

# INTERNATIONAL STANDARD

**Multicore and symmetrical pair/quad cables for digital communications –  
Part 12: Symmetrical single pair cables with transmission characteristics up to  
600 MHz – Work area wiring – Sectional specification**

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INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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## CONTENTS

|                                                                      |    |
|----------------------------------------------------------------------|----|
| FOREWORD.....                                                        | 5  |
| 1 Scope.....                                                         | 7  |
| 2 Normative references .....                                         | 7  |
| 3 Terms and definitions .....                                        | 8  |
| 4 Installation considerations .....                                  | 8  |
| 4.1 General remarks .....                                            | 8  |
| 4.2 Bending radius of installed cable.....                           | 8  |
| 4.3 Climatic conditions.....                                         | 8  |
| 5 Materials and cable construction .....                             | 8  |
| 5.1 General remarks .....                                            | 8  |
| 5.2 Cable construction .....                                         | 9  |
| 5.3 Conductor .....                                                  | 9  |
| 5.4 Insulation .....                                                 | 9  |
| 5.5 Cable element.....                                               | 9  |
| 5.6 Screening of the cable element.....                              | 9  |
| 5.7 Cable make-up.....                                               | 9  |
| 5.8 Screening of the cable core .....                                | 9  |
| 5.9 Sheath .....                                                     | 9  |
| 5.10 Identification .....                                            | 10 |
| 5.11 Finished cable .....                                            | 10 |
| 6 Characteristics and requirements .....                             | 10 |
| 6.1 General remarks .....                                            | 10 |
| 6.2 Electrical characteristics and tests .....                       | 10 |
| 6.2.1 Conductor resistance.....                                      | 10 |
| 6.2.2 Resistance unbalance.....                                      | 10 |
| 6.2.3 Dielectric strength.....                                       | 11 |
| 6.2.4 Insulation resistance.....                                     | 11 |
| 6.2.5 Mutual capacitance.....                                        | 11 |
| 6.2.6 Capacitance unbalance .....                                    | 11 |
| 6.2.7 Transfer impedance.....                                        | 11 |
| 6.2.8 Coupling attenuation.....                                      | 11 |
| 6.2.9 Current-carrying capacity.....                                 | 12 |
| 6.3 Transmission characteristics .....                               | 12 |
| 6.3.1 Velocity of propagation (phase velocity).....                  | 12 |
| 6.3.2 Phase delay.....                                               | 12 |
| 6.3.3 Attenuation ( $\alpha$ ).....                                  | 12 |
| 6.3.4 Unbalance attenuation ( $TCL$ and $ELTCTL$ ).....              | 13 |
| 6.3.5 Alien (exogenous) near-end crosstalk ( $PS\ ANEXT$ ) .....     | 13 |
| 6.3.6 Alien (exogenous) far-end crosstalk ( $PS\ AACR-F$ ).....      | 14 |
| 6.3.7 Alien (exogenous) crosstalk of bundled cables .....            | 14 |
| 6.3.8 Impedance.....                                                 | 14 |
| 6.3.9 Return loss ( $RL$ ).....                                      | 14 |
| 6.4 Mechanical and dimensional characteristics and requirements..... | 15 |
| 6.4.1 Dimensional requirements .....                                 | 15 |
| 6.4.2 Elongation at break of the conductor.....                      | 15 |
| 6.4.3 Tensile strength of the insulation .....                       | 15 |

|                                                |                                                                                  |    |
|------------------------------------------------|----------------------------------------------------------------------------------|----|
| 6.4.4                                          | Elongation at break of the insulation .....                                      | 15 |
| 6.4.5                                          | Adhesion of the insulation to the conductor.....                                 | 15 |
| 6.4.6                                          | Elongation at break of the sheath .....                                          | 15 |
| 6.4.7                                          | Tensile strength of the sheath.....                                              | 15 |
| 6.4.8                                          | Crush test of the cable.....                                                     | 15 |
| 6.4.9                                          | Impact test of the cable .....                                                   | 15 |
| 6.4.10                                         | Bending under tension .....                                                      | 16 |
| 6.4.11                                         | Repeated bending of the cable .....                                              | 16 |
| 6.4.12                                         | Tensile performance of the cable.....                                            | 16 |
| 6.4.13                                         | Shock-test requirements of the cable .....                                       | 16 |
| 6.4.14                                         | Bump-test requirements of the cable .....                                        | 16 |
| 6.4.15                                         | Vibration-test requirements of a cable .....                                     | 16 |
| 6.5                                            | Environmental characteristics .....                                              | 16 |
| 6.5.1                                          | Shrinkage of insulation .....                                                    | 16 |
| 6.5.2                                          | Wrapping test of insulation after thermal ageing .....                           | 16 |
| 6.5.3                                          | Bending test of insulation at low temperature.....                               | 16 |
| 6.5.4                                          | Elongation at break of the sheath after ageing.....                              | 16 |
| 6.5.5                                          | Tensile strength of the sheath after ageing .....                                | 16 |
| 6.5.6                                          | Sheath pressure test at high temperature .....                                   | 16 |
| 6.5.7                                          | Cold bend test of the cable .....                                                | 17 |
| 6.5.8                                          | Heat shock test.....                                                             | 17 |
| 6.5.9                                          | Damp heat steady state .....                                                     | 17 |
| 6.5.10                                         | Solar radiation (UV test) .....                                                  | 17 |
| 6.5.11                                         | Solvents and contaminating fluids.....                                           | 17 |
| 6.5.12                                         | Salt mist and sulphur dioxide.....                                               | 17 |
| 6.5.13                                         | Water immersion .....                                                            | 17 |
| 6.5.14                                         | Hygroscopicity .....                                                             | 17 |
| 6.5.15                                         | Wicking.....                                                                     | 17 |
| 6.5.16                                         | Flame propagation characteristics of a single cable .....                        | 17 |
| 6.5.17                                         | Flame propagation characteristics of bunched cables .....                        | 17 |
| 6.5.18                                         | Halogen gas evolution .....                                                      | 17 |
| 6.5.19                                         | Smoke generation.....                                                            | 17 |
| 6.5.20                                         | Toxic gas emission .....                                                         | 18 |
| 6.5.21                                         | Integrated fire test method for cables in environmental air handling spaces..... | 18 |
| 7                                              | Bundled cable requirements .....                                                 | 18 |
| 7.1                                            | General.....                                                                     | 18 |
| 7.2                                            | Single pairs sharing one sheath .....                                            | 18 |
| 7.2.1                                          | General .....                                                                    | 18 |
| 7.2.2                                          | Near-end crosstalk ( <i>NEXT</i> ).....                                          | 18 |
| 7.2.3                                          | Attenuation to crosstalk ratio far-end ( <i>PS ACR-F</i> ) .....                 | 18 |
| Annex A (informative)                          | Blank detail specification .....                                                 | 20 |
| Bibliography                                   | .....                                                                            | 25 |
| Table 1 – Transfer impedance .....             |                                                                                  | 11 |
| Table 2 – Coupling attenuation .....           |                                                                                  | 12 |
| Table 3 – Attenuation equation constants ..... |                                                                                  | 13 |
| Table 4 – <i>TCL</i> requirements .....        |                                                                                  | 13 |

|                                                                |    |
|----------------------------------------------------------------|----|
| Table 5 – <i>ELTCTL</i> requirements .....                     | 13 |
| Table 6 – <i>PS ANEXT</i> requirements .....                   | 14 |
| Table 7 – <i>PS AACR-F</i> requirements .....                  | 14 |
| Table 8 – <i>RL</i> requirements .....                         | 15 |
| Table 9 – <i>NEXT</i> and <i>PS NEXT</i> requirements .....    | 18 |
| Table 10 – <i>ACR-F</i> and <i>PS ACR-F</i> requirements ..... | 19 |

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES  
FOR DIGITAL COMMUNICATIONS –****Part 12: Symmetrical single pair cables with transmission characteristics  
up to 600 MHz – Work area wiring – Sectional specification**

## FOREWORD

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International Standard IEC 61156-12 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:

| CDV          | Report on voting |
|--------------|------------------|
| 46C/1136/CDV | 46C/1152/RVC     |

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 61156 series, published under the general title *Multicore and symmetrical pair/quad 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,
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- amended.

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## MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

### Part 12: Symmetrical single pair cables with transmission characteristics up to 600 MHz – Work area wiring – Sectional specification

#### 1 Scope

This part of IEC 61156 describes cables intended to be used for transmission of 1 Gbit/s over a single twisted pair for office, home and industrial application. An example of an existing application is 1000BASE-T1; see ISO/IEC TR 11801-9906. The transmission characteristics of these cables are specified up to a frequency of 600 MHz and at a temperature of 20 °C. The cable type recognised is intended to be used for the work area wiring of shielded channels with a nominal length of 40 m. Possible designs are U/FTP, X/UTP and X/FTP, where X stands for F, S or SF.

These cables can comprise more than one pair in case several systems are operated in parallel. In this case, refer to Clause 7 of this document.

The cables covered by this document are intended to operate with voltages and currents normally encountered in communication systems. While these cables are not intended to be used in conjunction with low impedance sources, e.g. the electric power supplies of public utility mains, they are intended to be used to support the delivery of low voltage remote powering applications.

Annex A provides a blank detail specification (BDS) that can be used to summarize design and performance requirements agreed upon between the supplier and the user of a specific cable type.

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

IEC 61156-1:2007, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*  
IEC 61156-1:2007/AMD1:2009<sup>1</sup>

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

IEC 62153-4-5, *Metallic communication cables test methods – Part 4-5: Electromagnetic compatibility (EMC) – Coupling or screening attenuation – Absorbing clamp method*

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<sup>1</sup> A consolidated edition 3.1 of this publication exists, comprising IEC 61156-1:2007 and IEC 61156-1:2007/AMD1:2009.

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

ISO/IEC TS 29125:2017, *Information technology – Telecommunications cabling requirements for remote powering of terminal equipment*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61156-1:2007 and in IEC 61156-1:2007/AMD1:2009 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>

### 4 Installation considerations

#### 4.1 General remarks

Installation area considerations are defined in Clause 4 of IEC 61156-1:2007. Other areas may be considered.

#### 4.2 Bending radius of installed cable

The maximum value of the minimum bending radius shall be four times the cable diameter unless otherwise specified.

#### 4.3 Climatic conditions

Under static conditions, the cable shall operate at least in the temperature range of the environment from  $-20\text{ }^{\circ}\text{C}$  to  $+60\text{ }^{\circ}\text{C}$ .

The attenuation increase due to the elevated operating temperature (temperature of the environment) is described in 6.3.3.2.

In the case of application of remote powering, the maximum temperature of the conductor shall not exceed the maximum operation temperature under static conditions in order to maintain the integrity of the dielectric material performance which is aligned to environmental temperature range.

Extended temperature ranges are permitted and may be specified in the relevant detail specification.

### 5 Materials and cable construction

#### 5.1 General remarks

The choice of materials and cable construction shall be suitable for the intended application and installation of the cable and in line with the requirements of IEC 61156-1:2007. Particular care shall be taken to meet any requirements for EMC and fire performance (such as burning properties, smoke generation, evolution of halogen gas).

## 5.2 Cable construction

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

## 5.3 Conductor

The conductor shall be a stranded or solid annealed copper conductor in accordance with 5.2.1 of IEC 61156-1:2007 and should have a nominal diameter between 0,4 mm and 0,65 mm. A conductor diameter of up to 1,0 mm may be used.

## 5.4 Insulation

The conductor shall be insulated with a suitable material. Examples of suitable materials are

- polyolefin,
- fluoropolymer, and
- low-smoke zero-halogen thermoplastic material.

The colour code shall be in accordance with IEC 60708 if not specified differently in the relevant detail specification.

## 5.5 Cable element

The cable element shall be a pair and shall be twisted. The entire cable may comprise more than one cable element, see 6.3.5 and Clause 7.

## 5.6 Screening of the cable element

When required, the screen for the cable element shall be in accordance with 5.2.3.2 of IEC 61156-1:2007.

## 5.7 Cable make-up

Spacers may be used in the cable elements and to separate cable elements. The cable elements and their screens, in case they are screened, may be covered by an intermediate jacket. This jacket shall be in accordance with 5.9 of this document. The core of the cable may be wrapped with a protective layer of non-hygroscopic and non-wicking material.

## 5.8 Screening of the cable core

When required, a screen for the cable core shall be provided. The screen shall be in accordance with 5.2.5 of IEC 61156-1:2007.

## 5.9 Sheath

The sheath material shall consist of a suitable material. Examples of suitable materials are

- polyolefin,
- PVC,
- fluoropolymer, and
- low-smoke zero-halogen thermoplastic material.

The sheath shall be continuous, having a thickness as uniform as possible. A non-metallic ripcord may be provided. When provided, the ripcord shall be non-hygroscopic and non-wicking.

The colour of the sheath is not specified but it should be specified in the relevant detail specification

### 5.10 Identification

Each length of cable shall be identified as to the supplier and, when required, a traceability code, using one of the following methods:

- appropriately coloured threads or tapes;
- a printed tape;
- printing on the cable core wrapping;
- marking on the sheath.

Additional markings, such as length marking, are permitted. If used, such markings shall refer to this document.

### 5.11 Finished cable

The finished cable shall be adequately protected for storage and shipment.

## 6 Characteristics and requirements

### 6.1 General remarks

Clause 6 lists the characteristics and minimum requirements of a cable complying with this document. Test methods shall be in accordance with Clause 6 of IEC 61156-1:2007 and IEC 61156-1:2007/AMD1:2009, except for the length of the cable under test which shall be as specified in Clause 6 of this document.

The computed requirements in dB, rounded to one decimal place, shall be used to determine compliance.

The tests for electrical characteristics according to 6.2 shall be carried out on a cable length of not less than 100 m, unless otherwise specified.

The tests for transmission characteristics according to 6.3 shall be carried out on a cable length of 100 m, unless otherwise specified. For a better accuracy in high frequencies, the cable length may be reduced to 50 m unless the test is performed with very sensitive test equipment.

### 6.2 Electrical characteristics and tests

#### 6.2.1 Conductor resistance

The maximum conductor resistance at or corrected to 20 °C shall not exceed 145  $\Omega$ /km.

#### 6.2.2 Resistance unbalance

##### 6.2.2.1 Resistance unbalance within a pair

The resistance unbalance shall not exceed 2,0 %.

##### 6.2.2.2 Resistance unbalance between pairs

Not applicable.

### 6.2.3 Dielectric strength

There shall be no failures when a test is performed on conductor/conductor and, where screen(s) are present, a conductor/screen with 1,0 kV DC for 1 min or, alternatively, with 2,5 kV DC for 2 s. An AC voltage may be used. The AC voltage levels in these cases shall be 0,7 kV AC for 1 min or, alternatively, 1,7 kV AC for 2 s.

### 6.2.4 Insulation resistance

The test shall be performed on:

- conductor/conductor;
- conductor/screen.

The minimum insulation resistance at or corrected to 20 °C shall be not less than 5 GΩ·km.

### 6.2.5 Mutual capacitance

The mutual capacitance is not specified but may be indicated in the relevant detail specification.

### 6.2.6 Capacitance unbalance

The maximum capacitance unbalance pair to ground shall not exceed 1 600 pF/km at a frequency of 800 Hz or 1 000 Hz.

### 6.2.7 Transfer impedance

Two grades of performance are recognised for transfer impedance. The transfer impedance measured in accordance with IEC 62153-4-3 shall not exceed the values of at least one grade shown in Table 1.

**Table 1 – Transfer impedance**

| Frequency range<br>MHz            | Maximum surface transfer impedance<br>mΩ/m |                                     |
|-----------------------------------|--------------------------------------------|-------------------------------------|
|                                   | Grade 1                                    | Grade 2                             |
| 1 to 10                           | $Z_t \leq 15 \cdot (f)^{-0,176}$           | $Z_t \leq 50 \cdot (f)^{0,301}$     |
| 10 to 30                          | $Z_t \leq 10 \cdot \frac{f}{10}$           | $Z_t \leq 23,392 \cdot (f)^{0,631}$ |
| <i>f</i> is the frequency in MHz. |                                            |                                     |

### 6.2.8 Coupling attenuation

Coupling attenuation shall be measured using either the absorbing clamp method (IEC 62153-4-5) or the triaxial method for screened cables (IEC 62153-4-9). When measured using one of these methods, the coupling attenuation in the frequency range from  $f = 30$  MHz to 1 000 MHz shall meet the requirements of Type I, Type Ib or Type II indicated in Table 2.

**Table 2 – Coupling attenuation**

| Coupling attenuation type | Frequency range<br>MHz | Coupling attenuation<br>dB                    |
|---------------------------|------------------------|-----------------------------------------------|
| Type I                    | 30 to 100              | $\geq 85$                                     |
|                           | 100 to 1 000           | $\geq 85 - 20 \log_{10} (f/100)$ ; $f$ in MHz |
| Type Ib                   | 30 to 100              | $\geq 70$                                     |
|                           | 100 to 1 000           | $\geq 70 - 20 \log_{10} (f/100)$ ; $f$ in MHz |
| Type II                   | 30 to 100              | $\geq 55$                                     |
|                           | 100 to 1 000           | $\geq 55 - 20 \log_{10} (f/100)$ ; $f$ in MHz |

### 6.2.9 Current-carrying capacity

The maximum current-carrying capacity is installation dependent and therefore not specified but may be indicated in the relevant detail specification. Further guidance with respect to current carrying capacity is provided by ISO/IEC TS 29125:2017.

## 6.3 Transmission characteristics

### 6.3.1 Velocity of propagation (phase velocity)

The requirements are not specified but may be indicated in the relevant detail specification.

### 6.3.2 Phase delay

The phase delay,  $\tau$ , shall not exceed the value obtained from Formula (1) in the frequency range from 4 MHz to 600 MHz.

$$\tau = 534 + \frac{36}{\sqrt{f}} \quad (1)$$

where

$\tau$  is the phase delay in ns/100 m;

$f$  is the frequency in MHz.

### 6.3.3 Attenuation ( $\alpha$ )

#### 6.3.3.1 Attenuation at 20 °C operating temperature

The maximum attenuation,  $\alpha$ , of any pair in the frequency range indicated in Table 3 shall not exceed the value obtained from Formula (2).

$$\alpha = a\sqrt{f} + bf + c/\sqrt{f} \quad (2)$$

where

$\alpha$  is the attenuation expressed in dB/100 m;

$a, b, c$  are constants indicated in Table 3;

$f$  is the frequency expressed in MHz.

**Table 3 – Attenuation equation constants**

| Frequency range<br>MHz | Constants |          |          |
|------------------------|-----------|----------|----------|
|                        | <i>a</i>  | <i>b</i> | <i>c</i> |
| 1 to 600               | 2,7       | 0,007 5  | 0,375    |

**6.3.3.2 Attenuation at elevated operating temperature**

The increase of the maximum attenuation from Formula (2) due to elevated environmental temperature above 20 °C is obtained by calculation as follows:

- for screened cables: 0,2 %/°C in the temperature range 20 °C to 60 °C;
- for other types of screened cables where the cable elements are surrounded by an intermediate sheath or bedding material: 0,4 %/°C, for the temperature range from 20 °C to 40 °C and 0,6 %/°C for the temperature range 40 °C to 60 °C.

In the event of application of remote powering, the actual conductor temperature should be considered in order to calculate the attenuation increase. If an extended environmental temperature range is specified (see 4.3), the temperature coefficients given in this paragraph might not be applicable. The method provided in IEC 61156-1:2007 should be used to determine temperature coefficients in this case.

**6.3.4 Unbalance attenuation (*TCL* and *ELTCTL*)**

The minimum near-end unbalance attenuation (transverse conversion loss or *TCL*) shall not be less than the value obtained from Table 4.

**Table 4 – *TCL* requirements**

| Frequency range<br>MHz | <i>TCL</i> requirements<br>dB                              |
|------------------------|------------------------------------------------------------|
| 1 to 600               | $50 - 15 \log_{10}(f)$ ; <i>f</i> in MHz;<br>40 dB maximum |

The minimum equal-level far-end unbalance attenuation (equal-level transverse conversion transfer loss or *ELTCTL*) shall not be less than the value obtained from Table 5.

**Table 5 – *ELTCTL* requirements**

| Frequency range<br>MHz | <i>ELTCTL</i><br>dB                                       |
|------------------------|-----------------------------------------------------------|
| 1 to 600               | $40 - 20 \log_{10}(f)$ ; <i>f</i> in MHz;<br>5 dB minimum |

For calculation of *ELTCTL*, the *TCTL* and the attenuation measurement of the test specimen with the same length defined in 6.1 shall be used.

**6.3.5 Alien (exogenous) near-end crosstalk (*PS ANEXT*)**

The *PS ANEXT* (power sum alien near-end crosstalk) of the cable when tested in accordance with 6.3.7.1 of IEC 61156-1:2007 shall be not less than the values obtained from Table 6.

**Table 6 – *PS ANEXT* requirements**

| Frequency range<br>MHz | <i>PS ANEXT</i><br>dB |
|------------------------|-----------------------|
| 1 to 100               | 67                    |
| 100 to 600             | 67                    |

For screened cables meeting the requirements of 6.2.7 and 6.2.8 (minimum Type Ib), *ANEXT* is proven by design.

### 6.3.6 Alien (exogenous) far-end crosstalk (*PS AACR-F*)

The *PS AACR-F* (power-sum alien attenuation to crosstalk ratio far-end) of the cable when tested in accordance with 6.3.8 of IEC 61156-1:2007 shall not be less than the values obtained from Table 7.

**Table 7 – *PS AACR-F* requirements**

| Frequency range<br>MHz | <i>PS AACR-F</i><br>dB               |
|------------------------|--------------------------------------|
| 1 to 600               | $103 - 20 \log_{10}(f)$ ; $f$ in MHz |

For those frequencies where the calculated limit value of *PS AACR-F* is greater than 80 dB, the requirement shall be 80 dB.

If *AFEXT* up to 600 MHz is greater than 90 dB, *PS AACR-F* may not be calculated.

For calculation of *AACR-F*, the *AFEXT* and the attenuation measurement of the test specimen with the same length defined in 6.1 shall be used.

For screened cables meeting the requirements of 6.2.7 and 6.2.8 (minimum Type Ib), *AFEXT* is proven by design.

### 6.3.7 Alien (exogenous) crosstalk of bundled cables

The relevant requirements of this document – especially those of 6.3.5 and 6.3.6 – apply.

### 6.3.8 Impedance

The fitted or mean characteristic impedance measured in accordance with 6.3.10.2 or 6.3.10.3 of IEC 61156-1/AMD1:2009 shall be  $100 \Omega \pm 5 \Omega$  at 100 MHz. A measurement of the input impedance is not enough to ensure return loss limits.

When using a balun-less measurement technique, the corresponding descriptions of IEC TR 61156-1-2 may be considered. Recommendations contained in IEC TR 61156-1-5 for improvement of measurement uncertainty by correction technique may be considered.

### 6.3.9 Return loss (*RL*)

The minimum return loss of any pair in the frequency range indicated in Table 8 shall not be less than the values in Table 8.

**Table 8 – *RL* requirements**

| Frequency range<br>MHz | <i>RL</i><br>dB                                             |
|------------------------|-------------------------------------------------------------|
| 1 to 10                | $20 + 5 \log_{10}(f)$ ; $f$ in MHz                          |
| 10 to 20               | 25                                                          |
| 20 to 600              | $25 - 8,6 \log_{10}(f/20)$ ; $f$ in MHz;<br>15,6 dB minimum |

When using a balun-less measurement technique, the corresponding descriptions of IEC TR 61156-1-2 may be considered. Recommendations contained in IEC TR 61156-1-5 for improvement of measurement uncertainty by correction technique may be considered.

## **6.4 Mechanical and dimensional characteristics and requirements**

### **6.4.1 Dimensional requirements**

The overall diameter of insulation, the nominal thickness of the sheath and the maximum overall diameter of the sheath are not specified, but shall be indicated in the relevant detail specification.

### **6.4.2 Elongation at break of the conductor**

The minimum elongation of the conductor shall be not less than 8 %.

### **6.4.3 Tensile strength of the insulation**

The tensile strength of the insulation is not specified, but may be indicated in the relevant detail specification.

### **6.4.4 Elongation at break of the insulation**

The minimum value of the elongation at break of the insulation shall be not less than 100 %.

### **6.4.5 Adhesion of the insulation to the conductor**

The adhesion of the insulation to the conductor is not specified, but may be indicated in the relevant detail specification.

### **6.4.6 Elongation at break of the sheath**

The minimum value of the elongation at break of any sheath shall be not less than 100 %.

### **6.4.7 Tensile strength of the sheath**

The minimum tensile strength of any sheath shall be not less than 9 MPa.

### **6.4.8 Crush test of the cable**

The crush resistance of the cable is not specified but may be indicated in the relevant detail specification.

### **6.4.9 Impact test of the cable**

The impact resistance of the cable is not specified but may be indicated in the relevant detail specification.

#### **6.4.10 Bending under tension**

The bending performance of the cable is not specified but may be indicated in the relevant detail specification.

#### **6.4.11 Repeated bending of the cable**

Not applicable.

#### **6.4.12 Tensile performance of the cable**

The tensile strength of the cable is not specified but may be indicated in the relevant detail specification.

#### **6.4.13 Shock-test requirements of the cable**

Not applicable.

#### **6.4.14 Bump-test requirements of the cable**

Not applicable.

#### **6.4.15 Vibration-test requirements of a cable**

Not applicable.

### **6.5 Environmental characteristics**

#### **6.5.1 Shrinkage of insulation**

When tested at  $(100 \pm 2) ^\circ\text{C}$  for 1 h, the shrinkage of the insulation shall not exceed 5 %. The length of the sample shall be 150 mm, and the shrink-back shall be measured as the sum from both ends.

#### **6.5.2 Wrapping test of insulation after thermal ageing**

Not applicable.

#### **6.5.3 Bending test of insulation at low temperature**

The bending test of the insulated conductor shall be carried out at  $(-20 \pm 2) ^\circ\text{C}$ . The mandrel diameter shall be 6 mm. There shall be no cracks in the insulation.

#### **6.5.4 Elongation at break of the sheath after ageing**

The ageing regime shall be seven days at  $(100 \pm 2) ^\circ\text{C}$ . The elongation shall not be less than 50 % of the unaged value.

#### **6.5.5 Tensile strength of the sheath after ageing**

The ageing regime shall be seven days at  $(100 \pm 2) ^\circ\text{C}$ . The tensile strength shall be not less than 70 % of the unaged value.

#### **6.5.6 Sheath pressure test at high temperature**

Not applicable.

**6.5.7 Cold bend test of the cable**

The bending test shall be carried out at  $(-20 \pm 2) ^\circ\text{C}$ . The mandrel diameter shall be eight times the overall diameter of the cable. There shall be no cracks in the sheath.

**6.5.8 Heat shock test**

Not applicable.

**6.5.9 Damp heat steady state**

Not applicable.

**6.5.10 Solar radiation (UV test)**

The resistance to solar radiation is not specified but may be specified in the relevant detail specification.

**6.5.11 Solvents and contaminating fluids**

The resistance to solvents and contaminating fluids is not specified but may be specified in the relevant detail specification.

**6.5.12 Salt mist and sulphur dioxide**

Not applicable.

**6.5.13 Water immersion**

Not applicable.

**6.5.14 Hygroscopicity**

The amount of moisture gained after 3 h shall not exceed 1 % in mass.

**6.5.15 Wicking**

The test solution shall not wet the filter paper at the end of 6 h.

**6.5.16 Flame propagation characteristics of a single cable**

If required by local regulations and/or indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1 unless regional or local regulations apply.

**6.5.17 Flame propagation characteristics of bunched cables**

If required by local regulations and/or indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1 unless regional or local regulations apply.

**6.5.18 Halogen gas evolution**

If required by local regulations and/or indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1 unless regional or local regulations apply.

**6.5.19 Smoke generation**

If required by local regulations and/or indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1 unless regional or local regulations apply.

### 6.5.20 Toxic gas emission

If required by local regulations and/or indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1 unless regional or local regulations apply.

### 6.5.21 Integrated fire test method for cables in environmental air handling spaces

If required by local regulations and/or indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1 unless regional or local regulations apply.

## 7 Bundled cable requirements

### 7.1 General

In bundled cables, break-out cables or cable harnesses, several one-pair cables as described in this specification may be bundled. Such arrangements shall be specified in a detail specification agreed on by the manufacturer and the customer. Relevant safety regulations in addition to this document shall be taken into account. The limits for alien crosstalk shall apply for the crosstalk between the one-pair cables as described in this document.

### 7.2 Single pairs sharing one sheath

#### 7.2.1 General

In the event that several pairs are operating in parallel in a multi-pair cable, the crosstalk between the pairs shall be considered. The most obvious case of four-pair cables is assumed in 7.2 for the requirements of near-end and far-end crosstalk. In case of a different pair-count, the applicable power sum requirements shall be met in order to achieve similar noise levels.

#### 7.2.2 Near-end crosstalk (*NEXT*)

The requirements of this subclause apply to four-pair cables only. If applicable, the worst near-end crosstalk shall not be less than the values indicated in Table 9.

**Table 9 – *NEXT* and *PS NEXT* requirements**

| Frequency range<br>MHz | <i>NEXT</i> requirement<br>dB             | <i>PS NEXT</i> requirement<br>dB          |
|------------------------|-------------------------------------------|-------------------------------------------|
| 1 to 600               | $111,7 - 15 \log_{10}(f)$ ;<br>$f$ in MHz | $108,7 - 15 \log_{10}(f)$ ;<br>$f$ in MHz |

For those frequencies where the calculated value of *NEXT* is greater than 78 dB, the requirement shall be 78 dB. For those frequencies where the calculated value of *PS NEXT* is greater than 75 dB, the requirement shall be 75 dB.

#### 7.2.3 Attenuation to crosstalk ratio far-end (*PS ACR-F*)

The requirements of this subclause apply to four-pair cables only. If applicable, the pair-to-pair *ACR-F* in dB for any combination shall be greater than or equal to that obtained from Table 10.

**Table 10 – *ACR-F* and *PS ACR-F* requirements**

| Frequency range<br>MHz | <i>ACR-F</i> requirement<br>dB          | <i>PS ACR-F</i> requirement<br>dB       |
|------------------------|-----------------------------------------|-----------------------------------------|
| 1 to 600               | $99 - 20 \log_{10} (f)$ ;<br>$f$ in MHz | $96 - 20 \log_{10} (f)$ ;<br>$f$ in MHz |

For calculation of *ACR-F*, the *FEXT* and the attenuation measurement of the test specimen with the same length defined in 6.1 shall be used.

For those frequencies where the calculated limit value of *ACR-F* is greater than 78 dB, the requirement shall be 78 dB. For those frequencies where the calculated value of *PS ACR-F* is greater than 75 dB, the requirement shall be 75 dB.

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## Annex A (informative)

### Blank detail specification

The blank detail specification determines the layout and style for detail specifications describing symmetrical single pair cables with transmission characteristics up to 600 MHz. Detail specifications, based on the blank detail specification, may be prepared by a national organization, a manufacturer, or a user. The detail specification shall be written in accordance with the layout of the blank detail specification described here.

This blank detail specification includes additional recommended environmental characteristics and severities, which are derived from the environmental classifications that are specified for cabling for various environments.

NOTE Environmental classifications are presented in ISO/IEC 11801-1 with three levels of severity in four areas: mechanical, ingress, climatic, and electromagnetic; thus, in tabular form, they are referred to as the "MICE table".

The numbers shown in brackets in Annex A correspond to the following items of required information, which shall be entered in the spaces provided.

- [1] Name and address of the organization that has prepared the document.
- [2] IEC document number, issue number and date of issue.
- [3] Address of the organization from which the document is available.
- [4] Related documents.
- [5] Any other reference to the cable: national reference, trade name, etc.
- [6] A complete description of the cable which shall include:
  - a) type and number of elements;
  - b) nominal impedance;
  - c) screening;
  - d) application;
  - e) other distinguishing performance characteristics.
- [7] Details of the cable material and construction.
- [8] Special requirements for bending radius or operating temperatures.
- [9] List of cable characteristics. They are separated into electrical, transmission, mechanical and environmental characteristics.
- [10] Appropriate subclause references to sectional specification IEC 61156-12.
- [11] Requirements applicable to this cable. The values entered shall meet as a minimum the requirements of sectional specification IEC 61156-12.
- [12] Comments – Relevant remarks.

|                                                                                                                                                                                |                             |                                                                                                                                           |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|----------|
| [1] Prepared by:                                                                                                                                                               |                             | [2] Document:<br>Issue:<br>Date:                                                                                                          |          |
| [3] Available from:                                                                                                                                                            |                             | [4] Generic specification: IEC 61156-1<br>Sectional specification: IEC 61156-12<br>Blank detail specification: IEC 61156-12:2021, Annex A |          |
| [5] Additional references:                                                                                                                                                     |                             |                                                                                                                                           |          |
| [6] Cable description:<br>a) Type and number of elements:<br>b) Nominal impedance:<br>c) Screening:<br>d) Application:<br>e) Other distinguishing performance characteristics: |                             |                                                                                                                                           |          |
| <b>[7] Cable construction:</b>                                                                                                                                                 | Subclause                   |                                                                                                                                           | Comments |
|                                                                                                                                                                                | 5.2                         | Cable construction:                                                                                                                       |          |
|                                                                                                                                                                                | 5.3                         | Conductor description:                                                                                                                    |          |
|                                                                                                                                                                                | 5.4                         | Insulation description:<br>Maximum diameter:<br>Colour code of elements:                                                                  |          |
|                                                                                                                                                                                | 5.5                         | Cable element:                                                                                                                            |          |
|                                                                                                                                                                                | 5.6                         | Screening of the cable element:<br>Tape material<br>Minimum overlap<br>Drain wire<br>Braid wire<br>Braid material                         |          |
|                                                                                                                                                                                | 5.7                         | Cable make-up:                                                                                                                            |          |
|                                                                                                                                                                                | 5.8                         | Screening of the cable core:<br>Tape material<br>Minimum overlap<br>Drain wire<br>Braid wire<br>Braid material                            |          |
|                                                                                                                                                                                | 5.9                         | Sheath<br>Material<br>Nominal thickness<br>Colour<br>Maximum overall diameter<br>Marking<br>Ripcord                                       |          |
|                                                                                                                                                                                | 5.10                        | Identification                                                                                                                            |          |
| 5.11                                                                                                                                                                           | Packaging of finished cable |                                                                                                                                           |          |

| <p>[8]</p> <p>Minimum bending radius for static bending:</p> <p>Minimum bending radius for dynamic bending:</p> <p>Temperature range for installation:</p> <p>Operating temperature range under static conditions:</p> <p>C1: -10 °C to +60 °C</p> <p>C2: -25 °C to +70 °C</p> <p>C3: -40 °C to +70 °C</p> |                   |                                          |                                                                                                                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| [9]<br>Characteristics                                                                                                                                                                                                                                                                                     | [10]<br>Subclause | [11]                                     | Comments                                                                                                            |
| <b>Electrical characteristics</b>                                                                                                                                                                                                                                                                          | 6.2               |                                          |                                                                                                                     |
| Conductor resistance                                                                                                                                                                                                                                                                                       | 6.2.1             | $\leq \dots \Omega/\text{km}$            |                                                                                                                     |
| Resistance unbalance                                                                                                                                                                                                                                                                                       | 6.2.2             |                                          |                                                                                                                     |
| Resistance unbalance within a pair                                                                                                                                                                                                                                                                         | 6.2.2.1           | $\leq \dots \%$                          |                                                                                                                     |
| Resistance unbalance between pairs                                                                                                                                                                                                                                                                         | 6.2.2.2           | $\leq \dots \%$                          |                                                                                                                     |
| Dielectric strength                                                                                                                                                                                                                                                                                        |                   |                                          |                                                                                                                     |
| Conductor/conductor                                                                                                                                                                                                                                                                                        | 6.2.3             | $\dots \text{ kV (time of application)}$ |                                                                                                                     |
| Conductor/screen                                                                                                                                                                                                                                                                                           | 6.2.3             | $\dots \text{ kV (time of application)}$ |                                                                                                                     |
| Insulation resistance                                                                                                                                                                                                                                                                                      |                   |                                          |                                                                                                                     |
| Conductor/conductor                                                                                                                                                                                                                                                                                        | 6.2.4             | $\geq \dots \text{ M}\Omega \text{ km}$  |                                                                                                                     |
| Conductor/screen                                                                                                                                                                                                                                                                                           | 6.2.4             | $\geq \dots \text{ M}\Omega \text{ km}$  |                                                                                                                     |
| Mutual capacitance                                                                                                                                                                                                                                                                                         | 6.2.5             | $\leq \dots \text{ nF/km}$               |                                                                                                                     |
| Capacitance unbalance pair to ground                                                                                                                                                                                                                                                                       | 6.2.6             | $\leq \dots \text{ pF/km}$               |                                                                                                                     |
| Transfer impedance                                                                                                                                                                                                                                                                                         | 6.2.7             |                                          | Cable should be according to Grade 1 or Grade 2, if screened.                                                       |
| Coupling attenuation                                                                                                                                                                                                                                                                                       | 6.2.8             | $\dots \text{ dB}$<br>Cable type.....    | Cable type should be Type I, Ib or II.                                                                              |
| Current-carrying capacity                                                                                                                                                                                                                                                                                  | 6.2.9             | $\dots \text{ mA}$                       | The current carrying capacity is dependent on the installation conditions in accordance with ISO/IEC TS 29125:2017. |
| <b>Transmission characteristics</b>                                                                                                                                                                                                                                                                        | 6.3               |                                          |                                                                                                                     |
| Velocity of propagation                                                                                                                                                                                                                                                                                    | 6.3.1             |                                          |                                                                                                                     |
| Phase delay                                                                                                                                                                                                                                                                                                | 6.3.2             | $\leq \dots \text{ ns/100 m}$            |                                                                                                                     |
| Attenuation                                                                                                                                                                                                                                                                                                | 6.3.3             |                                          |                                                                                                                     |
| General figures                                                                                                                                                                                                                                                                                            | 6.3.3.1           | $\leq \dots \text{ dB/100 m}$            |                                                                                                                     |
| Environmental temperature effects                                                                                                                                                                                                                                                                          | 6.3.3.2           | $\leq \dots \text{ }^\circ\text{C}$      |                                                                                                                     |
| Unbalance attenuation near-end (TCL)                                                                                                                                                                                                                                                                       | 6.3.4             | $\geq \dots \text{ dB}$                  | Cable grade shall be identified.                                                                                    |
| Unbalance attenuation far-end (EL TCL)                                                                                                                                                                                                                                                                     | 6.3.4             | $\geq \dots \text{ dB}$                  |                                                                                                                     |
| Power sum alien (exogenous) near-end crosstalk                                                                                                                                                                                                                                                             | 6.3.5             | $\geq \dots \text{ dB}$                  |                                                                                                                     |