly.

7.3.2 Test procedure

The test procedure shall be as follows.

a) After VNA is fully preheated, set the measurement frequency range and the test mode to S12 or S21. The number of scanning points shall be set according to Formula (3) by using the longer cable length of the TS and should not be less than 801 points. When the value calculated according to Formula (3) exceeds the maximum number of points of the device, the highest number of points that the device can reach should be taken.

b) System calibration: full two port calibration shall be performed at the ends of the test cables.

c) Connect the longer TS to the test port of VNA. Measure its insertion loss noted as $IL_1(f)$.

d) Remove the longer TS and connect the shorter TS to the test port of VNA. Measure its insertion loss noted as $IL_2(f)$.

e) Calculate the attenuation constant of the TS by using Formula (5):

$$\alpha(f) = \frac{100 \times \left[IL_1(f) - IL_2(f)\right]}{l_1 - l_2} \tag{5}$$

where

α	is the attenuation constant, dB/100 m;
$IL_1(f)$	is the insertion loss of the longer TS, dB;
$IL_2(f)$	is the insertion loss of the shorter TS, dB;
l_1	is the length of the longer TS in metres, m;
l_2	is the length of the shorter TS in metres, m.