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INTERNATIONAL STANDARD

colour inside

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

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This consolidated version of IEC 61156-8 consists of the first edition (2009) [documents 46C/887/FDIS and 46C/894/RVD], its corrigendum (July 2009) and its amendment 1 (2013) [documents 46C/957/CDV and 46C/966/RVC]. It bears the edition number 1.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 61156-8 has been prepared by subcommittee 46C: Wires and symmetric cables, of IEC technical committee 46: Cables, wires, waveguides, R.F. connectors, R.F. and microwave passive components and accessories.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61156 series, 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 the base publication and its amendment will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

Part 8: Symmetrical pair/quad cables with transmission characteristics up to 1 200 MHz – Work area wiring – Sectional specification

1 Scope

This sectional specification 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 patch, equipment, and work area cables as defined in ISO/IEC 11801 and ISO/IEC 15018.

It covers a cable having four individually screened (STP) pairs. The cable may be provided with a common screen over the cable core. The transmission characteristics are specified for a frequency range 4 MHz to 1 200 MHz and at 20 °C.

These cables can be used for various communication channels which use as many as four pairs simultaneously. In this sense, this sectional specification provides the cable characteristics required by system developers to evaluate new systems.

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

2 Normative references

The following referenced documents are indispensable for the application 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 61156-1:2007, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

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 analog communication cables*

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in IEC 61156-1 apply.

4 Installation considerations

4.1 Installation conditions

Installation considerations are defined in Clause 4 of IEC 61156-1.

4.2 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, and should be taken into account for the design of an actual cabling system.

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. Particular care shall be taken to meet any special requirements for the fire performance (such as burning properties, smoke generation, evolution of halogen gas, etc.).

5.2 Cable construction

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

5.2.1 Conductor

The conductor shall be solid or stranded annealed copper conductor, in accordance with IEC 61156-1 and shall have a nominal diameter between 0,4 mm to 0,65 mm. The stranded conductor should have preferably seven strands. Higher conductor diameters may be used if compatible with the connecting hardware.

5.2.2 Insulation

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

– polyolefin;
– fluoropolymer;
– low-smoke zero-halogen 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 insulation 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.

5.2.3 Cable element

The cable element shall be screened pair or quad adequately twisted.

The screen of the cable element shall be in accordance with 5.2.3.1 of IEC 61156-1.

5.2.4 Cable make-up

A spacer may be used to separate the cable elements. The cable elements, including spacers, shall be assembled to form the cable core.

The core of the cable may be wrapped with a protective layer of non-hygroscopic and not-wicking material.

5.2.5 Screening of cable core

When required by the relevant detail specification, a screen for the cable core shall be provided.

The screen shall be in accordance with 5.2.5 of IEC 61156-1.

5.2.6 Sheath

The sheath material shall consist of a suitable thermoplastic material.

Examples of suitable materials are

– polyolefin;
– PVC;
– fluoropolymer;
– 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 not-wicking.

The colour of the sheath is not specified, but it shall be stated in the relevant detail specification.

5.2.7 Identification

Each length of cable shall be identified as to the manufacturer, and when required, the year of manufacture, using one of the following methods:

a) appropriately coloured threads or tapes;
b) with a 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 shall refer to this specification.

5.2.8 Finished cable

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

6 Characteristics and requirements

6.1 General remarks

This clause lists the characteristics and minimum requirements of a cable complying with this sectional specification. Test methods shall be in accordance with Clause 6 of IEC 61156-1.

All the tests shall be carried out on a cable length of 100 m, unless otherwise specified.

6.2 Electrical characteristics

The tests shall be carried out on a cable length of not less than 100 m, unless otherwise specified.

6.2.1 Conductor resistance

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

6.2.2 Resistance unbalance

6.2.2.1 Resistance unbalance within a pair

The resistance unbalance shall not exceed 1,5 %.

~~**6.2.2.2 Resistance unbalance between pairs**~~

~~The pair-to-pair resistance unbalance shall not exceed 4 %.~~

6.2.3 Dielectric strength

There shall be no failures when a test is performed on conductor/conductor and conductor/screen with 1,0 kV d.c. for 1 min or, alternately, with 2,5 kV d.c. for 2 s. A a.c. voltage may be used. The a.c. voltage levels in these cases shall be 0,7 kV a.c. for 1 min or, alternately, 1,7 kV a.c. for 2 s.

6.2.4 Insulation resistance

The test shall be performed on

– conductor/conductor;
– conductor/screen.

The minimum insulation resistance at 20 °C shall not be less than 5 000 MΩ·m.

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 1 200 pF/km at a frequency of 1 kHz.

6.2.7 Transfer impedance

The transfer impedance shall not exceed the values shown in Table 1 at the discrete frequencies indicated.

Table 1 – Transfer impedance

Frequency MHz	**Maximum surface transfer impedance** mΩ/m
1	10
10	10
30	30
100	60

6.2.8 Coupling attenuation

When measured using the absorbing clamp method, the coupling attenuation in the frequency range from f = 30 MHz to 1 200 MHz shall be equal to or greater than the values indicated in Table 2.

Table 2 – Coupling attenuation

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

6.2.9 Current-carrying capacity

The maximum current-carrying capacity is not specified but may be indicated in the relevant detail specification.

6.2.10 Shield resistance

~~The d.c. resistance of the individual screens or an overall screen is not specified but may be indicated in the relevant detail specification.~~

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

6.3 Transmission characteristics

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

6.3.1 Velocity of propagation (phase velocity)

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

6.3.2 Phase delay and differential delay (delay skew)

The phase delay τ shall be less than or equal to

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

where

τ is the phase delay in ns/100 m;

f is the frequency in MHz.

When the delay is measured at (10 ± 2) °C and (40 ± 1) °C, the maximum delay skew between any two pairs at a given temperature shall not be greater than 25 ns/100 m in the frequency range from 4 MHz to 1 200 MHz.

The differential delay (delay skew) between any two pairs due to temperature shall not vary by more than ±10 ns/100 m over the temperature range from –20 °C to +60 °C.

6.3.3 Attenuation

6.3.3.1 General figures

The maximum attenuation α of any pair in the frequency range indicated in Table 2 shall not exceed the value obtained from equation (2) using the corresponding values of the constants given in Table 3.

$$\alpha = \mathrm{a} \times \sqrt{f} + \mathrm{b} \times f + \frac{\mathrm{c}}{\sqrt{f}} \quad \text{(dB/100 m)} \tag{2}$$

Table 3 – Attenuation, constant values

Frequency range MHz	Constants		
	a	B	c
4 – 1 200	2,70	0,015	0,3

6.3.3.2 Attenuation at elevated operating temperature

The increase in maximum attenuation requirement obtained from equation (2) due to elevated temperature shall be 0,2 %/°C for screened cables.

6.3.4 Unbalance attenuation

The minimum unbalance attenuation near-end (transverse conversion loss or TCL) shall be equal to or greater than the value obtained from equation (3) for the frequency range 1 MHz to 200 MHz.

NOTE The need for TCL values above 200 MHz is under consideration.

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

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

The formula for the $EL\ TCTL$ is

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

6.3.5 Near-end crosstalk (*NEXT*)

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

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

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

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

6.3.6 Far-end crosstalk (*FEXT*)

The worst pair power sum equal level far-end crosstalk, *PS EL FEXT*, of any pair in the frequency range 4 MHz to 1 200 MHz shall be not less than the value obtained from equation (6).

$$PS\ EL\ FEXT(f) = 91{,}0 - 20 \times \log_{10}(f) \quad \text{(dB for 100 m)} \tag{6}$$

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

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

6.3.7 Alien (exogenous) near-end crosstalk

Generally proven by design.

6.3.8 Alien (exogenous) far-end crosstalk

Generally proven by design.

6.3.9 Alien (exogenous) crosstalk of bundled cables

The minimum requirement is not specified but it should be stated in the relevant detail specification.

6.3.10 Impedance

The mean characteristic impedance shall be within ±5 % of the requested nominal impedance at 100 MHz.

6.3.11 Return loss (*RL*)

The minimum return loss of any pair in the frequency 1 MHz to 1 200 MHz shall be equal to or greater than the values obtained from Table 4.

Table 4 – Return loss (RL)

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

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 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 specified 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 specified 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 not be less than 100 %.

6.4.7 Tensile strength of the sheath

The minimum tensile strength of the sheath shall not be 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 shall 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 of the cable

Not applicable.

6.4.14 Bump test of the cable

Not applicable.

6.4.15 Vibration test 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 7 days at (100 ± 2) °C. The tensile strength 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 7 days at (100 ± 2) °C. The elongation 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

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

6.5.11 Solvents and contaminating fluids

The requirement is not specified but it 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 shall not exceed 1 % by 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

When required, the test shall be performed in accordance with IEC 61156-1.

6.5.17 Flame propagation characteristics of bunched cables

When required, the test shall be performed in accordance with IEC 61156-1.

6.5.18 Halogen gas evolution

When required, the test shall be performed in accordance with IEC 61156-1.

6.5.19 Smoke generation

When required, the test shall be performed in accordance with IEC 61156-1.

6.5.20 Toxic gas emission

When required, the test shall be performed in accordance with IEC 61156-1.

6.5.21 Integrated fire test

When required, the test shall be performed in accordance with IEC 61156-1.