

INTERNATIONAL STANDARD



**Multicore and symmetrical pair/quad cables for digital communications –
Part 6: Symmetrical pair/quad cables with transmission characteristics
up to 1 000 MHz – Work area wiring – Sectional specification**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.120.20

ISBN 978-2-8322-8148-2

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	5
1 Scope	7
2 Normative references	7
3 Terms and definitions	8
4 Installation considerations	8
4.1 General remarks	8
4.2 Bending radius of installed cable	8
4.3 Climatic conditions	8
5 Materials and cable construction	9
5.1 General remarks	9
5.2 Cable construction	9
5.2.1 Conductor	9
5.2.2 Insulation	9
5.2.3 Cable element	9
5.2.4 Cable make-up	9
5.2.5 Screening of the cable core	9
5.2.6 Sheath	10
5.2.7 Identification	10
5.2.8 Finished cable	10
6 Characteristics and requirements	10
6.1 General remarks	10
6.2 Electrical characteristics and tests	11
6.2.1 Conductor resistance	11
6.2.2 Resistance unbalance	11
6.2.3 Dielectric strength	11
6.2.4 Insulation resistance	11
6.2.5 Mutual capacitance	11
6.2.6 Capacitance unbalance	11
6.2.7 Transfer impedance	11
6.2.8 Coupling attenuation	12
6.2.9 Current-carrying capacity	13
6.3 Transmission characteristics	13
6.3.1 Velocity of propagation (phase velocity)	13
6.3.2 Phase delay and differential delay (delay skew)	13
6.3.3 Attenuation	13
6.3.4 Unbalance attenuation (<i>TCL</i>)	14
6.3.5 Near-end crosstalk (<i>NEXT</i>)	15
6.3.6 Attenuation to crosstalk ratio far end (<i>PS ACR-F</i>)	16
6.3.7 Alien (exogenous) near end crosstalk	16
6.3.8 Alien (exogenous) far-end crosstalk (<i>AACR-F</i>)	17
6.3.9 Alien (exogenous) crosstalk of bundled cables	17
6.3.10 Impedance	17
6.3.11 Return loss (<i>RL</i>)	18
6.4 Mechanical and dimensional characteristics and requirements	19
6.4.1 Dimensional requirements	19
6.4.2 Elongation at break of the conductors	19

6.4.3	Tensile strength of the insulation	19
6.4.4	Elongation at break of the insulation	19
6.4.5	Adhesion of the insulation to the conductor.....	19
6.4.6	Elongation at break of the sheath	19
6.4.7	Tensile strength of the sheath.....	19
6.4.8	Crush test of the cable.....	19
6.4.9	Impact test of the cable	19
6.4.10	Bending under tension	19
6.4.11	Repeated bending of the cable	19
6.4.12	Tensile performance of the cable	19
6.4.13	Shock-test requirements of the cable	20
6.4.14	Bump-test requirements of the cable	20
6.4.15	Vibration-test requirements of the cable.....	20
6.5	Environmental characteristics	20
6.5.1	Shrinkage of the insulation	20
6.5.2	Wrapping test of the insulation after thermal ageing	20
6.5.3	Bending test of the insulation at low temperature	20
6.5.4	Elongation at break of the sheath after ageing	20
6.5.5	Tensile strength of the sheath after ageing	20
6.5.6	Sheath pressure test at high temperature	20
6.5.7	Cold bend test of the cable	20
6.5.8	Heat shock test.....	20
6.5.9	Damp heat steady state	20
6.5.10	Solar radiation	21
6.5.11	Solvents and contaminating fluids.....	21
6.5.12	Salt mist and sulphur dioxide	21
6.5.13	Water immersion	21
6.5.14	Hygroscopicity	21
6.5.15	Wicking.....	21
6.5.16	Flame propagation characteristics of a single cable	21
6.5.17	Flame propagation characteristics of bunched cables	21
6.5.18	Halogen gas evolution	21
6.5.19	Smoke generation.....	21
6.5.20	Toxic gas emission	21
6.5.21	Integrated fire test	21
7	Introduction to the blank detail specification	22
Annex A (informative) Blank detail specification		23
Bibliography.....		28

Figure 1 — Impedance template

Table 1 – Cable categories	7
Table 2 – Transfer impedance	12
Table 3 – Coupling attenuation in dB	12
Table 4 – Attenuation, constant values	14
Table 5 – Near-end unbalance attenuation.....	15
Table 6 – Worst pair <i>PS NEXT</i> (1) values	15

	Table 7 – Worst pair <i>PS ACR-F</i> (1).....	16
	Table 8 – <i>PS ANEXT</i>	16
	Table 9 – <i>PS AACR-F</i> –(<i>PS AELFEXT</i>).....	17
	Table 10 – Return loss.....	18

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MULTICORE AND SYMMETRICAL PAIR/QUAD
CABLES FOR DIGITAL COMMUNICATIONS –****Part 6: Symmetrical pair/quad cables with transmission
characteristics up to 1 000 MHz – Work area wiring –
Sectional 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 61156-6 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.

This fourth edition cancels and replaces the third edition published in 2010 and Amendment 1:2012. This edition constitutes a technical revision.

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

- a) additional balance levels with respect to MICE implementation by certain cabling specifications;
- b) reference to current standards and technical reports with respect to measurement techniques and remote powering.

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

FDIS	Report on voting
46C/1141/FDIS	46C/1145/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

This International Standard is to be used in conjunction with IEC 61156-1:2007 and IEC 61156-1:2007/AMD1:2009.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- 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 document using a colour printer.

MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring – Sectional specification

1 Scope

~~This part of IEC 61156 makes reference to IEC 61156-1. The cables described herein are intended primarily for work area wiring as defined in ISO/IEC 11801 and ISO/IEC 24702.~~

This part of IEC 61156 describes the cables intended primarily for working area wiring as defined in ISO/IEC 11801 (all parts).

It covers cable designs comprising individually screened, common screened and unscreened pairs or quads. The transmission characteristics and the frequency range (see Table 1) of the cables are specified at 20 °C.

Table 1 – Cable categories

Cable designation	Maximum referenced frequency MHz
Category 5e	100
Category 6	250
Category 6 _A	500
Category 7	600
Category 7 _A	1 000

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

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 low voltage ~~and~~ remote powering applications such as IEEE 802.3af (Power over Ethernet) ~~and~~ or further developments for example according to IEEE 802.3at ~~(Power over Ethernet Plus)~~ or IEEE 802.3bt. More information on the capacity to support these applications according to the installation practices are given in IEC 61156-1-4, IEC TR 61156-1-6 and ISO/IEC TS 29125.

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 61156-1:2007, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*

IEC 61156-1:2007/AMD1:2009

~~IEC 61156-6-1, Multicore and symmetrical pair/quad cables for digital communications – Part 6-1: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring – Blank detail specification~~

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

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

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

INTERNATIONAL STANDARD

**Multicore and symmetrical pair/quad cables for digital communications –
Part 6: Symmetrical pair/quad cables with transmission characteristics
up to 1 000 MHz – Work area wiring – Sectional specification**

CONTENTS

FOREWORD	5
1 Scope	7
2 Normative references	7
3 Terms and definitions	8
4 Installation considerations	8
4.1 General remarks	8
4.2 Bending radius of installed cable.....	8
4.3 Climatic conditions.....	8
5 Materials and cable construction	8
5.1 General remarks	8
5.2 Cable construction	9
5.2.1 Conductor.....	9
5.2.2 Insulation.....	9
5.2.3 Cable element	9
5.2.4 Cable make-up	9
5.2.5 Screening of the cable core	9
5.2.6 Sheath.....	9
5.2.7 Identification.....	10
5.2.8 Finished cable	10
6 Characteristics and requirements	10
6.1 General remarks	10
6.2 Electrical characteristics and tests	10
6.2.1 Conductor resistance.....	10
6.2.2 Resistance unbalance.....	10
6.2.3 Dielectric strength.....	11
6.2.4 Insulation resistance.....	11
6.2.5 Mutual capacitance.....	11
6.2.6 Capacitance unbalance	11
6.2.7 Transfer impedance.....	11
6.2.8 Coupling attenuation.....	11
6.2.9 Current-carrying capacity.....	12
6.3 Transmission characteristics	12
6.3.1 Velocity of propagation (phase velocity).....	12
6.3.2 Phase delay and differential delay (delay skew).....	12
6.3.3 Attenuation	12
6.3.4 Unbalance attenuation (<i>TCL</i>)	13
6.3.5 Near-end crosstalk (<i>NEXT</i>).....	14
6.3.6 Attenuation to crosstalk ratio far end (<i>PS ACR-F</i>).....	15
6.3.7 Alien (exogenous) near end crosstalk	15
6.3.8 Alien (exogenous) far-end crosstalk (<i>AACR-F</i>)	16
6.3.9 Alien (exogenous) crosstalk of bundled cables	16
6.3.10 Impedance.....	16
6.3.11 Return loss (<i>RL</i>).....	16
6.4 Mechanical and dimensional characteristics and requirements.....	17
6.4.1 Dimensional requirements	17
6.4.2 Elongation at break of the conductors	17

6.4.3	Tensile strength of the insulation	17
6.4.4	Elongation at break of the insulation	17
6.4.5	Adhesion of the insulation to the conductor.....	17
6.4.6	Elongation at break of the sheath	17
6.4.7	Tensile strength of the sheath.....	17
6.4.8	Crush test of the cable.....	17
6.4.9	Impact test of the cable	18
6.4.10	Bending under tension	18
6.4.11	Repeated bending of the cable	18
6.4.12	Tensile performance of the cable	18
6.4.13	Shock-test requirements of the cable	18
6.4.14	Bump-test requirements of the cable	18
6.4.15	Vibration-test requirements of the cable.....	18
6.5	Environmental characteristics	18
6.5.1	Shrinkage of the insulation	18
6.5.2	Wrapping test of the insulation after thermal ageing	18
6.5.3	Bending test of the insulation at low temperature.....	18
6.5.4	Elongation at break of the sheath after ageing	18
6.5.5	Tensile strength of the sheath after ageing	18
6.5.6	Sheath pressure test at high temperature	19
6.5.7	Cold bend test of the cable	19
6.5.8	Heat shock test.....	19
6.5.9	Damp heat steady state	19
6.5.10	Solar radiation	19
6.5.11	Solvents and contaminating fluids.....	19
6.5.12	Salt mist and sulphur dioxide	19
6.5.13	Water immersion	19
6.5.14	Hygroscopicity	19
6.5.15	Wicking.....	19
6.5.16	Flame propagation characteristics of a single cable	19
6.5.17	Flame propagation characteristics of bunched cables	19
6.5.18	Halogen gas evolution	19
6.5.19	Smoke generation.....	20
6.5.20	Toxic gas emission	20
6.5.21	Integrated fire test	20
7	Introduction to the blank detail specification	20
Annex A (informative)	Blank detail specification	21
Bibliography		26
Table 1	– Cable categories	7
Table 2	– Transfer impedance	11
Table 3	– Coupling attenuation in dB	12
Table 4	– Attenuation, constant values	13
Table 5	– Near-end unbalance attenuation.....	14
Table 6	– Worst pair <i>PS NEXT</i> (1) values	14
Table 7	– Worst pair <i>PS ACR-F</i> (1).....	15
Table 8	– <i>PS ANEXT</i>	15

Table 9 – <i>PS AACR-F</i>	16
Table 10 – Return loss	17

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MULTICORE AND SYMMETRICAL PAIR/QUAD
CABLES FOR DIGITAL COMMUNICATIONS –****Part 6: Symmetrical pair/quad cables with transmission
characteristics up to 1 000 MHz – Work area wiring –
Sectional 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61156-6 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.

This fourth edition cancels and replaces the third edition published in 2010 and Amendment 1:2012. This edition constitutes a technical revision.

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

- a) additional balance levels with respect to MICE implementation by certain cabling specifications;

- b) reference to current standards and technical reports with respect to measurement techniques and remote powering.

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

FDIS	Report on voting
46C/1141/FDIS	46C/1145/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

This International Standard is to be used in conjunction with IEC 61156-1:2007 and IEC 61156-1:2007/AMD1:2009.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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

MULTICORE AND SYMMETRICAL PAIR/QUAD CABLES FOR DIGITAL COMMUNICATIONS –

Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Work area wiring – Sectional specification

1 Scope

This part of IEC 61156 describes the cables intended primarily for working area wiring as defined in ISO/IEC 11801 (all parts).

It covers cable designs comprising individually screened, common screened and unscreened pairs or quads. The transmission characteristics and the frequency range (see Table 1) of the cables are specified at 20 °C.

Table 1 – Cable categories

Cable designation	Maximum referenced frequency MHz
Category 5e	100
Category 6	250
Category 6 _A	500
Category 7	600
Category 7 _A	1 000

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

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 low voltage remote powering applications such as IEEE 802.3af (Power over Ethernet) or further developments for example according to IEEE 802.3at or IEEE 802.3bt. More information on the capacity to support these applications according to the installation practices are given in IEC 61156-1-4, IEC TR 61156-1-6 and ISO/IEC TS 29125.

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

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

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

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