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INTERNATIONAL STANDARD

colour inside

**Twinax cables for digital communications –
Part 1-1: Time domain test methods for twinax cables for digital communications – General requirements**

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

Draft	Report on voting
46C/1191/CDV	46C/1218/RVC

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/standardsdev/publications.

A list of all parts in the IEC 62783 series, published under the general title *Twinax cables for digital communications*, 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- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This document specifies the general requirements of time domain test methods for twinax cables used in information technology systems. The high data rates of these systems need both frequency domain test methods and time domain test methods to ensure signal integrity.

Time domain here refers to time domain analysis or display(s), as defined by an X-Y graph where the X-axis is either time or electrical length of device under test (DUT), and the Y-axis is magnitude (voltage, impedance or reflection coefficient). Time domain display provides a direct view of the DUT's characteristics. In addition, time domain method gives information concerning the reflection and transmission of the DUT and it can show the effect of each discontinuity as a function of time or distance.

TWINAX CABLES FOR DIGITAL COMMUNICATIONS –

Part 1-1: Time domain test methods for twinax cables for digital communications – General requirements

1 Scope

This part of IEC 62783-1 specifies time domain test methods, parameters and requirements for fixtures for twinax cables (known also as twin-axial cables or twin-coaxial cables) used in digital communication systems. The methods and fixtures facilitate measurements of differential and common mode transmission parameters as well as single-ended mode parameters.

This document is applicable to twinax cables and also to symmetric cables with pitch.

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 60050-726, *International Electrotechnical Vocabulary (IEV) – Part 726: Transmission lines and waveguides* (available at www.electropedia.org)

IEC 62783-1, *Twinax cables for digital communications – Part 1: Generic specification*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-726, IEC 62783-1 and the following apply.

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

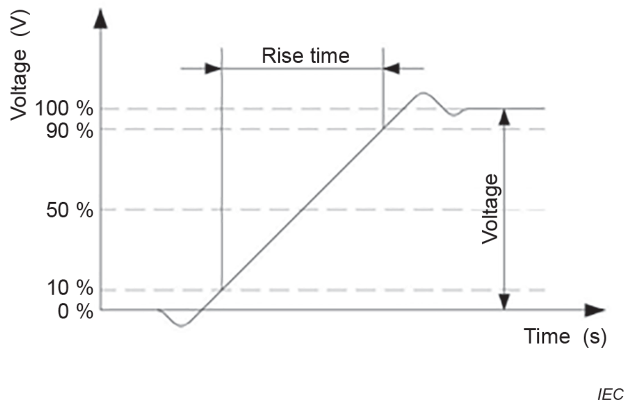
- ISO Online browsing platform: available at http://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

3.1.1
time domain reflectometer
TDR
instrument intended to measure reflections and transmissions of step pulse waves along the device under test (DUT), the individual reflections being measured and displayed as a function of time or distance

3.1.2
rise time
time interval between the instants at which the magnitude of the pulse first reaches a specified lower value and then a specified upper value

Note 1 to entry: In general, ignoring overshoot and undershoot, the lower level and upper level of pulse magnitude are specified at 10 % to 90 %, unless otherwise specified.

Note 2 to entry: Rise time is expressed in ps.



3.1.3
differential mode characteristic impedance
differential mode impedance
Z_{diff}
impedance between two wires of the same pair, with a specified rise time within the steady state time or length range, when the differential mode signals with opposite polarities and equal amplitudes are injected into the cable pair

Note 1 to entry: Differential mode characteristic impedance is expressed in ohm.

3.1.4
single-ended characteristic impedance
single-ended impedance
impedance between one wire of a symmetrical pair and the reference-ground plane when a single-ended signal is injected into this wire

Note 1 to entry: Single-ended characteristic impedance is expressed in ohm.

Note 2 to entry: The reference-ground plane generally comprises screening of the cable.

3.1.5
differential mode propagation delay
differential mode delay
time required for the transmission of differential mode pulse signal between two specified points at the specified rise time along the cable

Note 1 to entry: Differential mode propagation delay is expressed in ns/m.

3.1.6
common mode propagation delay
common mode delay
time required for the transmission of common mode pulse signal between two specified points at the specified rise time along the cable

Note 1 to entry: Common mode propagation delay is expressed in ns/m.

3.1.7
inter-pair skew
difference in propagation delay of any two pairs in the cable

Note 1 to entry: Inter-pair skew is expressed in ns/m.

Note 2 to entry: Inter-pair skew is applicable to differential mode inter-pair skew and common mode inter-pair skew.

3.1.8
intra-pair skew
signal transmission time difference per unit length between the two wires of the cable pair of the DUT in differential mode or in common mode when a differential mode signal or common mode signal at the specified rise time is transmitted through the cable pair of the DUT

Note 1 to entry: Intra-pair skew is usually expressed in ps/m.

Note 2 to entry: In the event of unbalance of coupled wires as in twinax cables, differential to common mode conversion in frequency domain shall be also considered.

3.1.9
through calibration kit
Thru kit
kit having the same quality and design as the test fixtures with the electrical length being twice that of the single fixture

3.2 Abbreviated terms

Abbreviated term	Full term
CUT	cable under test
DUT	device under test
IDFT	inverse discrete Fourier transformation
PCB	printed circuit board
TDR measurement	time domain reflection measurement
TDT measurement	time domain transmission measurement
VNA	vector network analyser

4 Test equipment

4.1 Measurement equipment

A sampling oscilloscope with two dual-channel TDR modules which can both generate and receive the step pulses are preferred, or one dual-channel TDR module used to generate the step pulses and one sampling module used to receive the step pulse may be used.

The rise time of the TDR module should cover the requirements of the cable under test (CUT).

Another option of measurement equipment is a 4-port vector network analyser with time domain analysis function if its precision can meet the test requirements. The VNA shall have the capability of mathematical baluns and can perform full 4-port calibration, at the same time the VNA shall have the time domain analysis function by using inverse discrete Fourier transformation (IDFT). The description of inverse discrete Fourier transformation (IDFT) can be found in IEC 62153-1-1.

Two 2-channel TDR modules or a 4-port VNA is a minimum requirement for a multi-pair measurement, in order to minimize the re-connection of the CUT for each pair combination, the use of an RF switching unit is also recommended.

4.2 Coaxial cables (test leads)

Four pieces of low loss, phase stable coaxial cables with an impedance of 50 Ω are used to connect the fixtures to the measurement equipment. The cables' bandwidth should meet the requirement of CUT.

The electrical length of the four coaxial cables should be equal. The time difference among the cables should be as small as possible, cable length should be less than 1 m.

4.3 Test fixtures

The test fixtures are used to connect the CUT through test leads to the measurement equipment. The frequency response characteristic of fixtures shall meet the test requirements throughout the test bandwidth, any error caused by fixtures shall be removed. For example, de-embedding technology or TRL technology may be used to eliminate fixture errors.

Either micro-strip line, strip line, or similarly accurate technologies are permitted to be used in the printed circuit board (PCB) of the test fixtures.

Types of test fixtures other than PCB may be used if their precision can meet the test requirements in the relevant detailed specifications.

For proper measurements, test fixtures shall be designed and built to specific requirements, as described in the list below, to ensure good measurement quality and consistency:

a) All the traces on the PCB shall be controlled and measured as single-ended characteristic impedance of (50 ± 2,5) Ω at a specified rise time. As a result, the differential mode impedance shall be (100 ± 5,0) Ω, unless otherwise specified.
b) All of the traces on the PCB shall have an equal electrical length, and the differential mode delay and/or common mode delay, intra-pair skew (if any), inter-pair skew of the traces should be specified in the relevant detailed specifications.
c) The PCB should have a through calibration kit (Thru kit) to remove both fixtures from the measurements.
d) A micro-coax 3,5 mm connector is recommended to be used. Other types of connectors, such as SMA, 2,92 mm, or 2,4 mm, are also permitted according to the application of the cable under test (CUT).

4.4 Termination resistors

Termination resistors are used to terminate unused pairs to eliminate the reflection, the termination resistors of each unused pair should be chip resistors, with an impedance equal to the CUT's differential mode characteristic impedance and the precision of termination resistors should be ±0,1 %.

4.5 Through calibration kit (Thru kit)

The attenuation of the through calibration kit should be as small as possible, and its return loss shall be 10 dB better than that of the cable under test, unless otherwise specified in detailed specification.

5 Test conditions

Unless otherwise specified, the measurements shall be done under the following conditions:

1) TDR equipment shall be adequately grounded to prevent any damage from electrostatic discharge (ESD) and electrical overvoltage stress (EOS).
2) The measurements shall be done at the temperature (20 ± 3) °C.
3) TDR equipment shall be warmed up to its steady state before the measurement.
4) The person carrying out the measurements wearing a grounded wrist strap during measurements.
5) The environment humidity is not specified in this document, but it may be specified in the relevant detailed specification.

6 Measurement methods

6.1 Calibration

Calibrate the TDR equipment or VNA with time domain analysis function at the end of test leads according to the calibration procedures provided by the equipment's manufacturer.

After calibration, the calibrated reference plane is established at the end of test leads.

6.2 De-skew

This step is only applicable to TDR equipment.

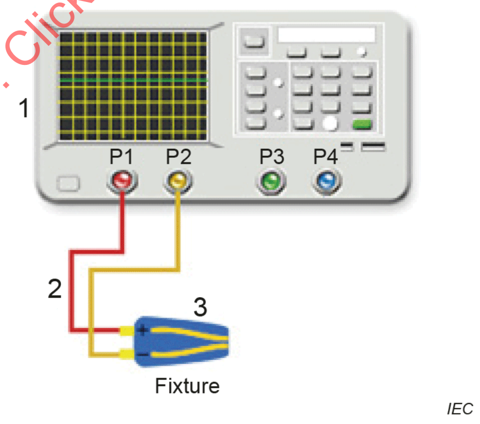
In order to make sure that the two step pulses within a TDR module are equal and that they propagate exactly at the same time in differential mode measurements, the time difference, or skew, between the two edges should be adjusted at the connection points.

Define the differential mode stimulus, set up the rise time to a specified value according to the CUT's application; minimize skew between the positive edge and negative edge by adjusting the edge's position until the skew of two edges is within ±1 ps.

The de-skew procedure for common mode measurements is similar to the above steps, the difference being defining the common mode stimulus and minimizing skew between the two positive edges (or two negative edges) by adjusting the edge's position until the skew of two edges is within ±1 ps.

6.3 Establish the reference plane for the TDR measurement

The test fixture is connected to the test leads and the end of test fixture is kept open as shown in Figure 1. Set up the measurement equipment in TDR measurement mode, record the time axis value T_0 at the open circuit position, which is the start location for the TDR measurement.



Key

1 Time domain reflectometer or VNA with time domain analysis function

2 Coaxial cables (test leads)

3 Test fixture

The port mapping depends on the actual equipment, for example, port 1 and port 3 may also be combined as a balanced port.

Figure 1 – Test schematic diagram for open location of the test fixture