

INTERNATIONAL STANDARD

**Twinax cables for digital communications –
Part 1: Generic specification**

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TWINAX CABLES FOR DIGITAL COMMUNICATIONS –

Part 1: Generic specification

FOREWORD

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International Standard IEC 62783-1 has been prepared by subcommittee 46C: Wires and symmetric cables, of IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories.

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

| | |
|---------------|------------------|
| FDIS | Report on voting |
| 46C/1107/FDIS | 46C/1113/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 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 "<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- withdrawn,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.

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INTRODUCTION

This International Standard specifies the generic characteristics of twinax cables, which use multiple twinax cable elements for transmission of digital signals.

These cables are intended for use in high-performance information technology systems and data interface interconnection systems. Twinax cables are generally used in short-reach data communication links, which reach about 1 m to 10 m. Information technology interconnection standards that use twinax cables include Ethernet, Fibre channel, SAS, SATA, and others.

IEC 62783 (all parts) includes separate family specifications, which are provided for each information technology interconnection standard's specific twinax cable requirements.

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TWINAX CABLES FOR DIGITAL COMMUNICATIONS –

Part 1: Generic specification

1 Scope

This part of IEC 62783 specifies definitions and requirements of twinax cables used in digital communication systems. These cables are intended to be used in indoor applications. This generic specification details the requirements and transmission characteristics for single twinax elements as well as multiple twinax elements within the same sheath, i.e. “twinax cable”.

This generic specification is supplemented with family specifications that give additional requirements based on the specific application, e.g. the maximum specified frequency of the cables.

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 60028, *International standard of resistance for copper*

IEC 60068 (all parts), *Environmental testing*

IEC 60189-1, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*

IEC 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60332-2-2, *Tests on electric and optical fibre cables under fire conditions – Part 2-2: Test for vertical flame propagation for a single small insulated wire or cable – Procedure for diffusion flame*

IEC 60332-3-10, *Tests on electric and optical fibre cables under fire conditions – Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables – Apparatus*

IEC TR 60344, *Calculation of d.c. resistance of plain and coated copper conductors of low-frequency cables and wires – Application guide*

IEC 60708, *Low-frequency cables with polyolefin insulation and moisture barrier polyolefin sheath*

IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures – General guidance*

IEC 60811-201, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness*

IEC 60811-203, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 203: General tests – Measurement of overall dimensions*

IEC 60811-401, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*

IEC 60811-406, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 406: Miscellaneous tests – Resistance to stress cracking of polyethylene and polypropylene compounds*

IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC 60811-502, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 502: Mechanical tests – Shrinkage test for insulations*

IEC 60811-504, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 504: Mechanical tests – Bending tests at low temperature for insulation and sheaths*

IEC 60811-506, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 506: Mechanical tests – Impact test at low temperature for insulations and sheaths*

IEC 60811-508, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths*

IEC 60811-509, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)*

IEC 60811-510, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 510: Mechanical tests – Methods specific to polyethylene and polypropylene compounds – Wrapping test after thermal ageing in air*

IEC 61034 (all parts), *Measurement of smoke density of electric cables burning under defined conditions*

IEC 61156-1, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC TR 61156-1-2, *Multicore and symmetrical pair/quad cables for digital communications – Part 1-2: Electrical transmission characteristics and test methods of symmetrical pair/quad cables*

IEC 62153-4-3, *Metallic communication cable test methods – Part 4-3: Electromagnetic compatibility (EMC) – Surface transfer impedance – Triaxial method*

IEC 62153-4 (all parts), *Metallic communication cable test methods – Part 4: Electromagnetic compatibility (EMC)*

IEC 62153-4-4, *Metallic communication cable test methods – Part 4-4: Electromagnetic compatibility (EMC) – Test method for measuring of the screening attenuation as up to and above 3 GHz, triaxial method*

IEC 62153-4-9, *Metallic communication cable test methods – Part 4-9: Electromagnetic compatibility (EMC) – Coupling attenuation of screened balanced cables, triaxial method*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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>

3.1

twinax element

pair of insulated conductors that are laid parallel, side-by-side, enclosed in a metal foil shield with drain wire (known also as twin-axial or twin-coaxial)

3.2

twinax cable

cable composed of multiple twinax elements

3.3

twinax cable assembly

twinax cable terminated on both ends with a connector

4 Requirements for cables construction

4.1 General remarks

The nominal twinax characteristic impedance is 100 Ω . Normal twinax cable configurations range from 2 to 32 elements, with a conductor size range from 0,2 mm to 0,6 mm (original designs used 32 AWG to 22 AWG), or other sizes as specified in the family.

The choice of materials and cable construction shall be suitable for the intended application and installation of the cable. Particular care shall be taken to meet any special requirements for fire performance (such as burning properties, smoke generation, evolution of acid gas, etc.).

4.2 Cable construction

4.2.1 General

The cable construction shall be in accordance with the details and dimensions given in the relevant family specification.

4.2.2 Conductor

The conductor shall consist of annealed copper in accordance with IEC 60028, shall be solid or stranded and circular in cross-section, and shall be silver-coated, tin-coated, bare copper, plated copper or copper alloy.

The conductor DC resistance and resistance unbalance, when specified, shall meet the values indicated in the relevant family specification. The maximum conductor DC resistance shall be calculated in accordance with IEC TR 60344.

4.2.3 Insulation

Conductor insulation is composed of one or more suitable dielectric materials. The insulation may be solid, cellular or composite (e.g. foam skin).

The insulation shall be continuous, having a thickness as uniform as possible. The minimum thickness of the insulation shall be measured in accordance with the method specified in IEC 60189-1.

The insulation shall be applied to fit closely to the conductor. The stripping properties of the insulation shall be checked in accordance with the method specified in IEC 60189-1. It shall be possible to strip the insulation from the conductor easily and without damage to the insulation or the conductor.

When required, the insulated conductors shall be coloured for identification. Colours shall correspond reasonably with the standard colours shown in IEC 60304.

4.2.4 Colour code

The colour code for insulation is given in the relevant cable specification.

4.2.5 Drain wire

The drain wire shall conform to the conductor requirements given in 4.2.2.

4.2.6 Screening of cable assembly element

The cable element consists of:

- a pair of wires consisting of two insulated conductors, designated wire "a" and wire "b",
- an element shield consisting of a conductive metal foil laminated to a plastic tape and an optional "drain wire", which is an uninsulated conductor, placed in continuous electrical contact with the metal foil.

Care should be taken when putting dissimilar metals in contact with each other. Coatings or other methods of protection may be necessary to prevent galvanic interaction.

A protective wrapping may be applied over the screen.

4.2.7 Cable make-up

The cable assembly consisting of 2 to 32 elements may be laid up in concentric layers or in unit construction. The cable core may be protected by wrappings of a non-hygroscopic tape and fillers may be used to maintain a circular formation.

4.2.8 Screening of the cable core

The cable core may be screened by a conductive metal foil laminated to a plastic tape and a tin coated copper braid.

Care should be taken when putting dissimilar metals in contact with each other. Coatings or other methods of protection may be necessary to prevent galvanic interaction.

A protective wrapping may be applied under or/and over the screen.

4.2.9 Sheath

The sheath shall have adequate mechanical strength and elasticity. These properties shall remain sufficiently constant during normal use.

The sheath shall be continuous, having a thickness as uniform as possible. The minimum thickness of the sheath shall be determined in accordance with the method specified in IEC 60189-1.

The sheath shall be applied to fit closely to the core of the cable. In the case of screened cables, the sheath shall not adhere to the screen except when it is intentionally bonded to it.

4.2.10 Colour of sheath

The colour of the sheath may be specified in the relevant family specification.

4.2.11 Identification

4.2.11.1 Cable marking

The cable shall be marked as specified in the family specification. The marking may include the following information:

- a) name of the manufacturer,
- b) date of manufacture,
- c) batch number,
- d) additional markings, as specified in the family specification.

One of the following marking methods should be used, or as specified in the family specification:

- 1) marking on the sheath,
- 2) printing on the core wrappings,
- 3) printed tape.

4.2.11.2 Labelling

The cable shall be labelled as specified in the family specification. The labelling may include the following information:

- a) type of cable,
- b) manufacturer's name or logo,
- c) date of manufacture,
- d) length of cable in metres.

4.2.12 Finished cable

Finished cable shall be adequately protected for storage and shipment as specified in the family specification.

5 Requirements and test methods

5.1 General

Unless otherwise specified, all tests shall be carried out under the conditions specified in IEC 60068 (all parts).

Under static conditions, the cables should operate in the temperature range from -20 °C to $+60\text{ °C}$ unless otherwise stated in the family specification. The temperature dependence of the cables is specified.

5.2 Electrical tests

5.2.1 Conductor resistance

The conductor resistance shall be as specified in the family specification and measured in accordance with IEC 60189-1.

5.2.2 Resistance unbalance

The resistance unbalance shall be as specified in the family specification and measured in accordance with IEC 60708.

5.2.3 Dielectric strength

Dielectric strength shall be as specified in the family specification and measured in accordance with IEC 60189-1 for conductor-to-conductor, for the sheath, for conductor-to-screen and screen-to-screen (if applicable).

5.2.4 Insulation resistance

Insulation resistance shall be as specified in the family specification and measured, between conductor-to-conductor, conductor-to-screen and screen-to-screen (if applicable) in accordance with IEC 60189-1. The test voltage shall be between 100 V and 500 V DC or as specified in the family specification.

5.2.5 Mutual capacitance

Mutual capacitance shall be as specified in the family specification and measured on all cable elements in accordance with IEC 60189-1.

5.2.6 Surface transfer impedance

Surface transfer impedance of the screen shall be as specified in the family specification and measured in accordance with IEC 62153-4-3.

5.3 Transmission requirements and tests

5.3.1 General

The transmission parameters are specified in the differential mode.

The transmission parameters nominal specification frequency range is from 1 MHz to 1 GHz (or higher).

The transmission parameters nominal specification length is 10 m, or shorter as specified in the family specification.

The transmission parameters of the cables are specified at 20 °C.

The following tests shall be conducted according to the procedures specified in IEC 61156-1, IEC TR 61156-1-2 and IEC 62153-4 (all parts), over the extended frequency range as specified in the family specification.

This standard's primary transmission parameter test method is given in IEC TR 61156-1-2. Alternative qualified test methods may be used. The primary test method described in IEC TR 61156-1-2 uses frequency domain techniques; however, time domain techniques may also be used, as needed to achieve sufficient accuracy.

NOTE Alternatives to frequency domain measurement techniques, such as time domain measurements, are a subject for further study.

5.3.2 Characteristic impedance

5.3.2.1 General

The mean characteristic impedance shall be $100 \Omega \pm 5 \Omega$, or the characteristic impedance shall be as specified in the family specification.

5.3.2.2 Measurement

Characteristic impedance shall be measured in accordance with IEC 61156-1.

5.3.3 Return loss

5.3.3.1 General

Return loss shall be as specified in the family specification.

5.3.3.2 Measurement

Return loss shall be measured in accordance with IEC TR 61156-1-2.

5.3.4 Attenuation

5.3.4.1 General

The attenuation shall be as specified in the family specification. Nominal attenuation values are given in Table 1.

Table 1 – Nominal attenuation values, dB/10 m

| f MHz | Conductor wire gauge mm and AWG | | | | | | | | | | | |
|------------|------------------------------------|--------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | 0,2 mm | 32 AWG | 0,25 mm | 30 AWG | 0,3 mm | 28 AWG | 0,4 mm | 26 AWG | 0,5 mm | 24 AWG | 0,6 mm | 22 AWG |
| 1 | 0,5 | 0,5 | 0,4 | 0,4 | 0,3 | 0,3 | 0,3 | 0,3 | 0,2 | 0,2 | 0,2 | 0,2 |
| 2 | 0,7 | 0,7 | 0,6 | 0,6 | 0,5 | 0,5 | 0,4 | 0,4 | 0,3 | 0,3 | 0,2 | 0,2 |
| 5 | 1,1 | 1,1 | 0,9 | 0,9 | 0,8 | 0,7 | 0,6 | 0,6 | 0,5 | 0,5 | 0,4 | 0,4 |
| 10 | 1,6 | 1,6 | 1,3 | 1,3 | 1,1 | 1,0 | 0,8 | 0,8 | 0,7 | 0,6 | 0,5 | 0,5 |
| 20 | 2,3 | 2,3 | 1,8 | 1,8 | 1,5 | 1,4 | 1,2 | 1,1 | 0,9 | 0,9 | 0,8 | 0,7 |
| 50 | 3,7 | 3,6 | 2,9 | 2,9 | 2,5 | 2,3 | 1,9 | 1,8 | 1,5 | 1,5 | 1,3 | 1,2 |
| 100 | 5,2 | 5,2 | 4,2 | 4,1 | 3,5 | 3,3 | 2,7 | 2,6 | 2,1 | 2,1 | 1,8 | 1,7 |
| 200 | 7,4 | 7,4 | 6,0 | 5,9 | 5,0 | 4,7 | 3,8 | 3,8 | 3,1 | 3,0 | 2,6 | 2,4 |
| 500 | 11,9 | 11,8 | 9,6 | 9,5 | 8,1 | 7,6 | 6,2 | 6,1 | 5,1 | 5,0 | 4,3 | 4,0 |
| 1 000 | 17,1 | 17,0 | 13,9 | 13,7 | 11,8 | 11,1 | 9,1 | 9,0 | 7,5 | 7,3 | 6,4 | 6,0 |
| 2 000 | 24,8 | 24,6 | 20,3 | 19,9 | 17,2 | 16,2 | 13,4 | 13,3 | 11,1 | 10,9 | 9,6 | 9,1 |
| 5 000 | 41,1 | 40,8 | 33,9 | 33,4 | 29,1 | 27,5 | 23,1 | 22,8 | 19,4 | 19,1 | 17,0 | 16,2 |
| 10 000 | 61,1 | 60,6 | 50,8 | 50,1 | 44,0 | 41,8 | 35,5 | 35,2 | 30,4 | 30,0 | 27,0 | 25,9 |

NOTE Nominal attenuation values are for information. Normative attenuation requirements are specified in the family specifications.

Nominal attenuation values are generated from the basic formula:

$$\alpha = a\sqrt{f} + b(f) \quad \alpha = a\sqrt{f} + b(f) \quad (1)$$

where

α is attenuation in dB;

a is the conductor coefficient for 10 m in dB;

b is the dielectric coefficient in dB;

f is frequency in MHz.

The conductor coefficient, for 10 m, is 0,2 dB for diameter: 0,510 559 227 mm (24 AWG size, 0,020 100 757 inches); the conductor coefficient for other conductor sizes is inversely proportional to diameter.

The dielectric coefficient is 0,001 dB for all sizes.

5.3.4.2 Measurement

Attenuation shall be measured in accordance with IEC TR 61156-1-2.

The CUT (cable under test) shall have a length of 10 m \pm 0,1 m, unless otherwise specified.

Attenuation is specified at 20 °C. Measurements are corrected from the ambient temperature to 20 °C as follows:

$$\alpha_{20} = \alpha_T / (1 + 0,000 2(T - 20)) \quad (\text{dB}/10 \text{ m}) \quad (2)$$

where

α_T is the measured attenuation in dB/10 m;

T is the ambient temperature in degrees Celsius;

α_{20} is the attenuation in dB/10 m, corrected to 20 °C.

NOTE The above correction is only applicable for insulating materials with a dielectric having a low temperature coefficient.

Measured values are corrected to a standard length of 10 m, or as specified in the family specification, using a linear variation with length.

5.3.5 Propagation delay, inter-element delay skew, and intra-element delay skew

5.3.5.1 General

Propagation delay, inter-element delay skew, and intra-element delay skew shall be as specified in the family specification.

5.3.5.2 Measurement

Propagation delay shall be measured in accordance with IEC TR 61156-1-2. Both frequency domain and time domain techniques may be used depending on the accuracy required. Inter-pair delay skew and intra-pair delay skew may be derived from balunless 4-port S-parameter mixed-mode frequency domain measurements made according to IEC TR 61156-1-2 or measured directly in time domain using a differential TDR.

5.3.6 Near-end crosstalk (NEXT)

5.3.6.1 General

Near-end crosstalk (NEXT) shall be as specified in the family specification.

5.3.6.2 Measurement

Near-end crosstalk (NEXT) shall be measured in accordance with IEC TR 61156-1-2. Both frequency domain and time domain (TDR/TDT) techniques may be used depending on the accuracy required.

5.3.7 Attenuation to crosstalk ratio far-end (ACR-F)

5.3.7.1 General

Far-end crosstalk (ACR-F) shall be as specified in the family specification.

5.3.7.2 Measurement

Far-end crosstalk (ACR-F) shall be measured in accordance with IEC TR 61156-1-2. Both frequency domain and time domain (TDR/TDT) techniques may be used depending on the accuracy required.

5.3.8 Transverse conversion loss (TCL)

5.3.8.1 General

TCL shall be as specified in the family specification.

5.3.8.2 Measurement

TCL shall be measured in accordance with IEC TR 61156-1-2. Both frequency domain and time domain (TDR/TDT) techniques may be used depending on the accuracy required.

5.3.9 Equal level transverse conversion transfer loss (ELTCTL)

5.3.9.1 General

ELTCTL shall be as specified in the family specification.

5.3.9.2 Measurement

TCTL shall be measured in accordance with IEC TR 61156-1-2. Both frequency domain and time domain (TDR/TDT) techniques may be used depending on the accuracy required.

5.3.10 Screening attenuation

Screening attenuation shall be as specified in the family specification and shall be measured in accordance with IEC 62153-4-4.

5.3.11 Coupling attenuation

Coupling attenuation shall be as specified in the family specification and shall be measured in accordance with IEC 62153-4-9. Alternatively, coupling attenuation may be verified by the combination of ELTCTL and screening attenuation verification.

5.4 Mechanical and dimensional requirements and test methods

5.4.1 General

Mechanical and dimensional requirements shall be as specified in the family specification.

5.4.2 Measurement of dimensions

The measurement of thickness and diameter shall be carried out in accordance with IEC 60811-201 and IEC 60811-203 respectively.