IEC 61156-1

Edition 3.1 2009-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

Câbles multiconducteurs à paires symétriques et quartes pour transmissions numériques – Partie 1: Spécification générique

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

Part 1: Generic specification

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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International Standard IEC 61156-1 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.

The cables are classified in the study of generic cabling for information technology being produced by ISO/IEC JTC1/SC 25.

This consolidated version of IEC 61156-1 consists of the third edition (2007) [documents 46C/815/FDIS and 46C/823/RVD], its amendment 1 (2009) [documents 46C/897/FDIS and 46C/899/RVD] and its corrigendum 1 (2015-08).

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 3.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

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

a) inclusion of definitions and test methods in support of the MICE table in ISO 24702;
b) inclusion of definitions and test methods in support of new cable categories 6_A and 7_A;
c) inclusion of definitions in support of PoEP.

This bilingual version (2008-02) replaces the English version.

The French version of this standard has not been voted upon.

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

The list of all the parts of the IEC 61156 series, under the general title *Multicore and symmetrical pair/quad cables for digital communication*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendments 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.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

Part 1: Generic specification

1 Scope

This part of IEC 61156 is applicable to communication systems such as ISDN, local area networks and data communication systems and specifies the definitions, requirements and test methods of multicore, symmetrical pair and quad cables.

This standard is also applicable to cables used for customer premises wiring.

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 60028, *International standard of resistance for copper*

IEC 60050-726, *International Electrotechnical Vocabulary (IEV) – Part 726: Transmission lines and wave guides*

IEC 60068-2-1, *Environmental testing – Part 2: Tests – Tests A: Cold*

IEC 60169-22, *Radio-frequency connectors – Part 22: RF two-pole bayonet coupled connectors for use with shielded balanced cables having twin inner conductors (Type BNO)*

IEC 60189-1:1986, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*[1)]

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

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

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

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

IEC 60332-3-24, *Tests on electric cables under fire conditions – Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category C*

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

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1) There exists a 2007 edition of 60189-1.

IEC 60754-2, *Test on gases evolved during combustion of electric cables – Part 2: Determination of the degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity*

IEC 60794-1-2:2003, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*

IEC 60811-1-1:1993, *Common test methods for insulating and sheathing materials of electric cables and optical cables – Part 1: Methods for general application – Section 1: Measurement of thickness and overall dimensions – Tests for determining the mechanical properties*

IEC 60811-1-2:1985, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 1: Methods for general application – Section Two: Thermal ageing methods*

IEC 60811-1-3:1993, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 1: Methods for general application – Section Three: Methods for determining the density – Water absorption tests – Shrinkage test*

IEC 60811-1-4:1985, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 1: Methods for general application – Section Four: Test at low temperature*

IEC 60811-3-1:1985, *Common test methods for insulating and sheathing materials of electric and optical cables – Part 3: Methods specific to PVC compounds – Section One: Pressure test at high temperature – Tests for resistance to cracking*

IEC 60811-4-2:2004, *Insulating and sheathing materials of electric cables – Common test methods – Part 4-2: Methods specific to polyethylene and polypropylene compounds – Tensile strength and elongation at break after conditioning at elevated temperature – Wrapping test after conditioning at elevated temperature – Wrapping test after thermal ageing in air – Measurement of mass increase – Long-term stability test – Test method for copper-catalyzed oxidative degradation*

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

IEC 61196-1-105, *Coaxial communication cables – Part 1-105: Electrical test methods – Test for withstand voltage of cable dielectric*

IEC 62012-1:2004, *Multicore and symmetrical pair/quad cables for digital communications to be used in harsh environments – Part 1: Generic specification*

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

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

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

IEC 62255 (all parts), *Multicore and symmetrical pair/quad cables for broadband digital communications (high bit rate digital access telecommunication networks) – Outside plant cables*

ITU-T Recommendation G.117:1996, *Transmission aspects of unbalance about earth*

ITU-T Recommendation O.9:1999, *Measuring arrangements to assess the degree of unbalance about earth*

3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those given in IEC 60050-726, apply.

3.1
resistance unbalance
difference in resistance of the conductors within a pair or one side of a quad or between pairs or quads

NOTE Resistance unbalance is expressed as a percentage (%).

3.2
capacitance unbalance to earth
arithmetic difference of the capacitance to earth of the conductors of a pair or one side of a quad

NOTE Capacitance unbalance is expressed in pF/m.

3.3
mutual capacitance
electrical charge storage parameter of a pair of conductors (or with respect to the side of a quad)

NOTE 1 Mutual capacitance is one of the four primary transmission line parameters: mutual capacitance, mutual inductance, resistance and conductance.

NOTE 2 Mutual capacitance is expressed in pF/m.

3.4
velocity of propagation (phase velocity)
speed at which a sinusoidal signal propagates on a pair in the cable

NOTE Velocity of propagation is expressed in m/s.

3.5
delay (phase delay)
time duration between the instants that the wave front of a sinusoidal travelling wave, defined by a specified phase, passes two given points in a cable

NOTE Phase delay is expressed in s/m.

3.6
differential phase delay (skew)
difference in phase delay between any two pairs in the cable

NOTE Differential phase delay (skew) is expressed in s.

3.7
attenuation
decrease in magnitude of power of a signal that propagates along a pair of a cable

NOTE Attenuation is expressed in dB/m.

3.8
unbalance attenuation
magnitude of power of a signal that propagates between the common-mode circuit and the differential-mode circuit of a cable

NOTE Unbalance attenuation is expressed in dB.

3.9
near-end crosstalk
NEXT
magnitude of the signal power coupling from a disturbing pair at the near end to a disturbed pair measured at the near end

NOTE Near-end crosstalk is expressed in dB.

3.10
far-end crosstalk
FEXT
magnitude of the signal power coupling from a disturbing pair at the near end to a disturbed pair measured at the far end

NOTE Far-end crosstalk is expressed in dB.

3.11
power sum of crosstalk
PS
summation of the crosstalk power from all disturbing pairs into a disturbed pair

NOTE 1 The summation is applicable to near-end and far-end crosstalk.

NOTE 2 The power sum of crosstalk is expressed in dB.

3.12
attenuation to crosstalk ratio, near-end
ACR-N
arithmetic difference between the near-end crosstalk and the attenuation of the disturbed pair

NOTE Attenuation to crosstalk ratio, near-end, is expressed in dB.

3.13
attenuation to crosstalk ratio, far-end
ACR-F
arithmetic difference between the far-end crosstalk and the attenuation of the disturbed pair

NOTE Attenuation to crosstalk ratio, far-end, is expressed in dB.

3.14
alien (exogenous) near-end crosstalk
ANEXT
near-end crosstalk where the disturbing and disturbed pairs are contained in different cables

NOTE Alien (exogenous) near-end crosstalk is expressed in dB.

3.15
alien (exogenous) far-end crosstalk
AFEXT
far-end crosstalk where the disturbing and disturbed pairs are contained in different cables

NOTE Alien (exogenous) far-end crosstalk is expressed in dB.

3.16
power sum of alien (exogenous) crosstalk
PSA
summation of the alien (exogenous) crosstalk power from all disturbing pairs into a disturbed pair in different cables

NOTE 1 The summation is applicable to near-end and far-end alien (exogenous) crosstalk.

NOTE 2 The power sum of alien (exogenous) crosstalk is expressed in dB.

3.17
characteristic impedance
Z_C
impedance at the input of a homogeneous line of infinite length

The impedance value is expressed in Ω, calculated, at relevant frequencies, as the square root of the product of the impedances measured at the near end (input) of a cable pair when the far end is terminated by a short-circuit load and then an open-circuit load.

NOTE 1 The asymptotic value at high frequencies is denoted as Z_∞.

NOTE 2 The characteristic impedance of a homogeneous cable pair is given by the quotient of a voltage wave and current wave which are propagating in the same direction, either forwards or backwards.

NOTE 3 For homogeneous ideal cables, this method yields a flat smooth curve over the whole frequency range. Real cables with distortions give curves with some roughness.

3.18
terminated input impedance
Z_{in}
impedance value, expressed in Ω, at relevant frequencies, measured at the near end (input) when the far end is terminated with the system nominal impedance, Z_R

(See IEC/TR 62152.)

3.19
fitted characteristic impedance
Z_m
impedance value, expressed in Ω, calculated by applying a least squares function fitting algorithm to the measured characteristic impedance values

3.20
mean characteristic impedance

Z_∞
asymptotic value at which the characteristic impedance approaches at sufficiently high frequencies (≈100 MHz) such that the imaginary part (phase angle) is insignificant

NOTE 1 Normally measured from the capacitance and time delay.

NOTE 2 Applicable for cables with frequency independence of mutual capacitance.

3.21
return loss
RL
ratio of reflected power to input power at the input terminals of a cable pair

NOTE Return loss is expressed in dB.

3.22
balun
balanced to unbalanced impedance matching transformer

3.23
bundled cable
grouping or assembly of several individual cables that are systematically laid up

NOTE Bundled cables are also referred to as speed-wrap, whip, or loomed cables.

3.24
current carrying capacity
maximum current a cable circuit (one or several conductors) can support resulting in a specified increase of the surface temperature of the conductor beyond the ambient temperature, not exceeding the maximum allowed operating temperature of the cable

3.25
hygroscopic
characteristic of a material to absorb moisture from the atmosphere

3.26
wicking
longitudinal flow of a liquid in a material due to capillary action

3.27
coupling attenuation
ratio between the transmitted power through the conductors and the maximum radiated peak power, conducted and generated by the exited common-mode currents

3.28
ambient temperature
the temperature of the room or space surrounding the cable

3.29
operating temperature
the surface temperature of the conductors of a cable

The operating temperature is the sum of ambient temperature and of the temperature increase due to the carried power.

4 Installation considerations

The cables shall be designed to meet the installation conditions encountered for each area as follows.

a) Equipment cables

The cables are used between work stations and peripheral equipment (for example, printer).

b) Work area cables

The cables are used between the work station and the communication outlets.

c) Horizontal floor wiring cables

The cables are used between the work area communication outlet and the communication closet.

d) Riser cables and building back-bone cables

The cables are used for horizontal installation or vertically between floors.

e) Campus cables

These cables are used to interconnect buildings and shall be suitable for outdoor installation. The cables should be sheathed and protected in accordance with IEC 62255.

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 EMC (Electromagnetic Compatibility) or fire performance.

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 consist of annealed copper, uniform in quality and free from defects. The properties of the copper shall be in accordance with IEC 60028.

The conductor may be either solid or stranded. The solid conductor shall be circular in section and may be plain or metal-coated. The solid conductor shall be drawn in one piece. Joints in the solid conductor are permitted, provided that the breaking strength of a joint is not less than 85 % of the breaking strength of the unjointed solid conductor.

The stranded conductor shall consist of strands circular in section and assembled without insulation between them by concentric stranding or bunched.

NOTE A bunched strand is not recommended for insulation displacement connection (IDC) application.

The individual strands of the conductor may be plain or metal-coated.

Joints in individual strands are permitted provided that the tensile strength of a joint is not less than 85 % of the breaking strength of the unjointed individual strand. Joints in the complete stranded conductor are not permitted unless allowed and specified in the relevant detail specification.

The conductor of the work area and equipment cables may consist of one or more elements of thin copper or copper alloy tape which shall be applied spirally over a fibrous thread. Joints in the complete element are not permitted.

5.2.2 Insulation

The conductor insulation is composed of one or more suitable dielectric materials. The insulation may be solid, cellular or composite (for example, foam skin).

The insulation shall be continuous, having a uniform thickness.

The insulation shall be applied to fit closely to the conductor.

The insulated conductors may be identified by colours and/or additional ring markings and/or symbols achieved by the use of coloured insulation or by a coloured surface using extrusion, printing or painting. Colours shall be clearly identifiable and shall correspond reasonably with the standard colours shown in IEC 60304.

5.2.2.1 Colour code

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