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INTERNATIONAL STANDARD

Multicore and symmetrical pair/quad cables for digital communications – Part 13: Symmetrical single pair cables with transmission characteristics up to 20 MHz – Horizontal floor wiring – Sectional specification

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CONTENTS

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MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

Part 13: Symmetrical single pair cables with transmission characteristics up to 20 MHz – Horizontal floor wiring – Sectional specification

FOREWORD

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IEC 61156-13 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. It is an International Standard.

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

Draft	Report on voting
46C/1256/FDIS	46C/1260/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 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 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- withdrawn,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.

MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

Part 13: Symmetrical single pair cables with transmission characteristics up to 20 MHz – Horizontal floor wiring – Sectional specification

1 Scope

This part of IEC 61156 describes cables intended to be used for transmission of 10 Mbit/s over a single twisted pair and distances of up to 1 km. The transmission characteristics of these cables are specified up to a frequency of 20 MHz and at a temperature of 20 °C. Depending on the MICE environment and the installation conditions, either unscreened or screened cables can be used. Furthermore, to consider different maximum transmission lengths, two sets of requirements are specified. The cable type A-1000 is a design supporting up to 1 km channel length while the cable type A-400 is supporting up to 400 m channel length. A blank detail specification can be found in Annex A.

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, for example the electric power supplies of public utility mains, they are intended to be used to support the delivery of DC low voltage remote powering applications.

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

IEC TS 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 61156-5, *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Horizontal floor wiring – Sectional specification*

IEC 62153-4-3, *Metallic communication cable test methods – Part 4-3: Electromagnetic compatibility (EMC) – Surface transfer impedance – 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 terms and definitions given in IEC 61156-1 apply.

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

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

4 Installation considerations

4.1 General remarks

Installation area considerations are defined in IEC 61156-1. 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 in the relevant detail specification.

4.3 Climatic conditions

Under static conditions, the cable shall operate at least in the temperature range of the environment from −20 °C to +60 °C.

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

When applications demand remote powering, the maximum temperature of the conductor shall not exceed the maximum operating temperature of the cable. Dielectric performance can be changed permanently due to over exposure of high temperatures.

Extended temperature ranges are permitted but might cause safety issues. An extended temperature range may be specified in the relevant detail specification.

5 Materials and cable construction

5.1 General remarks

For the purposes of this document, the respective requirements of IEC 61156-5 apply.

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. Any requirements for EMC and fire performance (such as burning properties, smoke generation, evolution of halogen gas) shall be met. Regional regulations can apply as well.

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 solid or stranded annealed copper conductor in accordance with IEC 61156-1 and should have a nominal diameter between 0,58 mm and 1,7 mm.

5.4 Insulation

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

– polyolefin,
– fluoropolymer, and
– low-smoke halogen-free thermoplastic material.

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

5.5 Cable element

The cable element shall be a pair and shall be twisted. A third insulated wire may be twisted together with the pair for earthing and grounding purposes.

5.6 Screening of the cable element

If screened, the screen of the cable element shall be in accordance with IEC 61156-1.

5.7 Cable make-up

Bedding material may be used in the cable element to separate the cable element from other design elements (e.g. braid, armouring). The cable element and its screen may be covered by an intermediate jacket. This jacket shall be in accordance with 5.9. 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

If screened, the screen of the cable core shall be in accordance with IEC 61156-1.

5.9 Sheath

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

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

The sheath shall be continuous. 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,
– with a printed tape,
– printing on the cable core wrapping,
– marking on the sheath.

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

5.11 Finished cable

The finished cable shall be protected for storage and transport as specified in the relevant detail specification.

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 IEC 61156-1, except for the length of the cable under test which shall be as specified below. If balun-less testing is used, it should be in accordance with IEC TS 61156-1-2.

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

The tests for electrical characteristics in accordance with 6.2 shall be carried out on a cable length of not less than 100 m, unless otherwise specified in the relevant detail specification.

The tests for transmission characteristics in accordance with 6.3 shall be carried out on a cable length of 100 m, unless otherwise specified in the relevant detail specification.

6.2 Electrical characteristics and tests

6.2.1 Conductor resistance

The maximum conductor resistance at or corrected to 20 °C shall not exceed 23 Ω/km for cable type A-1000 or 72,5 Ω/km for cable type A-400.

6.2.2 Resistance unbalance within a pair

The resistance unbalance shall not exceed 2,0 %.

6.2.3 Dielectric strength

There shall be no failures when a test is performed on a 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, immediately after the dielectric strength test, shall be performed on

– conductor/conductor, and
– conductor/screen if screen(s) are present.

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

Transfer impedance is only applicable to screened cables. Three grades of performance are recognized 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. Requirements at frequencies below 1 MHz are for further studies (ffs).

Table 1 – Transfer impedance

Frequency range, f MHz	**Maximum surface transfer impedance** mΩ/m		
	Grade 1	**Grade 1b**	**Grade 2**
0,1 to 1	15	30	50
1 to 10	$Z_t \leq 15 \times (f)^{-0,176}$	$Z_t \leq 30 \times (f)^{-0,176}$	$Z_t \leq 50 \times (f)^{0,301}$
10 to 20	$Z_t \leq 10 \times \frac{f}{10}$	$Z_t \leq 20 \times \frac{f}{10}$	$Z_t \leq 23{,}392 \times (f)^{0,631}$

6.2.8 Low frequency coupling attenuation

Four performance types for low frequency coupling attenuation are recognized (see Table 2). Low frequency coupling attenuation shall be measured using the triaxial method according to IEC 62153-4-9 in a tube of 3 m length. Background information for low frequency coupling attenuation is given in Annex B.

Table 2 – Low frequency coupling attenuation

Low frequency coupling attenuation type	**Frequency range** MHz	**Low frequency coupling attenuation** dB
Type I	0,1 to 20	≥ 85 − 10 $\log_{10}$ (f/30), 100 dB max. (ffs); f in MHz
Type Ib	0,1 to 20	≥ 70 − 10 $\log_{10}$ (f/30), 85 dB max. (ffs); f in MHz
Type II	0,1 to 20	≥ 55 − 10 $\log_{10}$ (f/30), 70 dB max. (ffs); f in MHz
Type III	0,1 to 20	≥ 40 − 10 $\log_{10}$ (f/30), 55 dB max. (ffs); f in MHz
NOTE Coupling attenuation Type II and Type III are not applicable for MICE E3 environment.		

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.

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, τ, shall not exceed the value obtained from Formula (1) in the frequency range from 0,1 MHz to 20 MHz.

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

where

τ is the phase delay in ns/100 m;

f is the frequency in MHz.

6.3.3 Attenuation (α)

6.3.3.1 Attenuation at 20 °C operating temperature

The maximum attenuation, α, in the frequency range from 0,1 MHz to 20 MHz shall not exceed the values obtained from Formula (2) using the coefficients indicated in Table 3.

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

where

α 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

Cable type	Constants		
	a	b	c
A-1000	1,23	0,01	0,2
A-400	1,82	0,009 1	0,25

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 in accordance with Formula (3) as specified in Table 4.

Table 4 – Attenuation temperature coefficients

	Temperature coefficients %/°C			
Temperature range	< 20 °C	from 20 °C to 40 °C	from 40 °C to 60 °C	> 60 °C
Unscreened cable	0,2	0,4	0,6	Given in Formula (3)
Screened cable	0,2	0,2	0,2	

$$\delta_{\text{cable}} = \frac{\alpha_T - \alpha_{20}}{\alpha_{20} \times (T - 20)} \times 100 \quad (3)$$

where

α_{20} is the attenuation measured at 20 °C (dB/100 m);

α_T is the attenuation at ambient temperature (dB/100 m);

δ_{cable} is the attenuation temperature coefficient (%/°C);

T is the ambient temperature (°C).

In the case of application of remote powering, the actual conductor temperature should be considered to calculate the attenuation increase. If an extended environmental temperature range is specified (see 4.3), the temperature coefficients given in Table 4 might not be applicable.

6.3.4 Unbalance attenuation (*TCL* and *EL TCTL*)

The minimum near-end unbalance attenuation (transverse conversion loss or *TCL*) shall not be less than the value obtained from Table 5 in the frequency range from 0,1 MHz to 20 MHz. The requirements from 0,1 MHz to 1 MHz are ffs.

Table 5 – *TCL* requirements

Level	Screened cables dB	Unscreened cables dB
Level 1	40 − 15 $\log_{10}$ (f); f in MHz; 40 dB maximum 7 dB minimum	68 − 15 $\log_{10}$ (f); f in MHz; 53 dB maximum 7 dB minimum
Level 2	68 − 15 $\log_{10}$ (f); f in MHz; 53 dB maximum 7 dB minimum	68 − 15 $\log_{10}$ (f); f in MHz; 53 dB maximum 7 dB minimum
Level 3	68 − 15 $\log_{10}$ (f); f in MHz; 53 dB maximum 7 dB minimum	76 − 15 $\log_{10}$ (f); f in MHz; 53 dB maximum 7 dB minimum
Level 4	68 − 15 $\log_{10}$ (f); f in MHz; 53 dB maximum 7 dB minimum	84 − 15 $\log_{10}$ (f); f in MHz; 53 dB maximum 7 dB minimum

The minimum equal-level far-end unbalance attenuation (equal-level transverse conversion transfer loss or *EL TCTL*) shall not be less than the value obtained from Table 6. The requirements from 0,1 MHz to 1 MHz are ffs.

Table 6 – *EL TCTL* requirements

Level	Screened cables dB	Unscreened cables dB
Level 1	40 − 20 $\log_{10}$ (f); f in MHz; 53 dB maximum 6 dB minimum	40 − 20 $\log_{10}$ (f); f in MHz; 53 dB maximum 6 dB minimum
Level 2	50 − 20 $\log_{10}$ (f); f in MHz; 53 dB maximum 6 dB minimum	50 − 20 $\log_{10}$ (f); f in MHz; 53 dB maximum 6 dB minimum
Level 3	60 − 20 $\log_{10}$ (f); f in MHz; 53 dB maximum 6 dB minimum	60 − 20 $\log_{10}$ (f); f in MHz; 53 dB maximum 6 dB minimum

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

The *PS ANEXT* (power sum alien (exogenous) near-end crosstalk) of the cable when tested in accordance with IEC 61156-1 shall not be less than the values obtained from Table 7.

Table 7 – *PS ANEXT* requirements

Frequency range MHz	**Minimum *PS ANEXT*** dB
0,1 to 20	$40 - 17 \log_{10} (f/20)$; f in MHz
Calculated values greater than 67 dB revert to a value of 67 dB.	

For screened cables meeting the coupling attenuation requirements of Type I or Type Ib (see 6.2.8), alien crosstalk requirements are proven by design.

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

The *PS AACR-F* (power-sum alien (exogenous) attenuation to crosstalk ratio far-end) of the cable when tested in accordance with IEC 61156-1 shall not be less than the values obtained from Table 8.

Table 8 – *PS AACR-F* requirements

Frequency range MHz	**Minimum PS AACR-F** dB
0,1 to 20	$40 - 18 \log_{10} (f/20)$; f in MHz
Calculated values greater than 67 dB revert to a value of 67 dB.	

For screened cables meeting the coupling attenuation requirements of Type I or Type Ib (see 6.2.8), alien crosstalk requirements are proven by design.

6.3.7 Impedance

The fitted or mean characteristic impedance measured in accordance with IEC 61156-1 shall be 100 Ω ± 5 Ω at 20 MHz. In case the fitted characteristic impedance is calculated, a measurement with the open/short method in accordance with IEC TS 61156-1-2 shall be used for the least square fitting calculation. A measurement of the input impedance is not sufficient to ensure return loss limits.

In case the fitted characteristic impedance is calculated, it is recommended to use log-frequency spacing, a frequency range from 100 kHz to 100 MHz and at least 401 measurement points to calculate the fitted impedance at 20 MHz.

Recommendations of IEC TS 61156-1-2 and IEC TR 61156-1-5 for improvement of measurement uncertainty may be considered.

6.3.8 Return loss (*RL*)

The minimum return loss in the frequency range indicated in Table 9 shall not be less than the values obtained from Table 9.

Table 9 – *RL* requirements

Frequency range MHz	*RL* requirement dB
0,1 to 10	$20 + 5 \log_{10} (f)$; f in MHz (ffs)
10 to 20	25 (ffs)

When using balun-less measurement technique, the respective descriptions of IEC TS 61156-1-2 may be considered.

Recommendations of 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 conductors

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

6.4.7 Tensile strength of the sheath

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

6.4.8 Crush test of the cable

The crush force shall be applied for 1 min. The crush force and the further parameters of application should be in accordance with the MICE mechanical classification and 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 ± 2) °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 ± 2) °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 ± 2) °C. The elongation at break after ageing 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 ± 2) °C. The tensile strength after ageing shall not be 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 ± 2) °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.

The test shall be performed in accordance with IEC 61156-1, if indicated in the relevant detail specification.

6.5.16 Flame propagation characteristics of bunched cables

The test shall be performed in accordance with IEC 61156-1, if indicated in the relevant detail specification.

6.5.17 Halogen gas evolution

The test shall be performed in accordance with IEC 61156-1, if indicated in the relevant detail specification.

6.5.18 Smoke generation

The test shall be performed in accordance with IEC 61156-1, if indicated in the relevant detail specification.

6.5.19 Toxic gas emission

The test shall be performed in accordance with IEC 61156-1, if indicated in the relevant detail specification.

6.5.20 Integrated fire test

The test shall be performed in accordance with IEC 61156-1, if indicated in the relevant detail specification.

7 Bundled cables requirements

In bundled cables, break-out cables or cable harnesses, several one-pair cables as described in this document may be bundled. Such arrangement shall be specified in a detail specification agreed on by the manufacturer and the customer. Additional relevant safety regulations can also exist. The limits for power sum alien crosstalk shall apply for the crosstalk between the one-pair cables as described in this document.

The maximum number of bundled cables is installation dependent and therefore not specified but may be indicated in the relevant detail specification. Further guidance with respect to cable heating is provided by ISO/IEC TS 29125.

8 Introduction to the blank detail specification (BDS)

The blank detail specification for cables described in this document can be found in Annex A. It should be used to identify a specific product.

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 20 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. 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 61156-13.

[11] Requirements applicable to this cable. The values entered shall meet as a minimum the requirements of sectional specification IEC 61156-13.

[12] Comments – Relevant remarks.

[1] Prepared by:		[2] Document: Issue: Date:	
[3] Available from:		[4] Generic specification: IEC 61156-1 Sectional specification: IEC 61156-13 Blank detail specification: IEC 61156-13, Annex A	
[5] Additional references:			
[6] Cable description: a) Type and number of elements: b) Nominal impedance: c) Screening: d) Application: e) Other distinguishing performance characteristics:			
[7] Cable construction:	Subclause		[12] Comments
	5.2	Cable construction:	
	5.3	Conductor description:	
	5.4	Insulation description: Maximum diameter: Colour code of elements:	
	5.5	Cable element:	
	5.6	Screening of the cable element: Tape material Minimum overlap Drain wire Braid wire Braid material	
	5.7	Cable make-up:	
	5.8	Screening of the cable core: Tape material Minimum overlap Drain wire Braid wire Braid material	
	5.9	Sheath Material Nominal thickness Colour Maximum overall diameter Marking Ripcord	
	5.10	Identification	
	5.11	Finished cable	

[8] Minimum bending radius for static bending: Minimum bending radius for dynamic bending: Temperature range for installation: Operating temperature range under static conditions: C1: −10 °C to +60 °C C2: −25 °C to +70 °C C3: −40 °C to +70 °C			
[9] Characteristics	[10] Subclause	[11]	[12] Comments
Electrical characteristics	6.2		
Conductor resistance	6.2.1	≤ .... Ω/km	
Resistance unbalance Resistance unbalance within a pair	6.2.2 6.2.2	 ≤ .... %	
Dielectric strength Conductor/conductor Conductor/screen	6.2.3	 ..... kV, time of voltage test ..... kV, time of voltage test	
Insulation resistance Conductor/conductor Conductor/screen	6.2.4	 ≥ ... MΩ km ≥ ... MΩ km	
Mutual capacitance	6.2.5	≤ .... nF/km	
Capacitance unbalance pair to ground	6.2.6	≤ .... pF/km	
Transfer impedance	6.2.7		Transfer impedance grade shall be indicated.
Low frequency coupling attenuation	6.2.8	......dB Cable type.....	Low frequency coupling attenuation type shall be indicated.
Current-carrying capacity	6.2.9	.....mA	Relevant installation conditions shall be specified.
Transmission characteristics	6.3		
Velocity of propagation	6.3.1		
Phase delay	6.3.2	≤ ... ns/100 m	
Attenuation General figures Environmental temperature effects	6.3.3.1 6.3.3.1 6.3.3.2	 ≤ ... dB/100 m ≤ ... %/°C	
Unbalance attenuation near-end (*TCL*) Unbalance attenuation far-end (*EL TCTL*)	6.3.4 6.3.4	≥ ... dB ≥ ... dB	Unbalance attenuation level shall be indicated.
Power sum alien (exogenous) near-end crosstalk	6.3.5	≥ ... dB	
Power sum alien (exogenous) attenuation to crosstalk ratio far end crosstalk	6.3.6	≥ ... dB	
Impedance	6.3.7		