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INTERNATIONAL STANDARD

Multicore and symmetrical pair/quad cables for digital communications – Part 8: Symmetrical pair cables with transmission characteristics up to 1 200 MHz – Work area wiring – Sectional specification

IEC 61156-8:2023-02(en)

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FOREWORD

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IEC 61156-8 has been prepared by subcommittee 46C: Wires and symmetrical cables, of IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories. It is an International Standard.

This part of IEC 61156 is to be read in conjunction with IEC 61156-1:2023 and IEC 61156-7:2023.

This second edition cancels and replaces the first edition published in 2009, and Amendment 1:2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) align clauses with IEC 61156-1:2023;

b) additional reference to IEC 62153-4-9 test method (triaxial) for coupling attenuation measurement to be consistent with all other parts of the IEC 61156 series;

c) incorporation of blank detail specification.

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

Draft	Report on voting
46C/1229/CDV	46C/1234/RVC

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

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/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- withdrawn,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 8: Symmetrical pair cables with transmission characteristics up to 1 200 MHz – Work area wiring – Sectional specification

1 Scope

This part of IEC 61156 relates to IEC 61156-1 and IEC 61156-7. The cables described herein are specified up to 1 200 MHz and are specifically designed to build work area cords.

It covers a cable having four individually screened (S/FTP) pairs. The cable can be provided with a common screen over the cable core.

The transmission characteristics are specified up to a frequency of 1 200 MHz and at a temperature of 20 °C.

The cables covered by this sectional specification are intended to operate with voltages and currents normally encountered in communication systems and support the delivery of DC low voltage remote powering applications. These cables are not intended to be used in conjunction with low impedance sources, for example the electric power supply of public utility mains.

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

IEC 61156-1:2023, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

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 cable test methods – Part 4-5: Electromagnetic compatibility (EMC) –Screening or coupling attenuation − Absorbing clamp method*

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

IEC 61156-7, *Multicore and symmetrical pair/quad cables for digital communications – Part 7: Symmetrical pair cables with transmission characteristics up to 1 200 MHz – Sectional specification for digital and analogue communication cables*

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 consideration

4.1 General remarks

Installation considerations are defined in IEC 61156-1.

4.2 Bending radius of installed cable

The bending radius of the installed cable shall not be less than 4 times the outside diameter of the cable.

4.3 Climatic conditions

Under static conditions, the cables shall operate in the temperature range from –20 °C to +60 °C. The temperature dependence of the cables is specified for screened cables and should be taken into account for the design of actual cabling systems.

The recommended temperature range during installation should be indicated in the relevant detail specification.

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.

5 Material 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. Particular care should be taken to meet any special requirements for fire performance (such as burning properties, smoke generation, evolution of halogen gas, etc.) and remote powering.

5.2 Cable construction

5.2.1 General

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

5.2.2 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 0,4 mm and 0,65 mm. The stranded conductor should have preferably seven strands. Higher conductor diameters may be used if compatible with the connecting hardware.

5.2.3 Insulation

5.2.3.1 Insulation material

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

– polyolefin;
– fluoropolymer;
– low-smoke halogen-free thermoplastic material.

The insulation may be solid or cellular with or without a solid dielectric skin. The insulation shall be continuous and shall have a thickness such that the completed cable meets the specified requirements. The nominal thickness of the insulation shall be compatible with the method of conductor termination.

5.2.3.2 Colour code of insulation

The colour code is not specified but shall be indicated in the relevant detail specification. The colours shall be readily identifiable and shall correspond reasonably with the standard colours shown in IEC 60304.

NOTE It is acceptable to mark or stripe the "a" wire with the colour of the "b" wire to facilitate pair identification.

5.2.4 Cable element

5.2.4.1 Cable element type

The cable element shall be a screened twisted pair.

5.2.4.2 Screening of the cable element

The screen for the cable element shall be in accordance with IEC 61156-1. If a braid is used, the minimum braid coverage shall be such as to meet the screening requirements of this document. The individual components used to screen the cable element shall be in electrical contact.

5.2.5 Cable make-up

The cable elements shall be assembled to form the cable core.

The core of the cable may be wrapped with a protective layer of non-hygroscopic and non-wicking material.

5.2.6 Screening of the cable core

A screen for the cable core may be provided. The screen shall be in accordance with IEC 61156-1.

5.2.7 Sheath

The sheath material shall consist of a suitable thermoplastic material.

Examples of suitable materials are:

– polyolefin;
– PVC;
– fluoropolymer;
– low-smoke halogen-free 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 should be specified in the relevant detail specification.

5.2.8 Identification

5.2.8.1 Cable marking

Each length of cable shall bear the name of the supplier and the cable type and, when provided, the year of manufacture, using one of the following methods:

a) coloured threads or tapes;
b) printed tape;
c) printing on the cable core wrapping;
d) marking on the sheath.

Additional markings, such as length marking, etc., are permitted. If used, such markings should be indicated in the relevant detail specification.

5.2.8.2 Labelling

The following information shall be provided either on a label attached to each length of finished cable or on the outside of the product package:

a) type of cable;
b) supplier's name or logo;
c) year of manufacture;
d) length of cable in metres.

5.2.9 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 IEC 61156-1:2023, Clause 6.

6.2 Electrical characteristics and tests

6.2.1 Conductor resistance

The maximum conductor resistance shall not exceed 14,5 Ω/100 m of cable.

6.2.2 Resistance unbalance within a pair

The resistance unbalance within a pair shall not exceed 2,0 %.

6.2.3 Dielectric strength

The test shall be performed on conductor/conductor and conductor/screen with 1,0 kV DC for 1 min or, alternately, 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, alternately, 1,7 kV AC for 2 s.

When installed in conjunction with power cables, local regulations can require a higher test voltage

6.2.4 Insulation resistance

The test, immediately after the dielectric strength test, shall be performed on

– conductor/conductor;
– conductor/screen.

The minimum insulation resistance at 20 °C shall not be less than 5 000 MΩ·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 pair to ground

The maximum capacitance unbalance pair to ground shall not exceed 1 200 pF/km at a frequency of 1 kHz.

6.2.7 Transfer impedance

When measured using the triaxial method (IEC 62153-4-3), the transfer impedance shall not exceed the values listed in Table 1 at the indicated frequencies.

Table 1 – Transfer impedance

Frequency range MHz	Maximum surface transfer impedance mΩ/m
1 to 10	10
10 to 100	$10 \times f/10$

NOTE Values in the range 10 MHz to 100 MHz are equal to IEC 61156-5, Grade 1.

6.2.8 Coupling attenuation

When measured using the absorbing clamp method (IEC 62153-4-5) or the triaxial method (IEC 62153-4-9), the coupling attenuation in the frequency range from 30 MHz to 1 200 MHz shall meet the requirements indicated in Table 2.

Table 2 – Coupling attenuation

Frequency range MHz	Minimum coupling attenuation dB
30 to 100	85,0
100 to 1 200	$85{,}0 - 20 \times \log_{10}(f/100)$

NOTE Values in the range 30 MHz to 1 000 MHz are equal to IEC 61156-5, Type I.

6.2.9 Current-carrying capacity

The maximum current-carrying capacity is 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 and the test method described in IEC 61156-1-4.

6.2.10 Resistance of the screen

The maximum longitudinal DC resistance value of the individual screens or an overall screen shall be less than 20 mΩ/m.

6.3 Transmission characteristics

6.3.1 General remark

All the tests shall be carried out on a cable length of 50 m, unless otherwise specified.

6.3.2 Velocity of propagation (phase velocity)

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

6.3.3 Phase delay and differential phase delay (delay skew)

6.3.3.1 Phase delay

The phase delay, τ, shall not exceed the value obtained from:

$$\tau = 500 + \frac{36}{\sqrt{f}} \text{ [ns / 100 m]} \quad (1)$$

where

τ is the phase delay in ns/100 m;

f is the frequency in MHz.

6.3.3.2 Differential phase delay (delay skew)

Differential phase delay (delay skew) is the difference in phase delay between any two screened cable elements.

When the phase delay is measured at 10 °C ± 3 °C and 40 °C ± 1 °C, the maximum differential phase delay (delay skew) at a given temperature shall not be greater than 25,0 ns/100 m in the frequency range from 4 MHz to 1 200 MHz.

6.3.3.3 Environmental effects

The differential delay (delay skew) due to temperature shall not vary by more than ±10 ns/100 m over the temperature range from –20 °C to +60 °C while still meeting the differential phase delay (delay skew) of 6.3.3.2.

6.3.4 Attenuation (α)

6.3.4.1 Attenuation at 20 °C operating temperature

The maximum attenuation α of any pair in the frequency range 4 MHz to 1 200 MHz shall be less than, or equal to, the value obtained from Formula (2) using the corresponding values of the constants given in Table 3.

$$\alpha = \mathrm{A} \times \sqrt{f} + \mathrm{B} \times f + \frac{\mathrm{C}}{\sqrt{f}} \quad [\mathrm{dB}/100\,\mathrm{m}] \tag{2}$$

Table 3 – Attenuation, constant values

Constants		
A	**B**	**C**
2,70	0,015	0,3

NOTE Cable performance between 1 MHz and 4 MHz is achieved by design only and it is therefore not necessary to test for this performance below 4 MHz.

The values in Table 4 are for information only:

Table 4 – Attenuation values

Frequency MHz	**Maximum attenuation at 20 °C** dB/100 m
4	5,6
10	8,8
16	11,1
31,25	15,6
62,5	22,3
100	28,5
200	41,2
300	51,3
600	75,1
900	94,5
1 000	100,4
1 200	111,5

6.3.4.2 Attenuation at elevated ambient temperatures

The increase in attenuation due to elevated temperatures shall not be greater than 0,2 %/°C.

6.3.5 Unbalance attenuation near-end (*TCL*, *EL TCTL*)

The minimum unbalance attenuation near-end (transverse conversion loss or TCL) shall be equal to, or greater than, the value obtained from Formula (3) for all frequencies, f, in the frequency range from 1 MHz to 250 MHz:

$$TCL = 40{,}0 - 10 \times \log_{10}(f) \quad [\mathrm{dB}] \tag{3}$$

NOTE 1 Values in the range 1 MHz to 30 MHz are equal to IEC 61156-5, Level 1.

TCL requirements for frequencies higher than 250 MHz may be defined in the detail specification.

NOTE 2 If the intention is to increase the frequency range of balance measurements, IEC TR 61156-1-2 provides guidance on the respective (e.g., balunless) measurement techniques.

The minimum equal-level far-end unbalance attenuation (equal-level transverse conversion transfer loss or EL TCTL) shall be equal to, or greater than, the value obtained from Formula (4) for all frequencies, f, in the range from 1 MHz to 30 MHz.

$$EL\ TCTL = 35{,}0 - 20 \times \log_{10}(f) \quad [\text{dB}] \tag{4}$$

NOTE 3 Values in the range 1 MHz to 30 MHz are equal to IEC 61156-5:2020, Level 1.

EL TCTL requirements for frequencies higher than 30 MHz may be defined in the detail specification.

6.3.6 Near-end crosstalk (*PS NEXT*, *NEXT*)

The worst-pair power-sum near-end crosstalk, *PS NEXT*, of any pair for all frequencies in the range 4 MHz to 1 200 MHz shall be equal to, or greater than, the value obtained from Formula (5).

$$PS\ NEXT = 103{,}0 - 15 \times \log_{10}(f) \quad [\text{dB}] \tag{5}$$

where f is the frequency in MHz.

NOTE The cable performance between 1 MHz and 4 MHz is achieved by design only and it is therefore not necessary to test for this performance below 4 MHz.

The values given in Table 5 are for information only. For those frequencies where the calculated value of *PS NEXT* is greater than 75 dB, the requirement shall be 75 dB.

Table 5 – Near-end crosstalk, power-sum (*PS NEXT*)

Frequency MHz	**Minimum *PS NEXT*** dB
4	75
10	75
16	75
31,25	75
62,5	75
100	73
200	68
300	66
900	59
1 000	58
1 200	57

The minimum pair-to-pair *NEXT* for any pair combination shall be at least 3 dB better than the *PS NEXT* for any pair.

6.3.7 Far-end crosstalk (*PS ACR-F*, *ACR-F*)

The worst-pair power-sum equal level far-end crosstalk, $PS\,ACR\text{-}F$, of any pair for all frequencies in the range 4 MHz to 1 200 MHz shall be equal to, or greater than, the value obtained from Formula (6).

$$PS\ ACR-F = 91 - 20 \times \log_{10}(f) \quad \text{[dB]} \tag{6}$$

where f is the frequency in MHz.

NOTE The cable performance between 1 MHz and 4 MHz is achieved by design only and it is therefore not necessary to test for this performance below 4 MHz.

If $FEXT$ loss is greater than 90 dB, calculation of $PS\,ACR\text{-}F$ loss is not required.

The values given in Table 6 are for information only. For those frequencies where the calculated value of $PS\,ACR\text{-}F$ is greater than 75 dB, the requirement shall be 75 dB.

Table 6 – Far-end crosstalk (*PS ACR-F*)

Frequency MHz	**Minimum *PS ACR-F*** dB for 100 m
4	75
10	71
16	67
31,25	61
62,5	55
100	51
200	45
300	41
600	35
900	32
1 000	31
1 200	29

The minimum pair-to-pair $ACR\text{-}F$ for any pair combination shall be at least 3 dB better than the $PS\,ACR\text{-}F$ for any pair.

6.3.8 Alien (exogenous) near-end crosstalk

Generally proven by design.

6.3.9 Alien (exogenous) far-end crosstalk

Generally proven by design.

6.3.10 Alien (exogenous) crosstalk of bundled cables

Generally proven by design.

6.3.11 Impedance

The impedance requirement is specified as fitted or mean characteristic impedance at a certain frequency.

The impedance measured in accordance with IEC 61156-1 shall be 100 Ω ± 5 Ω at 100 MHz.

The return loss shall also be measured.

Further background on the measurement of fitted and mean characteristic impedance can be found in IEC TR 61156-1-2. Recommendations given in IEC TR 61156-1-2 and IEC TR 61156-1-5 for improvement of measurement uncertainty should be considered.

6.3.12 Return loss (RL)

The minimum return loss of any pair in the frequency range indicated in Table 7 shall be greater than the values in Table 7.

Table 7 – Return loss

Frequency range MHz	Minimum return loss dB
4 to10	$20{,}0 + 5{,}0 \times \log_{10}(f)$
10 to 20	25,0
20 to 250	$25{,}0 - 8{,}6 \times \log_{10}(f/20)$
250 to 600	15,6
600 to 1 200	$15{,}6 - 10 \times \log_{10}(f/600)$

6.4 Mechanical and dimensional characteristics and requirements

6.4.1 Dimensional requirements

The 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 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 the sheath shall be not less than 100 %.

6.4.7 Tensile strength of the sheath

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

6.4.8 Crush test of the cable

The minimum force shall be 1 000 N.

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 shall be indicated in the relevant detail specification.

6.4.11 Repeated bending of the cable

The cable shall withstand 500 cycles without cracking of the insulation or sheath or loss of continuity of the metallic components.

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 the 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 be not less than 70 % of the unaged value.

6.5.6 Sheath pressure 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 Hot shock test

Not applicable.

6.5.9 Damp heat steady state

Not applicable.

6.5.10 Solar radiation (UV)

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

6.5.11 Solvent 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 weight.

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 indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1. Local regulations can apply.

6.5.17 Flame propagation characteristics of bunched cables

If indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1. Local regulations can apply.

6.5.18 Resistance to fire

Not applicable.

6.5.19 Halogen gas evolution

If indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1. Local regulations can apply.

6.5.20 Smoke generation

If indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1. Local regulations can apply.

6.5.21 Toxic gas emission

If indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1. Local regulations can apply.

6.5.22 Integrated fire test

If indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1. Local regulations can apply.

7 Introduction to the blank detail specification

The blank detail specification for cables described in this document is given in Annex A and should be used to identify a specific product.

When completing the detail specification, the following information shall be supplied:

a) conductor size and type;
b) number of elements;
c) cable construction details;
d) nominal impedance of the cable;
e) electrical requirements;
f) transmission requirements;
g) mechanical requirements;
h) environmental requirements;
i) fire performance.

Annex A
(informative)

Blank detail specification

The blank detail specification determines the layout and style for detail specifications describing symmetrical pair/quad cables for digital communications. Detail specifications, based on the blank detail specification, may be prepared by a national organization, a manufacturer, or a user.

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 detail specification shall be written in accordance with the layout of the blank detail specification described here.

The numbers shown in square brackets in the following pages 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 including any 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 in the sectional specification IEC 61156-1.

[11] Requirements applicable to this cable. The values entered shall meet as a minimum the requirements of the sectional specification IEC 61156-8.

[12] Comments – Relevant remarks.

[1] Prepared by		[2] Document: Issue: Date:	
[3] Available from:		[4] Generic specification: IEC 61156-1 Sectional specification: IEC 61156-8 Blank detail specification: IEC 61156-8:2023, Annex A	
[5] Additional information:			
[6] Cable description:			
[7] Cable construction:	**IEC 61156-8: 2023[1], subclause**		[12] Comments
	5.2.2	Conductor:	
	5.2.3.1	Insulation material: Maximum diameter:	
	5.2.3.2	Colour code of insulation:	
	5.2.4.2	Screening of the cable element: Tape material Drain wire Braid wire Braid material	
	5.2.5	Cable make-up: Protective wrapping	
	5.2.6	Screening of the cable core: Tape material Minimum overlap Drain wire Braid wire Braid material	
	5.2.7	Sheath Material Nominal thickness Colour Maximum overall diameter Marking Ripcord	
	5.2.8	Identification	
	5.2.9	Finished cable: Packaging	
[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] **IEC 61156-8: 2023, subclause**	[11]	[12] Comments
Electrical characteristics and tests	**6.2**		
Conductor resistance	6.2.1	≤ … Ω/km	
Resistance unbalance within a pair	6.2.2	≤ … %	
Dielectric strength Conductor/conductor Conductor/screen	 6.2.3 6.2.3	 ….. kV DC/AC for … min / … s ….. kV DC/AC for … min / … s	
Insulation resistance Conductor/conductor Conductor/screen	 6.2.4 6.2.4	 ≥ … MΩ · km ≥ … MΩ · km	
Mutual capacitance	6.2.5	≤ … pF/m	
Capacitance unbalance pair to ground	6.2.6	≤ … pF/m	
Transfer impedance	6.2.7		
Coupling attenuation	6.2.8		
Current-carrying capacity	6.2.9	… mA	Respective installation conditions shall be specified
Resistance of the screen	6.2.10	≤ … mΩ/m	
Transmission characteristics	**6.3**		
Velocity of propagation	6.3.2		
Phase delay Differential phase delay (skew) Environmental temperature coefficient	6.3.3.1 6.3.3.2 6.3.3.3	≤ … ns/100 m ≤ … ns/100 m	
Attenuation Attenuation at 20 °C Attenuation at elevated temperatures: Environmental temperature coefficient	6.3.4 6.3.4.1 6.3.4.2	 ≤ … dB/100 m ≤ … %/°C	
Unbalance attenuation near-end (*TCL*)	6.3.5	≥ …dB	
Unbalance attenuation far-end (*EL TCTL*)	6.3.5	≥ …dB	
Near-end crosstalk	6.3.6	≥ …dB	
Attenuation to crosstalk ratio far-end	6.3.7	≥ …dB	
Impedance	6.3.11		
Return loss	6.3.12	≥ …dB	