IEC 61196-1-116

Edition 1.0 2015-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Coaxial communication cables –
Part 1-116: Electrical test methods – Test for impedance with time domain reflectometry (TDR)

Câbles coaxiaux de communication –
Partie 1-116: Méthodes d'essais électriques – Essai d'impédance par réflectométrie dans le domaine temporel (TDR)

IEC 61196-1-116:2015-11(en-fr)

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COAXIAL COMMUNICATION CABLES –

Part 1-116: Electrical test methods – Test for impedance with time domain reflectometry (TDR)

FOREWORD

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The International Standard IEC 61196-1-116 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/1270/FDIS	46A/1283/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.

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 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 publication will remain unchanged until the stability date indicated on the IEC website 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- withdrawn,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.

COAXIAL COMMUNICATION CABLES –

Part 1-116: Electrical test methods – Test for impedance with time domain reflectometry (TDR)

1 Scope

This part of IEC 61196 applies to coaxial communications cables. It specifies test methods for determining the impedance of coaxial communications cables with time domain reflectometry (TDR).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 62153-1-1, *Metallic communication cables test methods – Part 1-1: Electrical – Measurement of the pulse/step return loss in the frequency domain using the Inverse Discrete Fourier Transformation (IDFT)*

3 Terms and definitions

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

4 Principles

When a step function signal is sent to cable under test and the signal pass through the test point of cable, part of the energy is reflected. The distance (L) from the input end to the test point can be calculated by measuring the total signal traveling time (t) as Figure 1. The change of impedance can be also calculated by measuring the amplitude of the input and reflected signal, as shown in Figure 1.

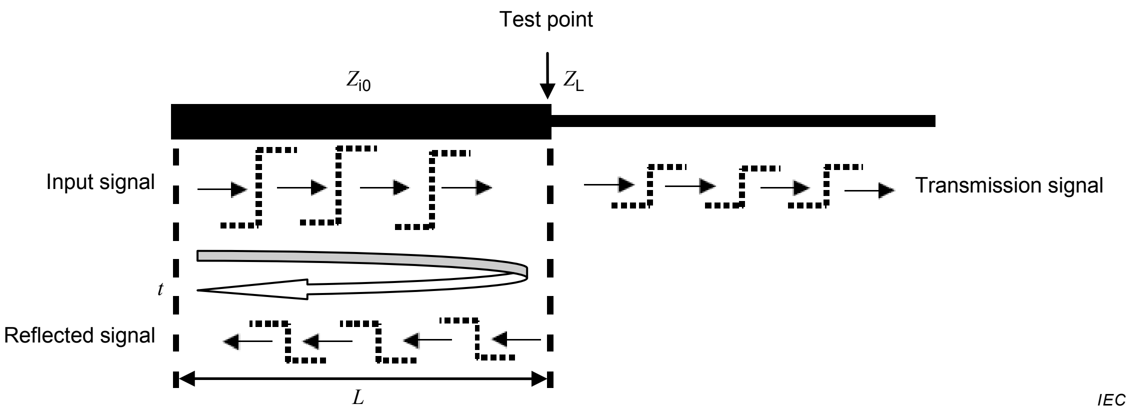


Figure 1 – Principle of TDR measurement

The distance L of the test point can be determined by:

$$L = \frac{v \times t}{2} = \frac{c \times t}{2 \times \sqrt{\varepsilon_r}} \tag{1}$$

The impedance of the test point should be:

$$\rho = \frac{U_{re}}{U_{in}} \tag{2}$$

$$Z_L = Z_{i0} \times \frac{1+\rho}{1-\rho} \tag{3}$$

where

L is the distance of the test point, in metres (m);

v is the propagation velocity, in metres per second (m/s);

t is the total signal traveling time as shown in Figure 1, in seconds (s);

c is the propagation velocity in free space (3×10^8 m/s);

ε_r is the dielectric constant of cable dielectric;

ρ is reflection coefficient;

U_{re} is the voltage of reflected signal, in volts (V);

U_{in} is the voltage of input signal, in volts (V);

Z_L is the impedance of the test point, in ohms (Ω);

Z_{i0} is the impedance of the reference line, in ohms (Ω).

5 Test method

5.1 Equipment

Test instrument: A time domain reflectometer (TDR) using a step voltage with enough resolution and accuracy and rise time less than 100 ps, or a vector network analyzer (VNA) with time domain capability using a step function in accordance with IEC 62153-1-1.

Reference components: A precision air-line and a precision load with the same nominal impedance as the cable under test.

5.2 Test sample

The cable under test (CUT) shall be terminated with suitable connectors at each end, as shown in Figure 2.

Maximum L_{sample} shall be determined: 3 m or 2 dB at 3 GHz whichever is shorter.

Minimum L_{sample} is mainly dependent on the resolution of TDR system rise time, which shall be determined by:

$$L_{\text{sample}} \geq \frac{2 \times t_{\text{system}} \times c}{\sqrt{\varepsilon_{\text{r}}}} \tag{4}$$

where

L_{sample} is the length of test sample shown in Figure 2, in metres (m);

t_{system} is the rise time of TDR system, in seconds (s);

c is the propagation velocity in free space (3×10^8 m/s);

ε_{r} s the dielectric constant of cable dielectric.

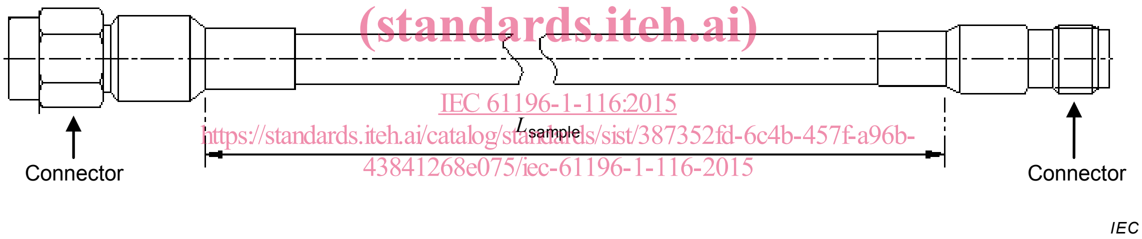


Figure 2 – Test sample

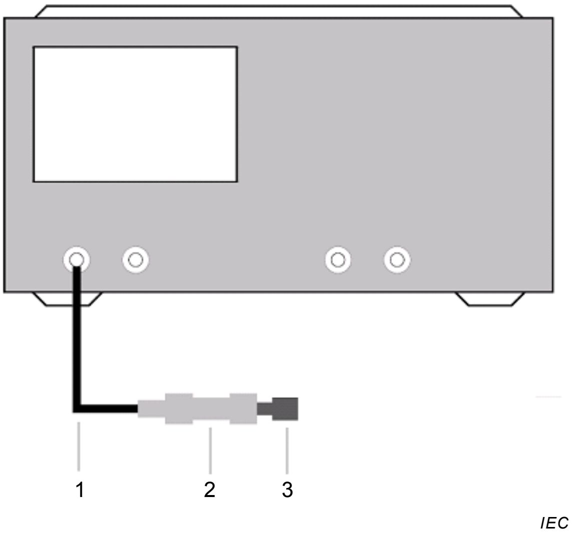
For higher precision, a pair of screw thread connectors suitable to interface of the TDR or VNA should be used.

5.3 Procedure

The procedure is as follows.

a) After fully preheating test instrument, set the test mode to measure impedance of the test sample.

b) The precision air-line shall be connected between the test instrument and the precision load, as shown in Figure 3. Set the test range of test instrument to regular impedance range of the precision air line, and record the average impedance Z_{air}.



Key

1 test lead

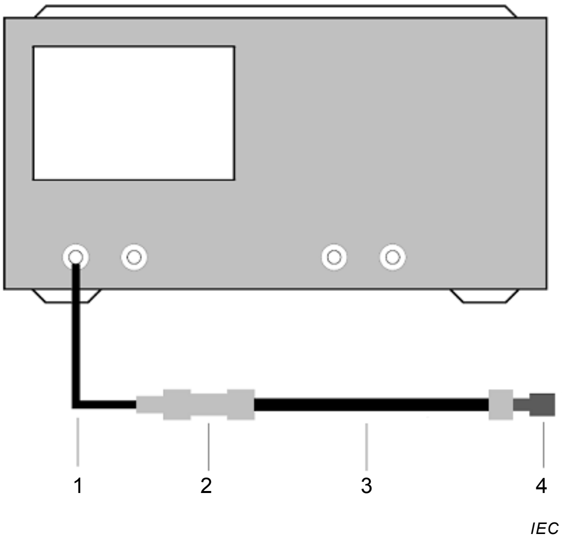
2 precision air line

3 precision load

Figure 3 – Z_{air} test set-up

For higher precision, test lead shall be as short as possible.

c) Insert the test sample between the precision air-line and the precision load, as shown in Figure 4. Set test range of test instrument to measure within the confines of "L_{sample}" as shown in Figure 2. Then measure the impedance, "Z_{sample}", and record the relevant data of impedance.



Key

1 test lead

2 precision air line

3 test sample

4 precision load

Figure 4 – Test set-up with test sample

d) The test sample shall then be turned end-to-end and the measurement repeated as 5.3 c).

5.4 Calculation of test data

5.4.1 Test instrument deviation calculation

The impedance deviation of test instrument is given by:

$$\delta = Z_0 - Z_{air} \tag{5}$$

where

δ is the impedance deviation of test instrument , in ohms (Ω);

Z_0 is the nominal impedance of precision air line, in ohms (Ω);

Z_{air} is the measured average impedance of precision air line, in ohms (Ω).

5.4.2 Correction calculation

The impedance of the test sample is given by:

$$Z = Z_{sample} + \delta \tag{6}$$

where

Z is the impedance of the test sample, in ohms (Ω);

Z_{sample} is the actual measured impedance of the test sample, in ohms (Ω);

δ is the impedance deviation of test instrument , in ohms (Ω).

6 Test report

The test report shall include:

- the test sample length L_{sample} , in metres (m);
- ambient temperature, in degree Celsius (°C);
- parameters set in the VNA (when applicable);
- the tolerance of the precision load and air line;
- the impedance of the test sample, in ohms (Ω).

7 Requirement

The results at both ends of the test sample shall not exceed the value specified in the detailed specification.