

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**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2012 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,...).

It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

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 978-2-8322-0562-4

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

CONTENTS

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

6.4.6	Elongation at break of the sheath	16
6.4.7	Tensile strength of the sheath	16
6.4.8	Crush test of the cable	16
6.4.9	Impact test of the cable	17
6.4.10	Bending under tension.....	17
6.4.11	Repeated bending of the cable	17
6.4.12	Tensile performance of the cable.....	17
6.4.13	Shock-test requirements of the cable.....	17
6.4.14	Bump-test requirements of the cable	17
6.4.15	Vibration-test requirements of a cable	17
6.5	Environmental characteristics.....	17
6.5.1	Shrinkage of the insulation	17
6.5.2	Wrapping test of the insulation after thermal ageing	17
6.5.3	Bending test of the insulation at low temperature.....	17
6.5.4	Elongation at break of the sheath after ageing.....	17
6.5.5	Tensile strength of the sheath after ageing	17
6.5.6	Sheath pressure test at high temperature	18
6.5.7	Cold bend test of the cable	18
6.5.8	Heat shock test.....	18
6.5.9	Damp heat steady state	18
6.5.10	Solar radiation	18
6.5.11	Solvents and contaminating fluids.....	18
6.5.12	Salt mist and sulphur dioxide.....	18
6.5.13	Water immersion	18
6.5.14	Hygroscopicity.....	18
6.5.15	Wicking	18
6.5.16	Flame propagation characteristics of a single cable.....	18
6.5.17	Flame propagation characteristics of bunched cables	18
6.5.18	Halogen gas evolution	18
6.5.19	Smoke generation	19
6.5.20	Toxic gas emission	19
6.5.21	Integrated fire test	19
7	Introduction to the blank detail specification	19
	Bibliography.....	20
	Figure 1 – Impedance template.....	15
	Table 1 – Cable categories	6
	Table 2 – Transfer impedance	10
	Table 3 – Coupling attenuation	10
	Table 4 – Attenuation, constant values	12
	Table 5 – Near-end unbalance attenuation.....	12
	Table 6 – Worst pair <i>PS NEXT</i> values	13
	Table 7 – Worst pair <i>PS ACR-F</i>	13
	Table 8 – <i>PS ANEXT</i>	14
	Table 9 – <i>PS AACR-F (PS AELFEXT)</i>	14
	Table 10 – Return loss.....	16

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 consolidated version of IEC 61156-6 consists of the third edition (2010) [documents 46C/903/FDIS and 46C/908/RVD] and its amendment 1 (2012) [documents 46C/955/CDV and 46C/968/RVC]. It bears the edition number 3.1.

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 61156-6 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 edition includes the following significant technical changes with respect to the previous edition:

- a) new requirements for new cables Cat6_A, Cat7_A;
- b) revised requirements and tests for the cables.

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

This standard shall be read in conjunction with IEC 61156-1:2007.

The list of all the 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 amendments will remain unchanged until the stability 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.

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 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.

It covers 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 sectional specification provides the cable characteristics required by system developers to evaluate new systems.

The cables covered by this standard 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, they are intended to be used to support the delivery of low voltage and power applications such as IEEE's 802.3af (Power over Ethernet) and 802.3at (Power over Ethernet Plus).

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

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 62153-4-5, 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

3 Terms and definitions

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

4 Installation considerations

See Clause 4 of IEC 61156-1.

4.1 Climatic conditions

Under static conditions, the cables shall operate in the temperature range from –20 °C to +60 °C. The conductor and cable temperature dependence is specified for screened and unscreened cables 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 EMC and 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 a solid or stranded annealed copper, in accordance with 5.2.1 of IEC 61156-1 and should have a nominal diameter between 0,4 mm and 0,65 mm. A conductor diameter of up to 0,8 mm may be used.

5.2.2 Insulation

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

- polyolefin;
- fluoropolymer;
- low-smoke zero-halogen thermoplastic material.

5.2.3 Cable element

The cable element shall be a pair or quad and shall be twisted.

5.2.3.1 Screening of the cable element

When required, the screen for 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 non-wicking material.

5.2.5 Screening of the 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 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 non-wicking.

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

5.2.7 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.

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 standard. Test methods shall be in accordance with Clause 6 of IEC 61156-1.

6.2 Electrical characteristics and tests

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

6.2.1 Conductor resistance

The maximum conductor resistance at, or corrected to, 20 °C shall not exceed 14,5 Ω /100 m of cable.

6.2.2 Resistance unbalance

6.2.2.1 Resistance unbalance within a pair

The resistance unbalance shall not exceed 2 %.

~~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, where screen(s) are present, a conductor/screen with 1,0 kV d.c. for 1 min or, alternatively, with 2,5 kV d.c. for 2 s. An 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, alternatively, 1,7 kV a.c. for 2 s.

6.2.4 Insulation resistance

The test shall be performed on

- conductor/conductor;
- conductor/screen (when present).

The minimum insulation resistance at, or corrected to, 20 °C shall be not less than 5 000 M Ω .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 1 600 pF/km at a frequency of 800 Hz or 1 000 Hz.

6.2.7 Transfer impedance

For cables containing a screen or screens, two grades of performance are recognized for transfer impedance. The transfer impedance shall not exceed the values shown in Table 2 at the discrete frequencies indicated for each grade.

Table 2 – Transfer impedance

Frequency MHz	Maximum surface transfer impedance mΩ/m	
	Grade 1	Grade 2
1	10	50
10	10	100
30	30	200
100	100	1 000

NOTE The screen longitudinal d.c. resistance of 30 mΩ/m or less is an indicator for fulfilling transfer impedance requirement of Grade 2. A measurement of d.c. resistance cannot replace a transfer impedance measurement.

6.2.8 Coupling attenuation

Three types of performance are recognized for coupling attenuation. When measured using the absorbing clamp method, the coupling attenuation in the frequency range from $f = 30,0$ MHz to 1 000 MHz shall meet the requirements indicated in Table 3.

Table 3 – Coupling attenuation

Coupling attenuation type	Frequency range MHz	Coupling attenuation dB
Type I	30 to 100	≥ 85
	100 to 1 000	$\geq 85 - 20 \times \log_{10}(f/100)$
Type II	30 to 100	≥ 55
	100 to 1 000	$\geq 55 - 20 \times \log_{10}(f/100)$
Type III	30 to 100	≥ 40
	100 to 1 000	$\geq 40 - 20 \times \log_{10}(f/100)$
NOTE For screened cables, the triaxial method of IEC 62153-4-9 may also be used.		

Four types of performance are recognized for 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 $f = 30$ MHz to 1 000 MHz shall meet the requirements indicated in Table 3. For screened cables, Type II is the minimum coupling attenuation requirement.

Table 3 – Coupling attenuation

Coupling attenuation type	Frequency range MHz	Coupling attenuation dB
Type I	30 to 100	> 85
Type I	100 to 1 000	$> 85 - 20 \times \log_{10}(f/100)$
Type Ib	30 to 100	> 70
Type Ib	100 to 1 000	$> 70 - 20 \times \log_{10}(f/100)$
Type II	30 to 100	> 55
Type II	100 to 1 000	$> 55 - 20 \times \log_{10}(f/100)$
Type III	30 to 100	> 40
Type III	100 to 1 000	$> 40 - 20 \times \log_{10}(f/100)$

6.2.9 Current-carrying capacity

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

6.3 Transmission characteristics

NOTE All the tests should be carried out on a cable length of 100 m, unless otherwise specified. Cat 7a test lengths should be 50 m.

6.3.1 Velocity of propagation (phase velocity)

NOTE The requirements are not specified but may be indicated in the relevant detail specification.

6.3.2 Phase delay and differential delay (delay skew)

6.3.2.1 Phase delay

The phase delay, τ , shall not exceed the value obtained from Equation (1) in the frequency range from 4 MHz to the maximum referenced frequency,

$$\tau = 534 + \frac{36}{\sqrt{f}} \quad (\text{ns/100 m}) \quad (1)$$

where f is the frequency in MHz.

6.3.2.2 Differential delay (delay skew)

When measured at $(20 \pm 1)^\circ\text{C}$, the maximum delay skew between any two pairs shall not exceed 45 ns/100 m for cat5e, cat6, cat6_A cables and 25 ns/100 m for cat 7 and cat 7_A cables in the frequency range from 4 MHz to the maximum referenced frequency.

6.3.3 Attenuation

6.3.3.1 Attenuation at 20 °C ambient temperature

The maximum attenuation α of any pair in the frequency range indicated in Table 4 shall not exceed the value obtained from Equation (2) using the corresponding values of the constants a, b and c given in Table 4.

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

where f is the frequency in MHz.

Table 4 – Attenuation, constant values

Cable designation	Frequency range MHz	Constants		
		a	b	c
Category 5e	1 to 100	2,866 ¹⁾	0,033	0,300
Category 6	1 to 250	2,730	0,026	0,375
Category 6 _A	1 to 500	2,730	0,0136 5	0,375
Category 7	1 to 600	2,700	0,015	0,300
Category 7 _A	1 to 1 000	2,700	0,007 5	0,300
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.				
¹⁾ 2,866 was arrived at by $1,5 \times 1,91 = 2,866$ as an approximate 150 % factor to accommodate smaller conductor stranding and also ILD since $2,866/1,5=1,9106$ fitted the old 11801 model; the actual 150 % attenuation should be a factor of 2,951.				

6.3.3.2 Attenuation at elevated operating temperature

The increase in maximum attenuation obtained from Equation (2) due to elevated temperature shall not be more than:

- for unscreened cables, 0,4 %/°C, for the temperature range from 20 °C to 40 °C and 0,6%/°C for the temperature range from 40 °C to 60 °C,
- for screened cables, 0,2 %/°C in the temperature range from 20 °C to 60 °C.

6.3.4 Unbalance attenuation

Two levels of performance are recognized for unbalance attenuation. The minimum near-end unbalance attenuation (transverse conversion loss or *TCL*) shall be not less than the value obtained from Equation (3) (level 1) and from Equation (4) (level 2), in the frequency ranges given in Table 5.

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

$$TCL = 50,0 - 10 \times \log_{10} (f) \text{ (dB)} \quad (4)$$

Table 5 – Near-end unbalance attenuation

Cable category	Frequency range MHz
Category 5e	1 to 100
Category 6	1 to 250
Category 6 _A	1 to 250
Category 7	1 to 250
Category 7 _A	1 to 250

The minimum equal-level far-end unbalance attenuation (equal-level transverse conversion transfer loss or *EL TCTL*) for all categories shall not be less than the value obtained from Equation (5) for all frequencies in the range from 1 MHz to 30 MHz.

$$EL \text{ TCTL} = 35,0 - 20 \times \log_{10} (f) \text{ (dB)/100 m} \quad (5)$$

6.3.5 Near-end crosstalk (*PS NEXT*)

The worst pair power sum near end crosstalk, *PS NEXT*, in the frequency range indicated in Table 6 shall not be less than the value obtained from Equation (6) using the corresponding value of *PS NEXT*(1) given in Table 6.

$$PS\ NEXT(f) = PS\ NEXT(1) - 15 \times \log_{10}(f) \quad (\text{dB}) \quad (6)$$

Table 6 – Worst pair *PS NEXT* values

Cable designation	Frequency range MHz	<i>PS NEXT</i> dB
Category 5e	1 to 100	62,3
Category 6	1 to 250	72,3
Category 6 _A	1 to 500	72,3
Category 7	1 to 600	99,4
Category 7 _A	1 to 1 000	105,4
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.		

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 Attenuation to crosstalk ratio far end (*PS ACR-F*)

The worst pair power sum attenuation to crosstalk ratio far end, *PS ACR-F*, in the frequency range indicated in Table 7 shall not be less than the value obtained from Equation (7) using the corresponding value of the *PS ACR-F*(1) given in Table 7.

$$PS\ ACR - F(f) = PS\ ACR - F(1) - 20 \times \log_{10}(f) \quad (\text{dB} / 100\ \text{m}) \quad (7)$$

Table 7 – Worst pair *PS ACR-F*

Cable designation	Frequency range MHz	<i>PS ACR-F</i> dB/ 100 m
Category 5e	1 to 100	61,0
Category 6	1 to 250	65,0
Category 6 _A	1 to 500	65, 0
Category 7	1 to 600	91,0
Category 7 _A	1 to 1 000	91, 0
NOTE 1 If <i>FEXT</i> loss is greater than 70 dB, <i>ACR-F</i> loss may not be measured.		
NOTE 2 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.		

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

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

6.3.7 Alien (exogenous) near end crosstalk

Alien (exogenous) near-end crosstalk is only a measurement consideration for unscreened cables. For Type I and Type II screened cables as defined in Table 3, the alien (exogenous) near-end crosstalk is proven by design.

The *PS ANEXT* (power sum alien (exogenous) near-end crosstalk) of cable when tested in accordance with 6.3.7.1 of IEC 61156-1 shall be not less than the values obtained from Table 8.

Table 8 – *PS ANEXT*

Category	Frequency range MHz	Minimum <i>PS ANEXT</i> dB
Cat6 _A	$1 \leq f \leq 500$	$92,5 - 15 \times \log_{10}(f)$
Cat7 _A	$1 \leq f \leq 1\,000$	$105 - 15 \times \log_{10}(f)$
NOTE Calculated values greater than 67 dB revert to a value of 67 dB.		

6.3.8 Alien (exogenous) far-end crosstalk (*AACR-F*)

Alien (exogenous) far end crosstalk is only a measurement consideration for unscreened cables. For Type I and Type II screened cables as defined in Table 3, the alien (exogenous) far-end crosstalk (*ACR-F*) is proven by design.

The *PS AACR-F* (power-sum alien attenuation to crosstalk ratio far end) of cable when tested in accordance with 6.3.8 of IEC 61156-1 shall be not less than the values obtained from Table 9.

Table 9 – *PS AACR-F (PS AELFEXT)*

Category	Frequency range MHz	Minimum <i>PS AACR-F</i> dB
Cat6 _A	$1 \leq f \leq 500$	$78,2 - 20 \times \log_{10}(f)$
Cat7 _A	$1 \leq f \leq 1\,000$	$92 - 20 \times \log_{10}(f)$
Calculated values greater than 67 dB revert to a value of 67 dB.		

6.3.9 Alien (exogenous) crosstalk of bundled cables

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

6.3.10 Impedance

The measured characteristic impedance in accordance with 6.3.10.1.1 of IEC 61156-1, for each cable category shall fall within the impedance template limits given in Figure 1. The relevant template limits are derived using Equation (8), Equation (9) and Equation (10) for the corresponding cable category, frequency range and return loss requirement given in Table 10.

Cables that meet the requirements of the template are not required to be measured for return loss; alternately, cables that meet the return loss requirements given in 6.3.11 are not required to be measured for characteristic impedance.

The upper impedance limit, Z_u of the template is given by Equation (8),

$$Z_u = Z_0 \times \left(\frac{1 + |\rho|}{1 - |\rho|} \right) \quad (8)$$

The lower impedance limit, Z_l of the template is given by Equation (9),

$$Z_l = Z_0 \times \left(\frac{1 - |\rho|}{1 + |\rho|} \right) \quad (9)$$

where

Z_0 is 100 Ω ;

ρ is the reflection coefficient.

The reflection coefficient, ρ , is calculated from Equation (10).

$$|\rho| = 10^{-\frac{RL}{20}} \quad (10)$$

where RL is the return loss given in 6.3.11.

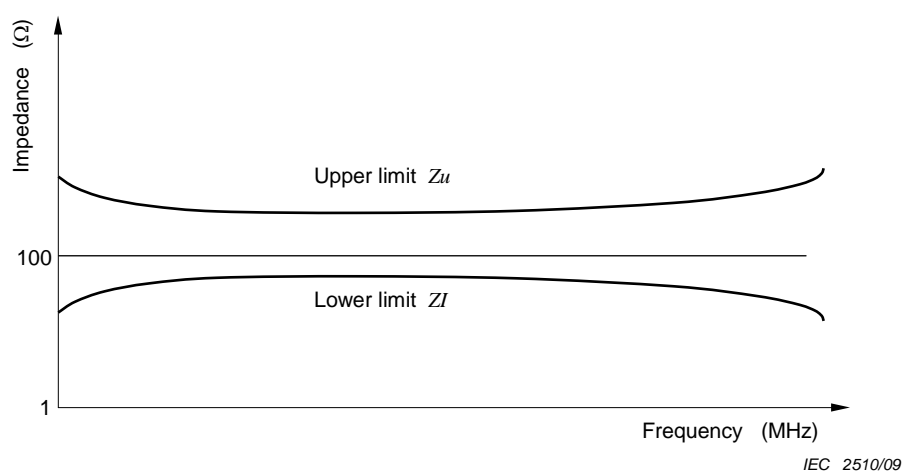


Figure 1 – Impedance template

6.3.11 Return loss (RL)

The minimum return loss of any pair in the frequency range indicated in Table 10 shall not be less than the values in Table 10 for the respective categories.

Table 10 – Return loss

Cable category	Frequency range MHz	Return loss dB
All (see Note 1)	1 to 10	$20,0 + 5,0 \times \log_{10}(f)$
All	10 to 20	25,0
Category 5e	20 to 100	$25,0 - 8,6 \times \log_{10}(f/20)$
Category 6	20 to 250	$25,0 - 8,6 \times \log_{10}(f/20)$
Category 6 _A (see Note 2)	20 to 500	$25,0 - 8,6 \times \log_{10}(f/20)$
Category 7 (see Note 2)	20 to 600	$25,0 - 8,6 \times \log_{10}(f/20)$
Category 7 _A (see Note 2)	20 to 600	$25,0 - 8,6 \times \log_{10}(f/20)$
Category 7 _A	600 to 1 000	$15,6 - 8,6 \times \log_{10}(f/600)$
NOTE 1 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.		
NOTE 2 Calculated values below 15,6 dB revert to a 15,6 dB plateau.		

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 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 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 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

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

6.4.12 Tensile performance of the cable

The tensile performance 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 the insulation

When tested at $(100 \pm 2) ^\circ\text{C}$ 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 the insulation after thermal ageing

Not applicable.

6.5.3 Bending test of the insulation at low temperature

The bending test of the insulated conductor shall be carried out at $(-20 \pm 2) ^\circ\text{C}$. 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 $(100 \pm 2) ^\circ\text{C}$. The tensile strength shall be not 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 $(100 \pm 2) ^\circ\text{C}$. The elongation shall be not 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 $(-20 \pm 2) ^\circ\text{C}$. 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 resistance to solar radiation is not specified but may be indicated 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 indicated 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 % 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

If required by local regulations and indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1.

6.5.17 Flame propagation characteristics of bunched cables

If required by local regulations and indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1.

6.5.18 Halogen gas evolution

If required by local regulations and indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1.

6.5.19 Smoke generation

If required by local regulations and indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1.

6.5.20 Toxic gas emission

If required by local regulations and indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1.

6.5.21 Integrated fire test

If required by local regulations and indicated in the relevant detail specification, the test shall be performed in accordance with IEC 61156-1.

7 Introduction to the blank detail specification

The blank detail specification for cables described in this standard is published as IEC 61156-6-1 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) category number (5e, 6, 6_A, 7, 7_A) to describe basic performance requirements;
- e) nominal impedance of the cable;
- f) mechanical requirements;
- g) environmental requirements;
- h) fire performance.

Bibliography

ISO/IEC 11801, *Information technology – Generic cabling for customer premises*

ISO/IEC 24702, *Information technology – Generic cabling – Industrial premises*

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch