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INTERNATIONAL STANDARD

AMENDMENT 2

Information technology – Generic cabling for customer premises

ISO/IEC 11801:2002/A2:2010(E)

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Information technology – Generic cabling for customer premises

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FOREWORD

Amendment 2 to International Standard ISO/IEC 11801 was prepared by subcommittee 25: Interconnection of information technology, of ISO/IEC joint technical committee 1: Information technology.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

INTRODUCTION

Add, at the end of the existing introductions the following text:

INTRODUCTION to Amendment 2

Amendment 2 of ISO/IEC 11801:2002 provides balanced cabling models, requirements and normative references for Category 6_A and Category 7_A components, requirements for Class E_A and Class F_A links, together with amendments to the requirements for optical fibre cabling.

Global change:

*Replace, throughout ISO/IEC 11801:2002 and Amendment 1:2008 "***optical fibre channel***" by "***optical fibre cabling channel***".*

2 Normative references

Replace the entire existing Clause 2 of both ISO/IEC 11801:2002, as well Amendment 1:2008, by the following:

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.

The provisions of the referenced specifications other than ISO/IEC, IEC, ISO and ITU documents, as identified in this clause, are valid within the context of this International Standard. The reference to such a specification within this International Standard does not give it any further status within ISO or IEC. In particular, it does not give the referenced specification the status of an International Standard.

IEC 60352 (all parts), *Solderless connections*

IEC 60352-3, *Solderless connections – Part 3: Solderless accessible insulation displacement connections – General requirements, test methods and practical guidance*

IEC 60352-4, *Solderless connections – Part 4: Solderless non-accessible insulation displacement connections – General requirements, test methods and practical guidance*

IEC 60352-5, *Solderless connections – Part 5: Press-in connections – General requirements, test methods and practical guidance*

IEC 60352-6, *Solderless connections – Part 6: Insulation piercing connections – General requirements, test methods and practical guidance*

IEC 60352-7, *Solderless connections – Part 7: Spring clamp connections – General requirements, test methods and practical guidance*

IEC 60352-8, *Solderless connections – Part 8: Compression mount connections – General requirements, test methods and practical guidance*[1]

IEC 60364-1, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60512-2-1, *Connectors for electronic equipment – Tests and measurements – Part 2-1: Electrical continuity and contact resistance tests – Test 2a: Contact resistance – Millivolt level method*

IEC 60512-3-1, *Connectors for electronic equipment – Tests and measurements – Part 3-1: Insulation tests – Test 3a: Insulation resistance*

IEC 60512-4-1, *Connectors for electronic equipment – Tests and measurements – Part 4-1: Voltage stress tests – Test 4a: Voltage proof*

IEC 60512-5-2, *Connectors for electronic equipment – Tests and measurements – Part 5-2: Current-carrying capacity tests – Test 5b: Current-temperature derating*

IEC 60512-25-1, *Connectors for electronic equipment – Tests and measurements – Part 25-1: Test 25a – Crosstalk ratio*

IEC 60512-25-2:2002, *Connectors for electronic equipment – Tests and measurements – Part 25-2: Test 25b – Attenuation (insertion loss)*

IEC 60512-25-4:2001, *Connectors for electronic equipment – Tests and measurements – Part 25-4: Test 25d – Propagation delay*

IEC 60512-25-5, *Connectors for electronic equipment – Tests and measurements – Part 25-5: Test 25e – Return loss*

IEC 60512-25-9:2008, *Connectors for electronic equipment – Tests and measurements – Part 25-9:* Signal integrity *tests – Test 25i: Alien crosstalk*

IEC 60512-26-100, *Connectors for electronic equipment – Tests and measurements – Part 26-100: Measurement setup, test and reference arrangements and measurements for connectors according to IEC 60603-7 – Tests 26a to 26g*

IEC 60603-7, *Connectors for electronic equipment – Part 7: Detail specification for 8-way, unshielded, free and fixed connectors*

IEC 60603-7-1, *Connectors for electronic equipment – Part 7-1: Detail specification for 8-way, shielded free and fixed connectors*

IEC 60603-7-2:–, *Connectors for electronic equipment – Part 7-2: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*[2]

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1 To be published.

2 Second edition to be published.

IEC 60603-7-3:–, *Connectors for electronic equipment – Part 7-3: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 100 MHz*[3]

IEC 60603-7-4:–, *Connectors for electronic equipment – Part 7-4: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*[4]

IEC 60603-7-5:–, *Connectors for electronic equipment – Part 7-5: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*[5]

IEC 60603-7-7:–, *Connectors for electronic equipment – Part 7-7: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 600 MHz*[6]

IEC 60603-7-41:–, *Connectors for electronic equipment – Part 7-41: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

IEC 60603-7-51:–, *Connectors for electronic equipment – Part 7-51: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

IEC 60603-7-71:–, *Connectors for electronic equipment – Part 7-71: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 1 000 MHz*[7]

IEC 60793-1-40, *Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation*

IEC 60793-1-44, *Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength*

IEC 60793-1-49, *Optical fibres – Part 1-49: Measurement methods and test procedures – Differential mode delay*

IEC 60793-2:2007, *Optical fibres – Part 2: Product specifications – General*

IEC 60793-2-10, *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*

IEC 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 60794 (all parts), *Optical fibre cables*

IEC 60794-2, *Optical fibre cables – Part 2: Indoor cables – Sectional specification*

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3 Second edition to be published.

4 Second edition to be published.

5 Second edition to be published.

6 Third edition to be published.

7 To be published.

IEC 60825 (all parts), *Safety of laser products*

IEC 60874-19-1:2007, *Fibre optic interconnecting devices and passive components Connectors for optical fibres and cables – Part 19-1: Fibre optic patch cord connector type SC-PC (floating duplex) standard terminated on multimode fibre type A1a, A1b – Detail specification*

IEC 60874-19-2:1999, *Connectors for optical fibres and cables – Part 19-2: Fibre optic adaptor (duplex) type SC for single-mode fibre connectors – Detail specification*

IEC 60874-19-3:2007, *Fibre optic interconnecting devices and passive components – Connectors for optical fibres and cables – Part 19-3 Fibre optic adaptor (duplex) type SC for multimode fibre connectors – Detail specification*

IEC 61073-1, *Fibre optic interconnecting devices and passive components – Mechanical splices and fusion splice protectors for optical fibres and cables – Part 1: Generic specification*

IEC 61076-3-104, *Connectors for electronic equipment – Part 3-104: Detail specification for 8-way, shielded free and fixed connectors for data transmissions with frequencies up to 1 000 MHz*

IEC 61076-3-110, *Connectors for electronic equipment – Part 3-110: Detail specification for shielded, free and fixed connectors for data transmission with frequencies up to 1 000 MHz*

IEC 61156 (all parts), *Multicore and symmetrical pair/quad cables for digital communications*

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

Amendment 1 (2009)

IEC 61156-2:, *Multicore and symmetrical pair/quad cables for digital communications – Part 2: Symmetrical pair/quad cables with transmission characteristics up to 100 MHz – Horizontal floor cable – Sectional specification*

IEC 61156-3:2008, *Multicore and symmetrical pair/quad cables for digital communications – Part 3: Work area wiring – Sectional specification*

IEC 61156-4:2009, *Multicore and symmetrical pair/quad cables for digital communications – Part 4: Riser cables – Sectional specification*

IEC 61156-5:2009, *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1 000 MHz – Horizontal floor wiring – Sectional specification*

IEC 61156-6, *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*[8]

IEC 61300-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance*

IEC 61300-2-2:1995, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-2: Tests – Mating durability*

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8 Refers to the third edition which is currently in preparation

IEC 61300-3-6:1997, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*
Amendment 1:1998
Amendment 2:1999

IEC 61300-3-34:2001, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-34: Examinations and measurements – Attenuation of random mated connectors*

IEC 61754-20:2002, *Fibre optic connector interfaces – Part 20: Type LC connector family*

IEC 61935-1, *Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 – Part 1: Installed cabling*

IEC 61935-2, *Testing of balanced communication cabling in accorance with ISO/IEC 11801 – Part 2: Patch cords and work area cords*

IEC 62153-4-12, *Metallic communication cable test methods – Part 4-12: Electromagnetic compatibility (EMC) – Coupling attenuation or screened attenuation of connecting hardware – Absorbing clamp method*

ISO/IEC TR 14763-2:2000, *Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation*

ISO/IEC 14763-3, *Information technology – Implementation and operation of customer premises cabling – Part 3: Testing of optical fibre cabling*

ISO/IEC 15018, *Information technology – Generic cabling for homes*

ISO/IEC 18010, *Information technology – Pathways and spaces for customer premises cabling*

ISO/IEC TR 24750:2007, *Information technology – Assessment and mitigation of installed balanced cabling channels in order to suport 10GBASE-T*

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

3.1 Terms and definitions

Add the following new terms and definitions:

3.1.84
cabled optical fibre category
system of defining requirements for the cabled optical fibre performance within optical fibre cabling channels and links

NOTE Also referred to as performance codes in some standards.[9]

3.1.85
equipment interface
location where a connection between equipment and the cabling system occurs

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[9] Standards developed by IEC subcommittee 86C use this definition in support of JTC 1/SC25 standards.

3.1.86
test interface
location where a connection between test equipment and the cabling to be tested occurs

3.1.74

Replace, in ISO/IEC 11801:2002, the existing definition 3.1.56 for the term "small form factor connector" *(renumbered as 3.1.74 by Amendment 1:2008) by the following:*

3.1.74
small form factor connector
optical fibre connector designed to accommodate two or more optical fibres with at least the same mounting density as achievable within the IEC 60603-7 series

3.2 Abbreviations

Add the following new abbreviations:

EI Equipment interface

TI Test interface

4 Conformance[10]

Replace, in Amendment 1:2008, point 2) of item b) by the following:

2) attachment of appropriate components to a permanent link or CP link design meeting the prescribed performance class of Clause 6 and Annex A. Channel performance shall be ensured where a channel is created by adding more than one cord to either end of a link meeting the requirements of Annex A;

Delete, in Amendment 1:2008, the following text and referenced footnote:

Until amendment 2[4] of ISO/IEC 11801:2002 has been published:

- conformance for Classes D, E and F with regards to TCL, ELTCTL and coupling attenuation can only be achieved by option 1) above;
- conformance for Classes E_A and F_A can only be achieved by option 1) above.

Add, after bullet h), the following text:

Test methods to assess conformance with the channel and link requirements of Clause 6 and Annex A respectively are specified in IEC 61935-1 for balanced cabling and ISO/IEC 14763-3 for optical fibre cabling. The treatment of measured results that fail to meet the requirements of Clause 6 and Annex A respectively, or lie within the relevant measurement accuracy, shall be clearly documented within a quality plan as described in ISO/IEC 14763-2.

Installation and administration of cabling in accordance with this International Standard shall be undertaken in accordance with ISO/IEC 14763-2.

This International Standard does not specify which tests and sampling levels should be adopted. The test parameters to be measured and the sampling levels to be applied for a particular installation shall be defined in the installation specification and quality plans for that installation prepared in accordance with ISO/IEC 14763-2.

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10 The entire Clause 4 of ISO/IEC 11801:2002, has been replaced by Amendment 1:2008.

5.5 Accommodation of functional elements

Replace, in ISO/IEC 11801:2002, the second sentence of the second paragraph beginning with “Guidance for …” *by the following:*

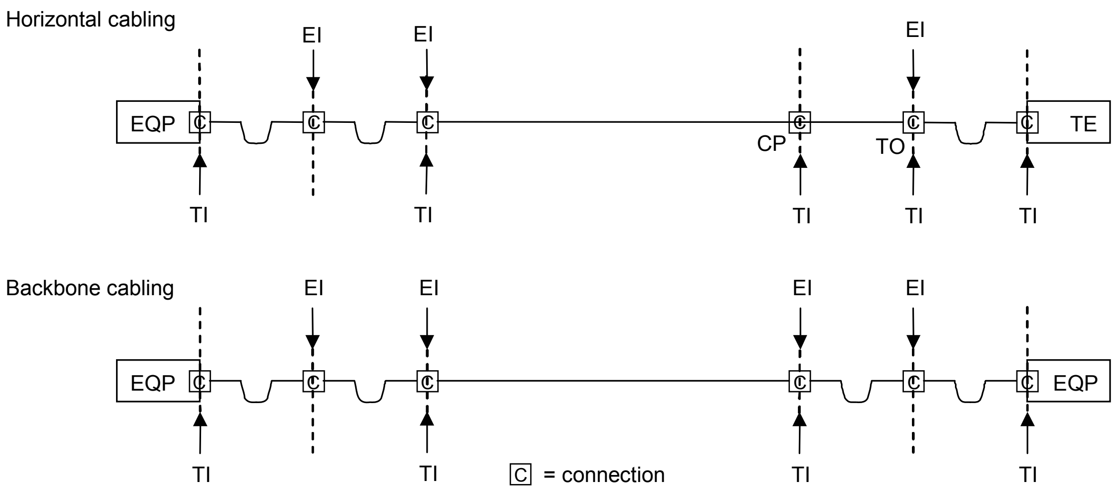
Requirements for the accommodation of distributors are given in ISO/IEC 14763-2 (first edition). Until ISO/IEC 14763-2 is published, relevant information can be found in ISO/IEC TR 14763-2.

Replace, in ISO/IEC 11801:2002, the second sentence of the third paragraph beginning with “Requirements for …” *by the following:*

Requirements for pathways and cable management systems are provided in ISO/IEC 14763-2 (first edition). Until ISO/IEC 14763-2 is published, relevant information can be found in ISO/IEC 18010.

5.6.1 Equipment interfaces and test interfaces

Replace, in ISO/IEC 11801:2002, the existing Figure 7 by the following new Figure 7:



Key

EI Equipment interface

TI Test interface

Figure 7 – Equipment and test interfaces

5.6.2 Channel and permanent link

Replace, in ISO/IEC 11801:2002, the existing first paragraph of by the following:

The transmission performance of generic cabling is detailed in Clauses 6, 8 and Annex A, in terms of the channel and the permanent link.

5.7.5.1 General requirements

Replace, in ISO/IEC 11801:2002, the second sentence of the first bullet point by the following:

Requirements on work area size are given in ISO/IEC 14763-2 (first edition). Until /IEC 14763-2 is published, relevant information can be found in ISO/IEC TR 14763-2.

Replace the last paragraph by the following:

For balanced cables, 2 pairs per TO may be used as an alternative to 4 pairs. However, this may require pair reassignment and will not support some applications (see Annex F). Care should be taken that the initial pair assignment, and all subsequent changes, are recorded (see ISO/IEC 14763-2 for details of administration requirements. Until ISO/IEC 14763-2 (first edition) is published, relevant information can be found in ISO/IEC TR 14763-2). Pair reassignment by means of inserts is allowed.

5.7.6 Consolidation point

Replace, in ISO/IEC 11801:2002, the existing text of bullet point d) by "void"*.*

6.2 Layout

Delete, in Amendment 1:2008, the NOTE which reads:

NOTE Component performance requirements for Category 6_A and Category 7_A will be available in Amendment 2 to ISO/IEC 11801:2002.

Delete, in ISO/IEC 11801:2002, the entire fourth paragraph beginning with "Most Class F channels…".

Replace, in ISO/IEC 11801:2002, the existing paragraph prior to Figure 11, as well as Figure 11 by the following:

Figure 11 shows an example of terminal equipment in the work area connected to transmission equipment using two different media channels which are cascaded. In fact, there is an optical fibre cabling channel (see Clause 8) connected via an active component in the FD to a balanced cabling channel. There are four channel interfaces; one at each end of the balanced channel and one at each end of the optical fibre cabling channel.

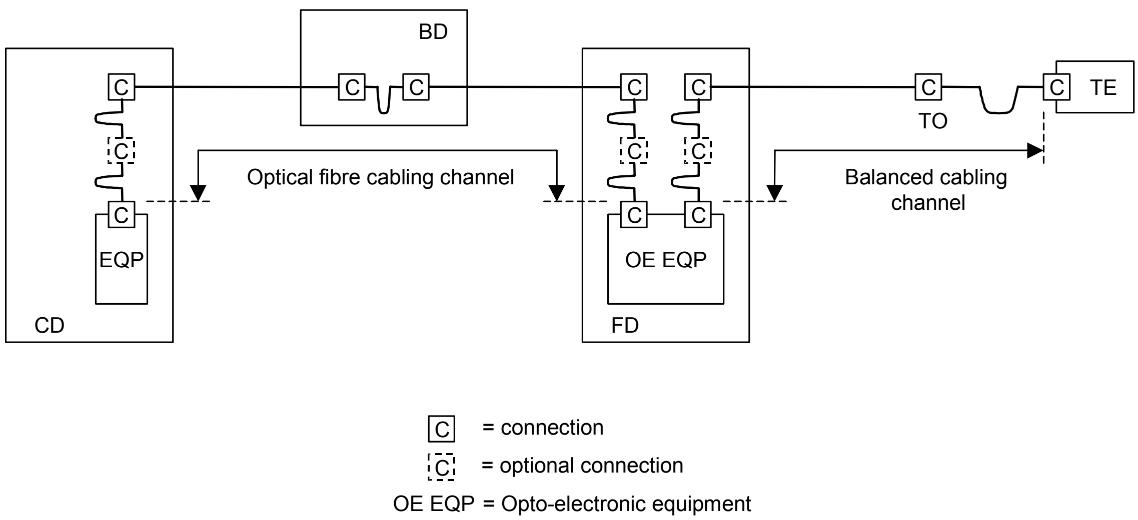


Figure 11 – Example of a system showing the location of cabling interfaces and extent of associated channels

Delete, in Amendment 1:2008, the NOTE *which reads:*

NOTE Permanent link and CP link requirements for Class E_A and Class F_A will be available in amendment 2 to ISO/IEC 11801:2002.

*Delete, in ISO/IEC 11801:2002, the entire last paragraph beginning with "*Most Class F channels…".

6.3 Classification of balanced cabling

Replace, in ISO/IEC 11801:2002, the second sentence of the second paragraph by the following:

Similarly, Class B, C, D, E, E_A, F and F_A channels provide the transmission performance to support Class B, C, D, E, E_A, F and F_A applications respectively.

6.4.2 Return loss

Replace, in ISO/IEC 11801:2002, the existing first paragraph by he following:

The return loss requirements are applicable to Classes C, D, E, E_A, F and F_A only.

6.4.3 Insertion loss/attenuation

Replace, in ISO/IEC 11801:2002, the last paragraph before Table 4 by the following:

When required, the insertion loss shall be measured according to IEC 61935-1.

6.4.5.1 General

Replace, in Amendment 1:2008, the entire text of this subclause by the following:

ACR-N and *PS ACR-N* requirements are applicable to Classes D, E, E_A, F and F_A only.

Except for the name, the definition and equations for *ACR-N* and *PS ACR-N* are identical to those used for *ACR* and *PS ACR,* respectively, in prior editions of this standard.

6.4.6.1 General

Replace, in Amendment 1:2008, the first paragraph by the following:

ACR-F and *PS ACR-F* requirements are applicable to Classes D, E, E_A, F and F_A only.

6.4.9 Current carrying capacity

Replace, in ISO/IEC 11801:2002, the existing subclause by the following:

The minimum current carrying capacity for channels of Classes D, E, E_A, F and F_A shall be 0,175 A d.c. per conductor for all temperatures at which the cabling will be used. This shall be achieved by an appropriate design.

For information on current carrying capacity in respect to applications using remote power supplied over balanced cabling, see ISO/IEC TR 29125.

6.4.13 Delay skew

Replace, in ISO/IEC 11801:2002, the existing second paragraph by the following:

When required, the delay skew shall be calculated according to IEC 61935-1.

6.4.15.5 PS AFEXT for Class E_A channels

Replace, in Amendment 1:2008, the existing third paragraph by the following:

The measured pair-to-pair *AFEXT* values of a wire pair k in a disturbed channel from the disturbing channel l are normalized by the difference of the insertion losses of disturbing and disturbed channels.

7.1 General

Replace, in ISO/IEC 11801:2002, the existing text by the following:

This clause describes implementations of generic balanced cabling that utilise components and assemblies referenced in Clauses 9, 10 and 13. These reference implementations meet the requirements of Clause 5, and when installed in accordance with ISO/IEC 14763-2 (until ISO/IEC 14763-2 is published, relevant information can be found in ISO/IEC TR 14763-2), comply with the channel performance requirements of Clause 6.

7.2.1 General

Replace, in ISO/IEC 11801:2002, the first paragraph by the following:

Balanced components referenced in Clauses 9 and 10 are defined in terms of impedance and category. In the reference implementations of this clause, the components used in each cabling channel shall have the same nominal impedance in accordance with 9.2.

7.2.2.1 Component choice

Replace, in Amendment 1 to ISO/IEC 11801:2008, the existing bullet points for Category 6_A and Category 7_A *by the following:*

- Category 6_A components provide Class E_A balanced cabling performance;
- Category 7_A components provide Class F_A balanced cabling performance;

7.2.2.2 Dimensions

Replace, in ISO/IEC 11801:2002, the existing Figure 12 by the following:

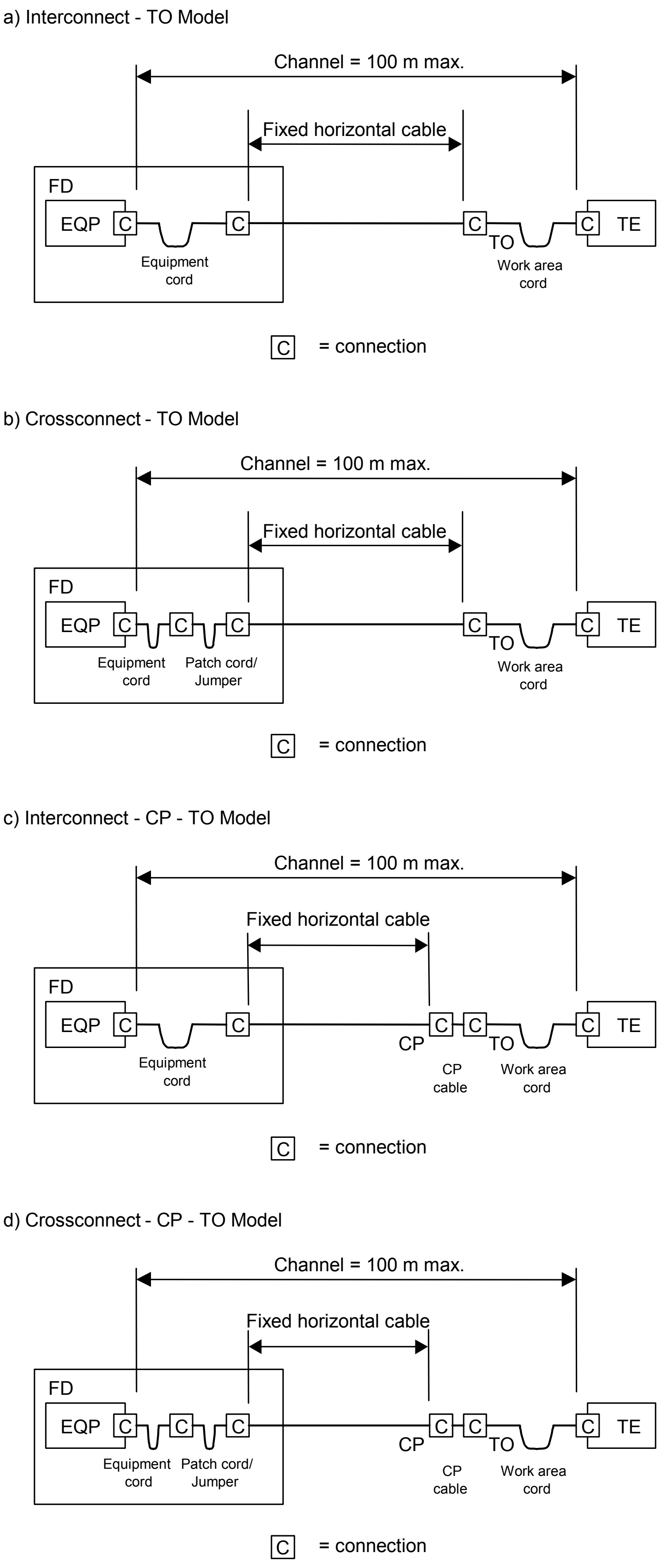


Figure 12 – Horizontal cabling models

7.2.2.2 Dimensions

Replace, in Amendment 1:2008, the existing paragraph before Table 31 by the following:

Table 31 contains the length assumptions of the mathematical model used to validate channel performance using components of Clauses 9, 10 and 13. They do not represent absolute restrictions on the implementation of channels and permanent links, but may be used for guidance in reference implementations.

Table 31[11]

Replace, in Amendment 1:2008, the table title by the following:

Table 31 – Length assumptions used in the mathematical modelling of balanced horizontal cabling

Add, in Amendment 1:2008, the following text before Table 32:

In addition to the cords, the channels shown in Figure 12c and Figure 12d contain a CP cable. The insertion loss specification for the CP cable may differ from that of both the fixed horizontal cable and the cords. In order to accommodate cables used for work area cords, CP cables, patch cords, jumpers and equipment cords with different insertion loss, the length of the cables used within a channel shall be determined by the equations shown in Table 32.

Replace, in Amendment 1:2008, Table 32 by the following:
(Note that Table 21 in ISO/IEC 11801:2002 has been replaced and renumbered by Amendment 1:2008 as Table 32.)

Table 32 – Horizontal channel length equations

		Implementation equation		
Model	**Figure**	**Class D**	**Class E and E_A**	**Class F and F_A**
Interconnect - TO	12a	$H = 109 – FX$	$H = 107 – 3^a – FX$	$H = 107 – 2^a – FX$
Cross-connect - TO	12b	$H = 107 – FX$	$H = 106 – 3^a – FX$	$H = 106 – 3^a – FX$
Interconnect - CP -TO	12c	$H = 107 – FX – CY$	$H = 106 - 3^a – FX – CY$	$H = 106 – 3^a – FX – CY$
Cross-connect - CP - TO	12d	$H = 105 – FX – CY$	$H = 105 - 3^a – FX – CY$	$H = 105 – 3^a – FX – CY$

H the maximum length of the fixed horizontal cable (m)

F combined length of patch cords/jumpers, equipment and work area cords (m)

C the length of the CP cable (m)

X the ratio of cord cable insertion loss (dB/m) to fixed horizontal cable insertion loss (dB/m)

Y the ratio of CP cable insertion loss (dB/m) to fixed horizontal cable insertion loss (dB/m)

NOTE For operating temperatures above 20 °C, H should be reduced by 0,2 % per °C for screened cables; 0,4 % per °C (20 °C to 40 °C) and 0,6 % per °C (>40 °C to 60 °C) for unscreened cables.

[a] This length reduction is to provide an allocated margin to accommodate insertion loss deviation.

Move, in Amendment 1:2008, after Table 32 the following text above the bulleted list:

For the purpose of calculation in Table 32 it is assumed that:

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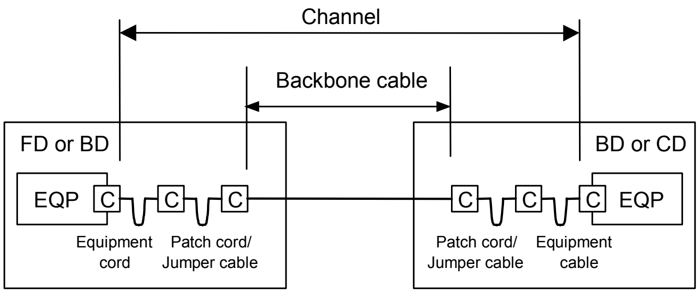
[11] Refers to Table 31 as added by Amendment 1 and not Table 31 (renumbered as Table 42 by Amendment 1:2008) in ISO/IEC 11801:2002.

7.2.3.2 Dimensions

Replace, in ISO/IEC 11801:2002, the last sentence of the first paragraph by the following:

This represents the maximum configuration for a Class D, E, E_A, F or F_A backbone channel.

Replace, in ISO/IEC 11801:2002, the existing Figure 13 of by the following:



EQP = equipment; C = connection (mated pair)

Figure 13 – Backbone cabling model

Replace, in ISO/IEC 11801:2002, the introductory sentence of the second paragraph with bullet points by the following:

The following general restrictions apply for Classes D, E, E_A, F and F_A:

Replace, in Amendment 1:2008, Table 33 by the following:
(Note that Table 22 in ISO/IEC 11801:2002 has been replaced and renumbered by Amendment 1:2008 as Table 33.)

Table 33 – Backbone channel length equations

	Implementation equations [a]							
Component Category	**Class A**	**Class B**	**Class C**	**Class D**	**Class E**	**Class E_A**	**Class F**	**Class F_A**
5	2 000	B = 250 − FX	B = 170 − FX	B = 105 − FX	–	–	–	–
6	2 000	B = 260 − FX	B = 185 − FX	B = 111 − FX	B = 105 – 3[b] – FX	–	–	–
6_A	2 000	B = 260 − FX	B = 189 − FX	B = 114 − FX	B = 108 – 3[b] – FX	B = 105 – 3[b] – FX	–	–
7	2 000	B = 260 − FX	B = 190 − FX	B = 115 − FX	B = 109 – 3[b] – FX	B = 107 – 3[b] – FX	B = 105 – 3[b] − FX	–
7_A	2 000	B = 260 − FX	B = 192 − FX	B = 117 − FX	B = 111 – 3[b] – FX	B = 105 – 3[b] – FX	B = 105 – 3[b] – FX	B = 105 – 3[b] − FX

B the maximum length of the backbone cable (m)

F combined length of patch cords/jumpers and equipment cords (m)

X the ratio of cord cable insertion loss (dB/m) to backbone cable insertion loss (dB/m)

NOTE 1 Where channels contain a different number of connections than in the model shown in Figure 13, the fixed cable length is reduced (where more connections exist) or increased (where fewer connections exist) by 2 m per connection for Category 5 cables and 1 m per connection for Category 6, 6_A, 7 and 7_A cables. Additionally, the *NEXT*, return loss (*RL*) and *ACR-F* performance should be verified.

NOTE 2 For operating temperatures above 20 °C, *B* should be reduced by 0,2 % per °C for screened cables; 0,4 % per °C (20 °C to 40 °C) and 0,6 % per °C (>40 °C to 60 °C) for unscreened cables.

[a] Applications limited by propagation delay or delay skew may not be supported if channel lengths exceed 100 m.

[b] This length reduction is to provide an allocated margin to accommodate insertion loss deviation.

8.1 General

Replace, in ISO/IEC 11801:2002, the entire text of this subclause by the following:

The selection of an optical fibre cabling channel design for use within a generic cabling system should be made with reference to Annex F. This standard specifies the following classes for optical fibre cabling:

Class OF-300 channels support applications over the cabled optical fibre Categories referenced in Clause 9 to a minimum of 300 m

Class OF-500 channels support applications over the cabled optical fibre Categories referenced in Clause 9 to a minimum of 500 m

Class OF-2 000 channels support applications over the cabled optical fibre Categories referenced in Clause 9 to a minimum of 2 000 m

Optical fibre cabling channels shall be comprised of components that comply with Clauses 9 and 10. These clauses specify physical construction (core/cladding diameter and numerical aperture) and transmission performance. Within the reference implementations of this clause, the cabled optical fibres used in each cabling channel shall be of the same specification.

8.2 Component choice

Replace, in ISO/IEC 11801:2002, the existing first paragraph by the following:

The selection of optical fibre components shall take into account the initial class of applications to be supported, and the required channel lengths, and should take into account any predicted changes to the class of applications to be supported during the expected life of the cabling.

8.3 Channel attenuation

Replace, in ISO/IEC 11801:2002, the existing last sentence of the first paragraph by the following:

The attenuation of channels and permanent links at a specified wavelength shall not exceed the sum of the specified attenuation values for the components at that wavelength (where the attenuation of a length of cabled optical fibre is calculated from its attenuation coefficient multiplied by its length).

8.4 Channel topology

Replace, in ISO/IEC 11801:2002, the existing first sentence of the second paragraph by the following:

The delivery of cabled optical fibre to the TO would not generally require transmission equipment at the FD (unless the design of optical fibre in the backbone cabling subsystem differs from that in the horizontal cabling subsystem).

Replace, in ISO/IEC 11801:2002, the existing Figure 14 by the following:

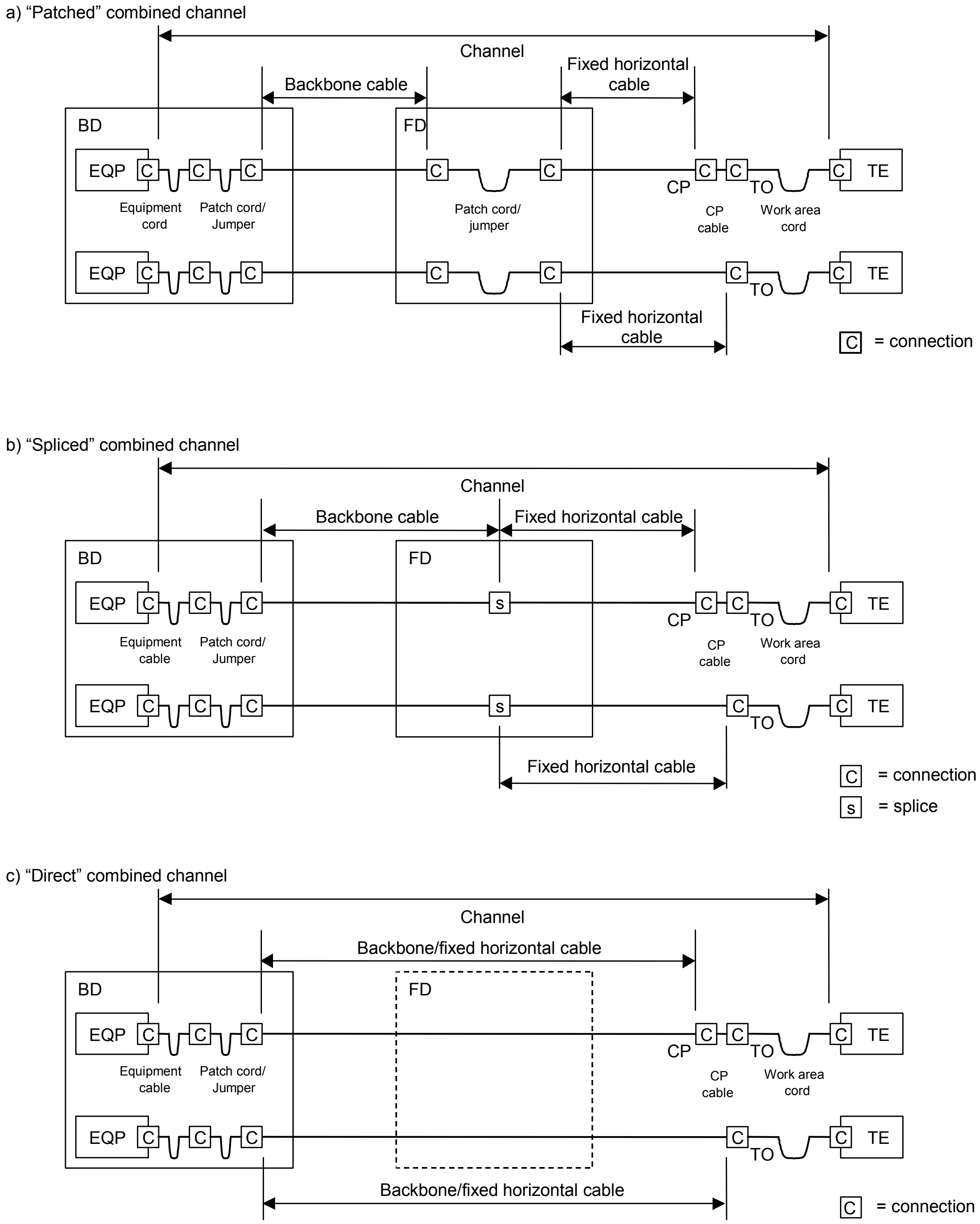


Figure 14 – Combined backbone/horizontal channels

8.5 Propagation delay

Replace, in ISO/IEC 11801:2002, the existing text of this subclause by the following:

For some applications, knowledge of the delay of optical fibre cabling channels is important. This ensures compliance with end-to-end delay requirements of complex networks consisting of multiple cascaded channels. For this reason, it is important to know the lengths of the optical fibre cabling channels. It is possible to calculate propagation delay based on cable performance (see Clause 9).

9.1 General

Replace, in ISO/IEC 11801:2002, the existing first paragraph by the following:

This clause specifies the minimum cable performance requirements for the reference implementations in Clause 7. The requirements in this clause are specified at a temperature of 20 °C. They include:

9.2 Balanced cables

9.2.1 Basic performance requirements

Replace, in ISO/IEC 11801:2002, the existing title of this subclause as follows:

9.2.1 Performance for balanced cables

Replace, in ISO/IEC 11801:2002, Table 24 (renumbered as Table 35 by Amendment 1:2008) by the following new title and Table 35:

Table 35 – Performance for balanced cables

IEC 61156-2, third edition [a]	Sectional specification for multicore and symmetrical pair/quad cables for digital communications – Horizontal wiring
IEC 61156-3, third edition [a]	Sectional specification for multicore and symmetrical pair/quad cables for digital communications – Work area wiring
IEC 61156-4 third edition [a]	Sectional specification for multicore and symmetrical pair/quad cables for digital communications – Riser cables
IEC 61156-5 second edition [a]	Symmetrical pair/quad cables for digital communications with transmission characteristics up to 1 000 MHz – Part 5: Horizontal wiring
IEC 61156-6 third edition [a]	Symmetrical pair/quad cables for digital communications with transmission characteristics up to 1 000 MHz – Part 6: Work area wiring
[a] In preparation, see Clause 2.	

9.2.2.3 Mean characteristic impedance

Replace, in ISO/IEC 11801:2002, the title and the text of the entire subclause by the following:

9.2.2.3 Characteristic impedance

Refer to 6.3.10 of IEC 61156-5:2009, measured according to 6.3.10.1.1 of IEC 61156-1:2007, on a standard length of 100 m. The nominal impedance shall be 100 Ω.

Alternative test methodologies that have been shown to correlate with these requirements may also be used.

9.2.2.4 Attenuation

Replace, in ISO/IEC 11801:2002, the first paragraph by the following:

For the attenuation of Category 5 cable the constants specified in 6.3.3.2 of IEC 61156-5:2009 shall be used. They result in a lower attenuation than given in Table 4 of 6.3.3.1 of IEC 61156-5:2009, for example in 21,3 dB/100 m at 100 MHz.

9.2.2.5 ELFEXT and PS ELFEXT

Replace, in ISO/IEC 11801:2002, the title and text of the entire subclause by the following:

9.2.2.5 ACR-F and PS ACR-F

9.2.2.5.1 ACR-F

The *ACR-F* of each pair combination shall meet the requirements derived by the equation in Table 60.

Table 60 – ACR-F for cables

Frequency MHz	**Minimum ACR-F** [a, b] dB				
	Cable category				
	5	**6**	**6_A**	**7**	**7_A**
$1 \le f \le 100$	$63{,}8 - 20 \lg(f)$	–	–	–	–
$1 \le f \le 250$	–	$67{,}8 - 20 \lg(f)$	–	–	–
$1 \le f \le 500$	–	–	$67{,}8 - 20 \lg(f)$	–	–
$1 \le f \le 600$	–	–	–	$94{,}0 - 20 \lg(f)$	–
$1 \le f \le 1\,000$	–	–	–	–	$105{,}3 - 20 \lg(f)$

a *ACR-F* at frequencies that correspond to measured *FEXT* values of greater than 70 dB, are for information only.

b *ACR-F* at frequencies that correspond to calculated values of greater than 75,0 dB shall revert to a minimum requirement of 75,0 dB.

Table 61 – Informative ACR-F values for cables at key frequencies

Frequency MHz	**Minimum ACR-F** dB				
	Cable category				
	5	**6**	**6_A**	**7**	**7_A**
1	63,8	67,8	67,8	75,0	75,0
100	23,8	27,8	27,8	54,0	65,3
250	–	19,8	19,8	46,0	57,3
500	–	–	13,8	40,0	51,3
600	–	–	–	38,4	49,7
1 000	–	–	–	–	45,3

9.2.2.5.2 PS ACR-F

The *PS ACR-F* of each pair combination shall meet the requirements derived by the equation in Table 62.

Table 62 – PS ACR-F for cables

Frequency MHz	Minimum PS ACR-F [a, b] dB				
	Cable category				
	5	6	6_A	7	7_A
$1 \leq f \leq 100$	$60,8 - 20 \lg(f)$	–	–	–	–
$1 \leq f \leq 250$	–	$64,8 - 20 \lg(f)$	–	–	–
$1 \leq f \leq 500$	–	–	$64,8 - 20 \lg(f)$	–	–
$1 \leq f \leq 600$	–	–	–	$91,0 - 20 \lg(f)$	–
$1 \leq f \leq 1\ 000$	–	–	–	–	$102,3 - 20 \lg(f)$

[a] *PS ACR-F* at frequencies that correspond to measured PS *FEXT* values of greater than 67 dB, are for information only.

[b] *PS ACR-F* at frequencies that correspond to calculated values of greater than 72,0 dB shall revert to a minimum requirement of 72,0 dB.

Table 63 – Informative PS ACR-F values for cables at key frequencies

Frequency MHz	Minimum PS ACR-F dB				
	Cable category				
	5	6	6_A	7	7_A
1	60,8	64,8	64,8	72,0	72,0
100	20,8	24,8	24,8	51,0	62,3
250	–	16,8	16,8	43,0	54,3
500	–	–	10,8	37,0	48,3
600	–	–	–	35,4	46,7
1 000	–	–	–	–	42,3

9.2.2.6 Current carrying capacity

Replace, in ISO/IEC 11801:2002, the entire text of this subclause by the following:

Minimum d.c. current carrying capacity per conductor shall be as indicated in Table 64.

Table 64 – Minimum current carrying capacity

Minimum current A d.c.	Operating temperature t °C
0,300	$t \leq (T_R - 10)$
0,175	$(T_R - 10) < t \leq T_R$
NOTE T_R is the lowest specified operating temperature (maximum) of the cables comprising the cabling subsystem.	

Conformance shall be achieved by design.

Refer to ISO/IEC TR 29125 for additional information on current carrying capacity under different installation conditions.

9.2.2.7 Coupling attenuation

Replace, in ISO/IEC 11801:2002, the entire text of this subclause by the following:

Screened cables shall meet the requirements of Type II as described in IEC 61156-5.

9.2.2.8 Transfer impedance

Replace, in ISO/IEC 11801:2002, the entire text of this subclause by the following:

Screened cables shall meet the grade 2 transfer impedance requirements as described in IEC 61156-5.

Insert, after 9.2.2.8, the following new subclause:

9.2.2.9 Unbalance attenuation, near-end

Unscreened cables shall meet the requirements of level 2 as described in IEC 61156-5.

9.3 Additional crosstalk considerations for cable sharing in balanced cables

9.3.1 General

Replace, in ISO/IEC 11801:2002, the titles of 9.3 and 9.3.1 as follows:

9.3 Additional crosstalk considerations for balanced cables

9.3.1 Cable sharing

Delete the first paragraph of 9.3.1.

9.3.2 Power summation in backbone cables

Replace the last sentence of the first paragraph of by the following:

These cables shall additionally meet the *PS NEXT* requirements for crosstalk in bundled cable, i.e. 3.3.10 of IEC 61156-5:2002[12].

Insert, after subclause 9.3.3, the following new subclause:

9.3.4 Alien crosstalk

Cables used in class E_A and class F_A channels shall meet alien crosstalk requirements for category 6_A and category 7_A cables respectively, as specified in IEC 61156-5 and IEC 61156-6.

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[12] IEC 61156-5:2002, *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 600 MHz – Horizontal floor wiring – Sectional specification*

9.4 Optical fibre cables

Replace, in ISO/IEC 11801:2002, the title of this subclause as follows:

9.4 Optical fibre cable (cabled optical fibres)

9.4.1 Optical fibre types

Replace, in ISO/IEC 11801:2002, the title and the entire subclause by the following:

9.4.1 Cabled optical fibre Categories

Six cabled optical fibre Categories are specified to support various classes of applications, four multimode Categories (OM1, OM2, OM3 and OM4) and two single-mode Categories (OS1 and OS2).

Replace, in ISO/IEC 11801:2002, Table 26 (renumbered as Table 37 by Amendment 1:2008) by the following:

Table 37 – Cabled optical fibre attenuation

Cabled optical fibre attenuation (maximum) dB/km							
	OM1, OM2 OM3 and OM4 multimode		OS1 single-mode		OS2 single-mode		
Wavelength	850 nm	1 300 nm	1 310 nm	1 550 nm	1 310 nm	1 383 nm	1 550 nm
Attenuation	3,5	1,5	1,0	1,0	0,4	0,4	0,4

9.4.3 Multimode optical fibre cable

Replace, in ISO/IEC 11801:2002, the entire text and table of this subclause by the following: (Note that Table 27 was renumbered as Table 38 by Amendment 1:2008.)

Requirements of multimode optical fibre cables include compliance to

a) the cabled optical fibre performance,

b) the type of fibre,

c) the physical cable performance.

The cabled optical fibre Category designated as OM1 and OM2 is achieved using a multimode, graded-index optical fibre waveguide with nominal 50/125 µm or 62,5/125 µm core/cladding diameter and numerical aperture complying with A1b or A1a.1 optical fibre, respectively, of IEC 60793-2-10.

The cabled optical fibre Category designated as OM3 and OM4 is achieved using a multimode, graded-index optical fibre waveguide with nominal 50/125 µm core/cladding diameter and numerical aperture complying with A1a.2 and A1a.3 optical fibre respectively of IEC 60793-2-10.

The limits to be met for cabled optical fibre transmission performance are specified in Table 37 and Table 38. Attenuation shall be measured in accordance with IEC 60793-1-40.

The optical fibre cable shall meet mechanical and environmental requirements of the relevant specification of the IEC 60794 series.

Table 38 – Multimode optical fibre modal bandwidth

		Minimum modal bandwidth MHz × km		
		Overfilled launch bandwidth		Effective modal bandwidth
Wavelength		850 nm	1 300 nm	850 nm
Category	Nominal core diameter µm			
OM1	50 or 62,5	200	500	Not specified
OM2	50 or 62,5	500	500	Not specified
OM3	50	1 500	500	2 000
OM4	50	3 500	500	4 700
NOTE Modal bandwidth requirements apply to the optical fibre used to produce the relevant cabled optical fibre category and are assured by the parameters and test methods specified in IEC 60793-2-10. Optical fibres that meet only the overfilled launch modal bandwidth may not support some applications specified in Annex F.				

9.4.4 Single-mode optical fibre cables

Replace, in ISO/IEC 11801:2002, the entire text by the following:

Requirements of single-mode optical fibre cables include compliance to

a) the cabled optical fibre performance,

b) the type of fibre,

c) the physical cable performance.

The cabled optical fibre category designated as OS1 is achieved using a single-mode, fibre complying with B1.1, B1.3 or B6_a, respectively, of IEC 60793-2-50.

The cabled optical fibre category designated as OS2 is achieved using a single-mode, fibre complying with B1.1, B1.3 or B6_a, respectively, of IEC 60793-2-50.

NOTE 1 If concatenating different OSx cabled optical fibres manufactured with different optical fibre types, refer to IEC/TR 62000:2010[13] for additional guidance.

The requirements for cabled optical fibre transmission performance are specified:

a) for the attenuation in Table 37 when measured in accordance with IEC 60793-1-40;

b) for the cut-off wavelength being less than 1 260 nm when measured in accordance with IEC 60793-1-44.

The optical fibre cable shall meet mechanical and environmental requirements of the relevant specification of the IEC 60794 series.

NOTE 2 Channels with a specified attenuation at 1 383 nm can only be created using B1.3 or B6_a optical fibres.

NOTE 3 B1.1 optical fibre is not recommended where channels may contain both category OS1 and OS2 cabled optical fibre.

NOTE 4 B6_a optical fibre is recommended when it is expected that the optical fibre or the cable will have to support smaller bend radii than 25 mm.

13 The second edition is planned to be published in 2010.

10.1.1 Applicability

Replace, in ISO/IEC 11801:2002, the last sentence of the first paragraph by the following:

The requirements of the detail specifications for free connectors and fixed connectors referenced in this clause shall also be met.

10.1.6 Installation practices

Replace, in ISO/IEC 11801:2002, the existing third paragraph by the following:

The connecting hardware shall be identified according to the requirements of ISO/IEC 14763-2 (until ISO/IEC 14763-2 is published, relevant information can be found in ISO/IEC TR 14763-1). Planning and installation of connecting hardware should be carried out in accordance with ISO/IEC 14763-2 (until ISO/IEC 14763-2 is published, relevant information can be found in ISO/IEC TR 14763-2).

10.2.1 General requirements

Replace, in ISO/IEC 11801:2002, the entire text by the following:

The following requirements apply to all connecting hardware used to provide electrical connections with balanced cables that comply with the requirements of Clause 9. It is desirable that hardware used to directly terminate balanced cable elements be of the insulation piercing connection (IPC) type or the insulation displacement connection (IDC) type. In addition to these requirements, connecting hardware used with screened cabling shall be in full compliance with Clause 11.

The requirements of 10.2.3 and 10.2.4 are based upon the categories of connecting hardware specified in the reference implementations of Clause 7. For channel, permanent link, and CP link design routes to conformance, as specified in Clause 4, other connecting hardware can be used at places other than the TO.

10.2.3 Mechanical characteristics

Replace, in ISO/IEC 11801:2002, Table 28 (renumbered as Table 39 by Amendment 1:2008) by the following:

Table 39 – Mechanical characteristics of connecting hardware for use with balanced cabling

Mechanical characteristics			Requirement	Component or test standard
a)	Physical dimensions (TO only)	Category 5 unscreened	Mating dimensions and gauging	IEC 60603-7-2
		Category 5 screened	Mating dimensions and gauging	IEC 60603-7-3
		Category 6 unscreened	Mating dimensions and gauging	IEC 60603-7-4
		Category 6 screened	Mating dimensions and gauging	IEC 60603-7-5
		Category 6_A unscreened	Mating dimensions and gauging	IEC 60603-7-41
		Category 6_A screened	Mating dimensions and gauging	IEC 60603-7-51
		Category 7 screened	Mating dimensions and gauging	IEC 60603-7-7 [h]
		Category 7_A screened	Mating dimensions and gauging	IEC 60603-7-71 [h, i]
b)	Cable termination compatibility			
	Nominal conductor diameter – mm		0,5 to 0,65 [a]	–
	Cable type	Patching [d]	Stranded or solid conductors	–
		Jumpers	Stranded or solid conductors	–
		Other	Solid conductors	–
	Nominal diameter of insulated conductor mm	Categories 5 and 6	0,7 to 1,4 [b, c]	–
		Categories 6_A, 7, and 7_A	0,7 to 1,6 [b, c]	
	Number of conductors	Telecommunications outlet	8	Visual inspection
		Other	≥2 × n (n = 1, 2, 3, ...)	
	Cable outer diameter mm	Outlet	≤20	–
		Free connector (plug)	≤9 [e]	
	Means to connect screen [f]		Mechanical and environmental performance	Annex C and Clause 11
c)	Mechanical operation (durability)			
	Cable termination (cycles)	Non-reusable IDC	1	IEC 60352-3 or IEC 60352-4
		Reusable IDC	≥20	IEC 60352-3 or IEC 60352-4
		Non-reusable IPC	1	IEC 60352-6
	Jumper termination (cycles)		≥200 [g]	IEC 60352-3 or IEC 60352-4
	TO-type interface (cycles)		≥750	IEC 60603-7 (unscreened) or IEC 60603-7-1 (screened)
	Other connections		≥200	Annex C

[a] It is not required that connecting hardware be compatible with cables outside of this range. However, when cables with conductor diameters as low as 0,4 mm or as high as 0,8 mm are used, special care shall be taken to ensure compatibility with connecting hardware to which they connect.

[b] Use of the free connector (plug) specified in series IEC 60603-7 is typically limited to cables having insulated conductor diameters in the range of 0,8 mm to 1,0 mm.

[c] It is not required that connecting hardware be compatible with cables outside of this range. However, when cables with insulated conductor diameters as high as 1,6 mm are used, special care shall be taken to ensure compatibility with connecting hardware to which they connect.

[d] Free connectors (plugs) shall be compatible with the solid or stranded cable selected for work area or equipment cords.

[e] Applicable only to individual cable units.

[f] If it is intended to use screened cabling, care should be taken that the connector is designed to terminate the screen. There may be a difference between connectors designed to terminate balanced cables with overall screens only, as opposed to cables having both individually screened elements and an overall screen (see ANNEX E).

[g] This durability requirement is only applicable to connections designed to administer cabling system changes (i.e., at a distributor).

[h] In installations where other factors, such as BCT applications (see ISO/IEC 15018), take preference over the backward compatibility offered with IEC 60603-7-7 and IEC 60603-7-71, the interface specified in IEC 61076-3-104 may be used.

[i] If backwards compatibility is not required, the free connector (plug) specified in IEC 61076-3-110 may be used.

10.2.4.1 General

Replace, in ISO/IEC 11801:2002, the first paragraph by the following:

Connecting hardware intended for use with balanced cabling shall meet the following performance requirements. Connecting hardware shall be tested with terminations and test leads that match the nominal characteristic impedance of the types of cable that they are intended to terminate (see 9.2).

10.2.4.2 Telecommunications outlets

Replace, in ISO/IEC 11801:2002, Table 29 (renumbered as Table 40 by Amendment 1:2008) by the following:

Table 40 – Electrical characteristics of TOs intended for use with balanced cabling

Electrical characteristics of the telecommunications outlet		Requirement	Component or test standard
Interface type	**Frequency range** MHz		
Category 5 unscreened	d.c., 1 to 100	All	IEC 60603-7-2
Category 5 screened	d.c., 1 to 100	All	IEC 60603-7-3
Category 6 unscreened	d.c., 1 to 250	All	IEC 60603-7-4
Category 6 screened	d.c., 1 to 250	All	IEC 60603-7-5
Category 6_A unscreened	d.c., 1 to 500	All	IEC 60603-7-41
Category 6_A screened	d.c., 1 to 500	All	IEC 60603-7-51
Category 7 screened	d.c., 1 to 600	All	IEC 60603-7-7 [a]
Category 7_A screened	d.c., 1 to 1 000	All	IEC 60603-7-71 [a]

[a] In installations where other factors, such as BCT applications (see ISO/IEC 15018), take preference over the backward compatibility offered with IEC 60603-7-7, the interface specified in IEC 61076-3-104 may also be used.

10.2.4.3 Connecting hardware for use in distributors and consolidation points

Replace, in ISO/IEC 11801:2002, the first paragraph by the following:

Connecting hardware for use in distributors and consolidation points of a given category shall meet the corresponding performance requirements specified in the following tables irrespective of the mating interface used. All two-piece connections that are not covered by 10.2.4.2 shall comply with the mechanical and environmental performance requirements specified in Annex C for unscreened and screened connectors. All electrical requirements shall be met before and after mechanical and environmental performance testing, as prescribed in Annex C.

Add, in ISO/IEC 11801:2002, the following new paragraph, after the first paragraph:
(Note that Tables 32 and 33 were renumbered as Tables 43 and 44 by Amendment 1:2008.)

If the CP link portion of a Class F_A 3 connector permanent link (PL3 in Figure A.1) uses cable in accordance with IEC 61156-5, the connecting hardware at the CP requires NEXT and PSNEXT performance that is 6 dB better than the Category 7_A requirements specified in Table 43 and Table 44.

Replace, in ISO/IEC 11801:2002, Table 30 (renumbered as Table 41 by Amendment 1:2008) by the following:

Table 41 – Return loss for connector

Frequency MHz	**Minimum return loss** [a] dB					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
$1 \leq f \leq 100$	60 – 20 lg(f)	–	–	–	–	IEC 60512-25-5
$1 \leq f \leq 250$	–	64 – 20 lg(f)	–	–	–	
$1 \leq f \leq 500$	–	–	68 – 20 lg(f)	–	–	
$1 \leq f \leq 600$	–	–	–	68 – 20 lg(f)	–	
$1 \leq f \leq 1\,000$	–	–	–	–	68 – 20 lg(f) [b]	

[a] Return loss at frequencies that correspond to calculated values of greater than 30,0 dB shall revert to a minimum requirement of 30,0 dB.

[b] Calculated values below 10,0 dB revert to a 10,0 dB plateau.

Insert, in ISO/IEC 11801:2002, between Tables 30 and 31 (renumbered as Tables 41 and 42, by Amendment 1:2008) the following new Table 65:

Table 65 – Informative return loss values for connector at key frequencies

Frequency MHz	**Minimum return loss** dB				
	Connector category				
	5	**6**	**6_A**	**7**	**7_A**
1	30,0	30,0	30,0	30,0	30,0
100	20,0	24,0	28,0	28,0	28,0
250	–	16,0	20,0	20,0	20,0
500	–	–	14,0	14,0	14,0
600	–	–	–	12,4	12,4
1 000	–	–	–	–	10,0

Replace, in ISO/IEC 11801:2002, Table 31 (renumbered as Table 42 by Amendment 1:2008) by the following:

Table 42 – Insertion loss for connector

Frequency MHz	**Maximum insertion loss** [a] dB					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
$1 \leq f \leq 100$	$0{,}04\sqrt{f}$	–	–	–	–	IEC 60512-25-2
$1 \leq f \leq 250$	–	$0{,}02\sqrt{f}$	–	–	–	
$1 \leq f \leq 500$	–	–	$0{,}02\sqrt{f}$	–	–	
$1 \leq f \leq 600$	–	–	–	$0{,}02\sqrt{f}$	–	
$1 \leq f \leq 1\ 000$	–	–	–	–	$0{,}02\sqrt{f}$	

[a] Insertion loss at frequencies that correspond to calculated values of less than 0,1 dB shall revert to a requirement of 0,1 dB maximum.

Insert, in ISO/IEC 11801:2002, between Tables 31 and 32 (renumbered as Tables 42 and 43 by Amendment 1:2008) the following new Table 66:

Table 66 – Informative insertion loss values for connector at key frequencies

Frequency MHz	**Maximum insertion loss** dB				
	Connector category				
	5	**6**	**6_A**	**7**	**7_A**
1	0,10	0,10	0,10	0,10	0,10
100	0,40	0,20	0,20	0,20	0,20
250	–	0,32	0,32	0,32	0,32
500	–	–	0,45	0,45	0,45
600	–	–	–	0,49	0,49
1 000	–	–	–	–	0,63

Replace, in ISO/IEC 11801:2002, Table 32 (renumbered as Table 43 by Amendment 1:2008) by the following:

Table 43 – Near end crosstalk (NEXT) for connector

Frequency MHz	**Minimum NEXT** [a] dB					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
$1 \leq f \leq 100$	83 – 20 lg(f)	–	–	–	–	IEC 60512-25-1
$1 \leq f \leq 250$	–	94 – 20 lg(f)	94 – 20 lg(f)	–	–	
$250 < f \leq 500$	–	–	46,04 – 30 lg(f/250)	–	–	
$1 \leq f \leq 600$	–	–	–	102,4 – 15 lg(f)	116,3 – 20 lg(f)	
$600 < f \leq 1\ 000$	–	–	–	–	60,73 – 40 lg(f /600)	

[a] *NEXT* at frequencies that correspond to calculated values of greater than 75,0 dB shall revert to a minimum requirement of 75,0 dB.

Insert, in ISO/IEC 11801:2002, between Tables 32 and 33 (renumbered as Tables 43 and 44 by Amendment 1:2008) the following new Table 67:

Table 67 – Informative NEXT values for connector at key frequencies

Frequency MHz	**Minimum NEXT** dB				
	Connector category				
	5	**6**	**6_A**	**7**	**7_A**
1	75,0	75,0	75,0	75,0	75,0
100	43,0	54,0	54,0	72,4	75,0
250	–	46,0	46,0	66,4	68,3
500	–	–	37,0	61,9	62,3
600	–	–	–	60,7	60,7
1 000	–	–	–	–	51,9

Replace, in ISO/IEC 11801:2002, Table 33 (renumbered as Table 44 by Amendment 1:2008) by the following:

Table 44 – Power sum near end crosstalk (PS NEXT) for connector (for information only)

Frequency MHz	**Minimum PS NEXT** [a] dB					**Test standard**
	Connector category					
	5	**6**	**6$_A$**	**7**	**7$_A$**	
$1 \le f \le 100$	80 − 20 lg(f)	–	–	–	–	IEC 60512-25-1
$1 \le f \le 250$	–	90 − 20 lg(f)	90 − 20 lg(f)	–	–	
$250 < f \le 500$	–	–	42,04 − 30 lg(f/250)	–	–	
$1 \le f \le 600$	–	–	–	99,4 − 15 lg(f)	113,3 − 20 lg(f)	
$600 < f \le 1\,000$	–	–	–	–	57,73 − 40 lg(f/600)	

[a] *PS NEXT* at frequencies that correspond to calculated values of greater than 72,0 dB shall revert to a minimum requirement of 72,0 dB.

Insert, in ISO/IEC 11801:2002, between Tables 33 and 34 (renumbered as Tables 44 and 45 by Amendment 1:2008) the following new Table 68.

Table 68 – Informative PS NEXT values for connector at key frequencies

Frequency MHz	**Minimum PS NEXT** dB				
	Connector category				
	5	**6**	**6$_A$**	**7**	**7$_A$**
1	72,0	72,0	72,0	72,0	72,0
100	40,0	50,0	50,0	69,4	72,0
250	–	42,0	42,0	63,4	65,3
500	–	–	33,0	58,9	59,3
600	–	–	–	57,7	57,7
1 000	–	–	–	–	48,9

Replace, in ISO/IEC 11801:2002, Table 34 (renumbered as Table 45 by Amendment 1:2008) by the following:

Table 45 – Far end crosstalk (FEXT) for connector

Frequency MHz	**Minimum FEXT** [a, b] dB					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
$1 \leq f \leq 100$	75,1 − 20 lg(f)	–	–	–	–	IEC 60512-25-1
$1 \leq f \leq 250$	–	83,1 − 20 lg(f)	–	–	–	
$1 \leq f \leq 500$	–	–	83,1 − 20 lg(f)	–	–	
$1 \leq f \leq 600$	–	–	–	90 − 15 lg(f)	–	
$1 \leq f \leq 1\,000$	–	–	–	–	103,9 − 20 lg(f)	

[a] *FEXT* at frequencies that correspond to calculated values of greater than 75,0 dB shall revert to a minimum requirement of 75,0 dB.

[b] For connectors, the difference between *FEXT* and *ACR-F* is minimal. Therefore, connector *FEXT* requirements are used to model *ACR-F* performance for links and channels.

Insert, in ISO/IEC 11801:2002, between Tables 34 and 35 (renumbered as Tables 45 and 46 by Amendment 1:2008) the following new Table 69.

Table 69 – Informative FEXT values for connector at key frequencies

Frequency MHz	**Minimum FEXT** dB				
	Connector category				
	5	**6**	**6_A**	**7**	**7_A**
1	75,0	75,0	75,0	75,0	75,0
100	35,1	43,1	43,1	60,0	63,9
250	–	35,1	35,1	54,0	55,9
500	–	–	29,1	49,5	49,9
600	–	–	–	48,3	48,3
1 000	–	–	–	–	43,9

Replace, in ISO/IEC 11801:2002, Table 35 (renumbered as Table 46 by Amendment 1:2008) by the following:

Table 46 – Power sum far end crosstalk (PS FEXT) for connector (for information only)

Frequency MHz	**Minimum PS FEXT** [a, b] dB					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
$1 \leq f \leq 100$	72,1 - 20 lg(f)	–	–	–	–	IEC 60512-25-1
$1 \leq f \leq 250$	–	80,1 - 20 lg(f)	–	–	–	
$1 \leq f \leq 500$	–	–	80,1 - 20 lg(f)	–	–	
$1 \leq f \leq 600$	–	–	–	87 - 15 lg(f)	–	
$1 \leq f \leq 1\ 000$	–	–	–	–	100,9 - 20 lg(f)	

[a] *PS FEXT* at frequencies that correspond to calculated values of greater than 72,0 dB shall revert to a minimum requirement of 72,0 dB.

[b] For connectors, the difference between *PS FEXT* and *PS ACR-F* is minimal. Therefore, connector *PS FEXT* requirements are used to model *PS ACR-F* performance for links and channels.

Insert, in ISO/IEC 11801:2002, between Tables 35 and 36 (renumbered as Tables 45 and 46 by Amendment 1:2008) the following new Table 70.

Table 70 – Informative PS FEXT values for connector at key frequencies

Frequency MHz	**Minimum PS FEXT** dB				
	Connector category				
	5	**6**	**6_A**	**7**	**7_A**
1	72,0	72,0	72,0	72,0	72,0
100	32,1	40,1	40,1	57,0	60,9
250	–	32,1	32,1	51,0	52,9
500	–	–	26,1	46,5	46,9
600	–	–	–	45,3	45,3
1 000	–	–	–	–	40,9

Replace, in ISO/IEC 11801:2002, Table 36 (renumbered as Table 47 by Amendment 1:2008) by the following:

Table 47 – Input to output resistance

Frequency	**Maximum input to output resistance** mΩ					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
d.c.	200	200	200	200	200	IEC 60512-2-1 Test 2a

Replace, in ISO/IEC 11801:2002, Table 37 (renumbered as Table 48 by Amendment 1:2008) by the following:

Table 48 – Input to output resistance unbalance

Frequency	**Maximum input to output resistance unbalance** mΩ					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
d.c.	50	50	50	50	50	IEC 60512-2-1 Test 2a

Replace, in ISO/IEC 11801:2002, Table 38 (renumbered as Table 49 by Amendment 1:2008) by the following:

Table 49 – Current carrying capacity

Frequency	**Minimum current carrying capacity** [a, b] A					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
d.c.	0,75	0,75	0,75	0,75	0,75	IEC 60512-5-2 Test 5b
[a] Applicable for an ambient temperature of 60 °C.						
[b] Applicable to each conductor including the screen, if present.						

Replace, in ISO/IEC 11801:2002, Table 39 (renumbered as Table 50 by Amendment 1:2008) by the following:

Table 50 – Propagation delay

Frequency MHz	**Maximum propagation delay** ns					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
$1 \le f \le 100$	2,5	–	–	–	–	IEC 60512-25-4
$1 \le f \le 250$	–	2,5	–	–	–	
$1 \le f \le 500$	–	–	2,5	–	–	
$1 \le f \le 600$	–	–	–	2,5	–	
$1 \le f \le 1\ 000$	–	–	–	–	2,5	
This parameter shall be met by design.						

Replace, in ISO/IEC 11801:2002, Table 40 (renumbered as Table 51 by Amendment 1:2008) by the following:

Table 51 – Delay skew

Frequency MHz	**Maximum delay skew** ns **Connector category** 5	6	6_A	7	7_A	**Test standard**
$1 \le f \le 100$	1,25	–	–	–	–	IEC 60512-25-4
$1 \le f \le 250$	–	1,25	–	–	–	
$1 \le f \le 500$	–	–	1,25	–	–	
$1 \le f \le 600$	–	–	–	1,25	–	
$1 \le f \le 1\,000$	–	–	–	–	1,25	
This parameter shall be met by design.						

Replace, in ISO/IEC 11801:2002, Table 41 (renumbered as Table 52 by Amendment 1:2008) by the following:

Table 52 – Transverse conversion loss (TCL)

Frequency MHz	**Minimum transverse conversion loss (*TCL*)** [a] dB **Connector category** 5	6	6_A	7	7_A	**Test standard**
$1 \le f \le 100$	66 − 20 lg(f)	–	–	–	–	ITU-T Recommendation O.9
$1 \le f \le 250$	–	68 − 20 lg(f)	–	–	–	
$1 \le f \le 500$	–	–	68 − 20 lg(f)	–	–	
$1 \le f \le 600$	–	–	–	68 − 20 lg(f)	–	
$1 \le f \le 1\,000$	–	–	–	–	68 − 20 lg(f)	
[a] *TCL* at frequencies that correspond to calculated values of greater than 50,0 dB shall revert to a minimum requirement of 50,0 dB.						

Insert, in ISO/IEC 11801:2002, after Table 41 (renumbered as Table 52 by Amendment 1: 2008), the following new Tables 71, 72, and 73:

Table 71 – Informative TCL values for connector at key frequencies

Frequency MHz	**Minimum transverse conversion loss (*TCL*)** dB **Connector category** 5	6	6_A	7	7_A
1	50,0	50,0	50,0	50,0	50,0
100	26,0	28,0	28,0	28,0	28,0
250	–	20,0	20,0	20,0	20,0
500	–	–	14,0	14,0	14,0
600	–	–	–	12,4	12,4
1 000	–	–	–	–	8,0

Table 72 – Transverse conversion transfer loss (TCTL)

Frequency MHz	Minimum transverse conversion transfer loss (*TCTL*) [a] dB					Test standard
	Connector category					
	5	6	6_A	7	7_A	
$1 \leq f \leq 100$	66 − 20 lg(*f*)	–	–	–	–	ITU-T Recommendation O.9
$1 \leq f \leq 250$	–	68 − 20 lg(*f*)	–	–	–	
$1 \leq f \leq 500$	–	–	68 − 20 lg(*f*)	–	–	
$1 \leq f \leq 600$	–	–	–	68 − 20 lg(*f*)	–	
$1 \leq f \leq 1\,000$	–	–	–	–	68 − 20 lg(*f*)	

[a] *TCTL* at frequencies that correspond to calculated values of greater than 50,0 dB shall revert to a minimum requirement of 50,0 dB.

Table 73 – Informative TCTL values for connector at key frequencies

Frequency MHz	Minimum transverse conversion loss (*TCTL*) dB				
	Connector category				
	5	6	6_A	7	7_A
1	50,0	50,0	50,0	50,0	50,0
100	26,0	28,0	28,0	28,0	28,0
250	–	20,0	20,0	20,0	20,0
500	–	–	14,0	14,0	14,0
600	–	–	–	12,4	12,4
1 000	–	–	–	–	8,0

Replace, in ISO/IEC 11801:2002, Table 42 (renumbered as Table 53 by Amendment 1:2008) by the following:

Table 53 – Transfer impedance (screened connectors only)

Frequency MHz	Maximum transfer impedance Ω					Test standard
	Connector category					
	5	6	6_A	7	7_A	
$1 \leq f \leq 10$	$0{,}1\,f^{0,3}$	$0{,}1\,f^{0,3}$	$0{,}1\,f^{0,3}$	$0{,}05\,f^{0,3}$	$0{,}05\,f^{0,3}$	IEC 60512-26-100 Test 26e
$10 < f \leq 80$	$0{,}02\,f$	$0{,}02\,f$	$0{,}02\,f$	$0{,}01\,f$	$0{,}01\,f$	

Insert, in ISO/IEC 11801:2002, after Table 42 (renumbered as Table 53 by Amendment 1: 2008), the following new Tables 74, 75, and 76:

Table 74 – Informative transfer impedance values (screened connectors only) at key frequencies

Frequency MHz	**Maximum transfer impedance** Ω				
	Connector category				
	5	**6**	**6_A**	**7**	**7_A**
1	0,10	0,10	0,10	0,05	0,05
10	0,20	0,20	0,20	0,10	0,10
80	1,60	1,60	1,60	0,80	0,80

Table 75 – Coupling attenuation (screened connectors only)

Frequency MHz	**Minimum coupling attenuation** dB					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
$30 \leq f \leq 100$	≥45,0	≥45,0	≥45,0	≥45,0	≥45,0	IEC 62153-4-12
$100 < f \leq$ NOTE	–	85-20 lg(f)	85-20 lg(f)	85-20 lg(f)	85-20 lg(f)	
NOTE Coupling attenuation is measured to 1 000 MHz but the limit applies to the upper frequency of the Category under test.						

Table 76 – Informative coupling attenuation values (screened connectors only) at key frequencies

Frequency MHz	**Minimum coupling attenuation** dB				
	Connector category				
	5	**6**	**6_A**	**7**	**7_A**
30	45,0	45,0	45,0	45,0	45,0
100	45,0	45,0	45,0	45,0	45,0
250	–	37,0	37,0	37,0	37,0
500	–	–	31,0	31,0	31,0
600	–	–	–	29,4	29,4
1 000	–	–	–	–	25,0

Replace, in ISO/IEC 11801:2002, Tables 43 and 44 (renumbered as Tables 54 and 55 by Amendment 1:2008) by the following:

Table 54 – Insulation resistance

Frequency	**Minimum insulation resistance** MΩ					**Test standard**
	Connector category					
	5	**6**	**6_A**	**7**	**7_A**	
d.c.	100	100	100	100	100	IEC 60512-3-1 Test 3a, Method C 500 V d.c.

Table 55 – Voltage proof

Electrical characteristics	**Frequency**	**Minimum voltage proof** V					**Test standard**
		Connector category					
		5	**6**	**6_A**	**7**	**7_A**	
Conductor to conductor	d.c.	1 000	1 000	1 000	1 000	1 000	IEC 60512-4-1 Test 4a
Conductor to test panel (and screen, if present)	d.c.	1 500	1 500	1 500	1 500	1 500	

Insert, in ISO/IEC 11801:2002, after Table 44 (renumbered as Table 55 by Amendment 1: 2008), the following new Tables 77, 78, 79, and 80:

Table 77 – Power sum alien near end crosstalk (PS ANEXT)

Frequency MHz	**Minimum power sum alien near end crosstalk (PS ANEXT)** [a] dB		**Test standard**
	Connector category		
	6_A	**7_A**	
$1 \leq f \leq 500$	$110{,}5 - 20\lg(f)$	–	IEC 60512-25-9
$1 \leq f \leq 1\,000$	–	$125{,}5 - 20\lg(f)$	

[a] *PS ANEXT* at frequencies that correspond to calculated values of greater than 72,0 dB shall revert to a minimum requirement of 72,0 dB.

Table 78 – Informative PS ANEXT values at key frequencies

Frequency MHz	**Minimum power sum alien near end crosstalk (PS ANEXT)** dB	
	Connector category	
	6_A	**7_A**
1	72,0	72,0
100	70,5	72,0
250	62,5	72,0
500	56,5	71,5
1 000	–	65,5

Table 79 – Power sum alien far end crosstalk (PS AFEXT)

Frequency MHz	**Minimum power sum alien far end crosstalk (PS AFEXT)** [a, b] dB		**Test standard**
	Connector category		
	6_A	**7_A**	
$1 \leq f \leq 500$	$107 - 20 \lg(f)$	–	IEC 60512-25-9
$1 \leq f \leq 1\,000$	–	$122 - 20 \lg(f)$	

[a] *PS AFEXT* at frequencies that correspond to calculated values of greater than 72,0 dB shall revert to a minimum requirement of 72,0 dB.

[b] For connectors, the difference between *PS AFEXT* and *PS AACR-F* is minimal. Therefore, connector *PS AFEXT* requirements are used to model *PS AACR-F* performance for links and channels.

Table 80 – Informative PS AFEXT values at key frequencies

Frequency MHz	**Minimum power sum alien far end crosstalk (PS AFEXT)** dB	
	Connector category	
	6_A	**7_A**
1	72,0	72,0
100	67,0	72,0
250	59,0	72,0
500	53,0	68,0
1 000	–	62,0

10.2.5 Telecommunications outlet requirements

Replace, in ISO/IEC 11801:2002, the title and the entire text including Figure 15 and Table 45 (renumbered as Table 56 by Amendment 1:2008) by the following:

10.2.5 TO requirements

For all cabling classes, each horizontal balanced cable shall be terminated at the telecommunications outlet with an unkeyed fixed connector (jack) that meets the specifications of 10.2.3 and 10.2.4. Pin and pair grouping assignments shall be as shown in Figures 15, 18 or 19.

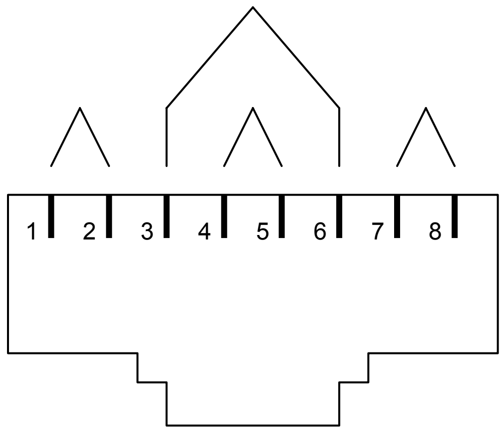
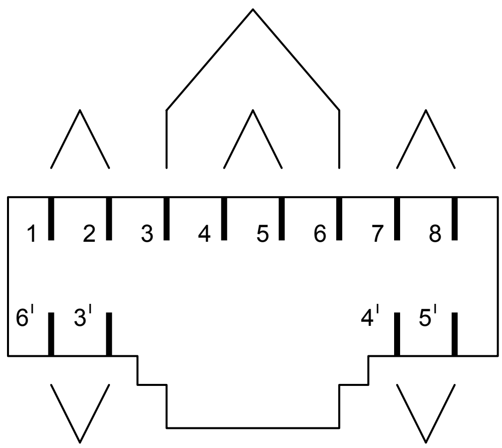


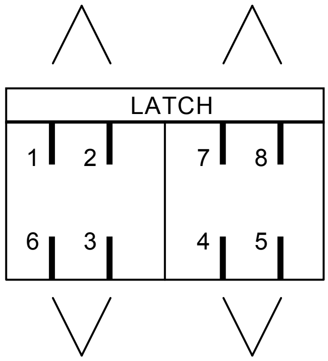
Figure 15 – Pin grouping and pair assignments for IEC 60603-7 series interface for Categories 5, 6 and 6_A (front view of fixed connector (jack), not to scale)



NOTE 1 Pin designations 1, 2, 3' , 4' , 5', 6', 7 and 8 are used for Categories 7 and 7_A and correspond to pin designations 1, 2, 3, 4, 5, 6, 7 and 8 for categories 5, 6, and 6_A.

NOTE 2 Figure 18 shows front view of fixed connector (jack), not to scale.

Figure 18 – Pin grouping and pair assignment for the IEC 60603-7 series interface for Categories 7 and 7_A



NOTE 1 Pin designations correspond to those of the IEC 60603-7 series interface.

NOTE 2 Figure 19 shows front view of fixed connector (jack), not to scale.

Figure 19 – Pin grouping and pair assignments for Categories 7 and 7_A (IEC 61076-3-104) interface

If different connecting hardware types are used at a distributor, CP or TO in the same link or channel the cabling connections shall be configured with consistent pin/pair assignments to ensure end-to-end connectivity. Pair rearrangement at the telecommunications outlet should not involve modification of the horizontal cable terminations. If pair rearrangement is used at the telecommunications outlet, the configuration of the outlet terminations shall be clearly identified.

Free and fixed connectors (plugs and jacks) that are intermateable shall be backward compatible with those of different performance categories. Backward compatibility means that the mated connections with free and fixed connectors (plugs and jacks) from different categories shall meet all of the requirements for the lower category component. See Table 56 for a matrix of backward compatible mated free and fixed connectors (plug and jack) performance that is representative of backward compatible connectivity.

Table 56 – Matrix of backward compatible mated free and fixed connector (plug and jack) performance

		Fixed connector (jack) performance at the TO				
		Category 5	**Category 6**	**Category 6_A**	**Category 7**	**Category 7_A**
Free connector (plug)	**Category 5**	Category 5	Category 5	Category 5	Category 5	Category 5
	Category 6	Category 5	Category 6	Category 6	Category 6	Category 6
	Category 6_A	Category 5	Category 6	Category 6_A	Category 6_A	Category 6_A
	Category 7	Category 5	Category 6	Category 6_A	Category 7	Category 7
	Category 7_A	Category 5	Category 6	Category 6_A	Category 7	Category 7_A

NOTE 1 When two physically similar cabling links are used in the same installation, special precautions are required to ensure that they are properly identified at the telecommunications outlet. Examples of when such identification is necessary would include different performance classes or cables with different nominal impedance. See also Clause 12.

NOTE 2 For proper connectivity, care is needed to ensure that pairs are terminated consistently at the telecommunications outlet and floor distributor. If pairs are terminated on different positions at the two ends of a link, although DC continuity may be maintained, through connectivity will be lost. See Clause 12 for cabling system administration.

10.3.1 General requirements

Replace, in ISO/IEC 11801:2002, the existing NOTE *by the following paragraph:*

Optical fibre adapters and connectors should be protected from dust and other contaminants, specifically while they are in an unmated state. End faces of connectors shall be inspected according to ISO/IEC 14763-3 and subsequently cleaned when necessary, prior to connection.

10.3.2 Marking and colour coding

Replace, in ISO/IEC 11801:2002, the entire text by the following:

Consistent coding of connectors and adapters, for example by colour, should be used to identify connections between:

- different cabled multimode optical fibre types;
- incompatible single-mode connecting hardware (e.g. blue for connectors with PC ferrules and green for connectors with APC ferrules).

In addition, keying and the identification of optical fibre positions may be used to ensure that correct polarity is maintained for duplex links.

NOTE 1 These markings are in addition to, and do not replace, other markings specified in Clause 12, or those required by local codes or regulations.

NOTE 2 The following colour codes apply to IEC 60874-19-1 SC duplex and IEC 60874-14[14] SC simplex connectors but may also be used for other connector types:

Multimode 50 µm and 62,5 µm:	Beige or black
Single-mode PC:	Blue
Single-mode APC:	Green

Replace, in ISO/IEC 11801:2002, Table 46 (renumbered as Table 57 by Amendment 1:2008) by the following:

[14] IEC 60874-14, *Connectors for optical fibres and cables – Part 14: Sectional specification for fibre optic connector – Type SC*. This publication has been withdrawn in 2002, but can still be ordered if needed.

Table 57 – Mechanical and optical characteristics of optical fibre connecting hardware

Mechanical and optical characteristics			Requirement	Component or test standard
a)	Physical dimensions (only at telecommunications outlet) [a]		Mating dimensions and gauging	IEC 61754-20, interface 5
b)	Cable termination compatibility			
	Nominal cladding diameter µm		125	IEC 60793-2, Clause 5 (A1a, A1b) and 32.2 (B1)
	Nominal buffer diameter mm		–	IEC 60794-2, 6.1
	Cable outer diameter mm		–	IEC 60794-2, 6.1
c)	Mechanical endurance (durability) cycles		≥500	IEC 61300-2-2
d)	Mated pair transmission performance			
	Maximum insertion loss [b] dB	Other	100% ≤ 0,75 dB 95% ≤ 0,50 dB 50% ≤ 0,35 dB	IEC 61300-3-34
		Splice	0,3	IEC 61073-1
	Minimum return loss dB	Multimode	20	IEC 61300-3-6
		Single-mode	35	

[a] See 10.3.4.

[b] Insertion loss of splices and connectors shall be met with the referenced test method where the optical source produces a controlled launch condition. The required metric to qualify the source is encircled flux. The required launch condition is specified in IEC 61300-1 and shall be based on LED. Under filling sources such as lasers will produce lower insertion loss values.

10.3.4 Telecommunications outlet requirements

Replace, in ISO/IEC 11801:2002, the title and the entire text of this subclause by the following:

10.3.4 TO requirements

The optical fibre cables in the work area shall be connected to horizontal cabling at the TO with a duplexable LC connector that complies with IEC 61754-20.

Networks having an installed base of IEC 60874-19-1 (SC-D) connectors and adapters may remain with the SC-D connector and adaptor for both existing and future additions to their optical fibre network. (For mating dimensions and gauging of multimode, see IEC 60874-19-3, and of single-mode, see IEC 60874-19-2.)

The optical fibre connector used at the TO shall meet the requirements of 10.3.3.

10.3.5.1 General

Replace, in ISO/IEC 11801:2002, the existing third and fourth paragraphs by the following:

On the work area side of TOs and the interconnect/cross-connect side of distributor panels, a duplex presentation maintains the correct polarity of transmit and receive optical fibres in two optical fibre transmission systems while still allowing transmission systems using other optical fibre counts. At the distributor, this presentation is preferably a duplex adapter that maintains the spacing and alignment as specified in IEC 61754-20 interface 5.

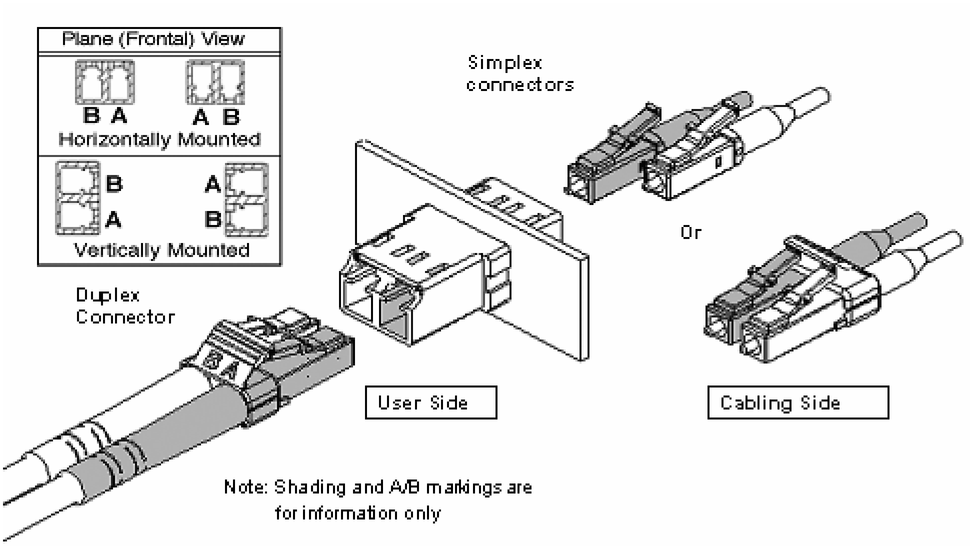
Polarity is defined at the TO for optical fibre positions A and B. To extend this polarity throughout the cabling system, it is important that the same orientation, colour coding, marking, and optical fibre configuration be applied consistently. Once the system is installed and correct polarity is verified, the correct polarity of transmit and receive optical fibres within the optical fibre cabling system will be maintained.

10.3.5.2 Connectivity options at the TO

Replace, in ISO/IEC 11801:2002, the entire text and Figure 16 by the following:

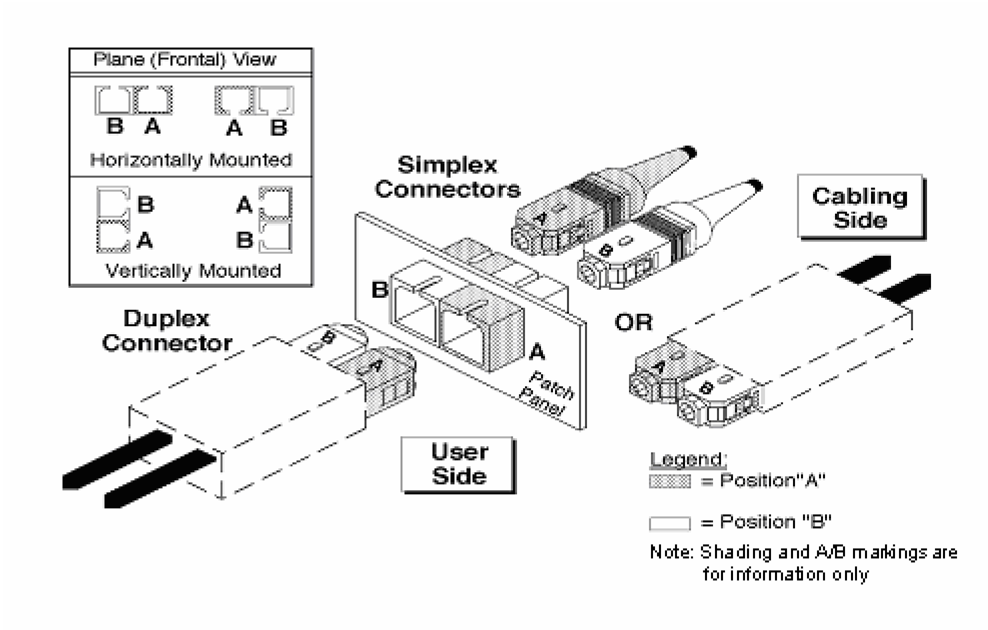
Where there is no installed base of optical fibre cabling, the LC connectivity is specified at the TO and should provide a means to identify the polarity by any combination of latching, keying, or labelling. See an example in Figure 20.

Where premises have an installed base of SC-D connectivity, additional TO connections may be made using SC-D connectivity provided their keys are oriented as in Figure 16.



NOTE Shading and A/B markings are for information only.

Figure 20 – Duplex-able LC connectivity configuration with an example of polarity identification



NOTE Shading and A/B markings are for information only.

Figure 16 – Duplex SC connectivity configuration

10.3.5.4 Other duplex connectors

Replace, in ISO/IEC 11801:2002, the two existing paragraphs by the following:

Alternative connector designs shall employ similar labelling and identification schemes to the duplex LC and SC. Position A and B on alternative duplex connector designs shall be in the same position as in Figure 16. For alternative connector designs utilising latches, the latch defines the positioning in the same manner as the key and keyways.

10.3.5.5 Cord termination configuration

Replace, in ISO/IEC 11801:2002, the existing Figure 17, by the following:

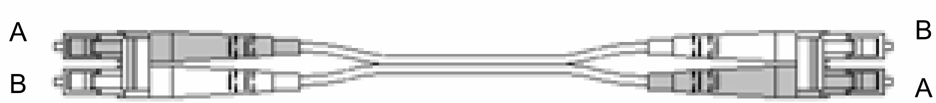


Figure 17 – Optical fibre cord

11 Screening practices

Add, in ISO/IEC 11801:2002, the following NOTE *below the title of Clause 11 title:*

NOTE When ISO/IEC 14763-2 is published the content of Clause 11 will be obsolete, and superseded by the content included in ISO/IEC 14763-2.

11.1 General

Replace, in ISO/IEC 11801:2002, the existing text of this subclause by the following:

This clause applies when screened cables or cables with screened elements or units are used. Only basic guidance is provided. The procedures necessary to provide adequate earthing for both electrical safety and EM performance are subject to national and local regulations, always to proper workmanship in accordance with ISO/IEC 14763-2 (until ISO/IEC 14763-2 is published, relevant information can be found in ISO/IEC TR 14763-2), and in certain cases to installation specific engineering. Some cabling employs components that utilise screening for additional crosstalk performance and is therefore also subject to screening practices. Note that a proper handling of screens in accordance with ISO/IEC 14763-2 (until ISO/IEC 14763-2 is published, relevant information can be found in ISO/IEC TR 14763-2) and suppliers' instructions will increase performance and safety.

12 Administration

Replace, in ISO/IEC 11801:2002, the existing second paragraph, and add the following NOTE:

Telecommunications cabling administration shall comply with ISO/IEC 14763-2 (until ISO/IEC 14763-2 is published, relevant information can be found in ISO/IEC TR 14763-1).

NOTE When ISO/IEC 14763-2 is published, the content of Clause 12 will be obsolete, and superseded by the content of ISO/IEC 14763-2.

13 Balanced cords

13.1 Introduction

Replace, in ISO/IEC 11801:2002, the existing first paragraph by the following:

This clause covers balanced cords constructed with balanced cables as specified in the IEC 61156 series and two free connectors (plugs) as specified in Clause 10. The components used in these cords shall meet the requirements of Clauses 9 and 10 respectively. The cable used to make balanced cords shall meet the requirements of IEC 61156-5 or IEC 61156-6 for the corresponding category. The purpose of cords is to connect to connecting hardware that utilises fixed connectors (jacks) that are also defined in Clause 10. Compliance to transmission parameters that are not specified in this clause are considered to be met by design.

Replace, in ISO/IEC 11801:2002, the existing subclauses 13.3 and 13.4 by the following:
(Note that Table 49 was renumbered as Table 60 by Amendment 1:2008 and is superseded by this Amendment.[15]*)*

13.3 Return loss

Balanced cords shall meet *RL* requirements specified in Table 58. The cords shall meet the electrical and mechanical requirements of IEC 61935-2.

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15 Number 60 has been reused in this Amendment.

Table 58 – Minimum return loss for balanced cords

Frequency MHz	Return Loss [a] MHz				
	Cord category				
	5	**6**	**6_A**	**7**	**7_A**
$1 \leq f \leq 25$	19,8 + 3 lg(f)	19,8 + 3 lg(f)	19,8 + 3 lg(f)	19,8 + 3 lg(f)	19,8 + 3 lg(f)
$25 < f \leq 100$	38,0 − 10 lg(f)	38,0 − 10 lg(f)	38,0 − 10 lg(f)	38,0 − 10 lg(f)	38,0 − 10 lg(f)
$100 < f \leq 250$	–	38,0 − 10 lg(f)	38,0 − 10 lg(f)	38,0 − 10 lg(f)	38,0 − 10 lg(f)
$250 < f \leq 500$	–	–	14 − 15 lg(f/250)	38,0 − 10 lg(f)	38,0 − 10 lg(f)
$500 < f \leq 600$	–	–	–	38,0 − 10 lg(f)	38,0 − 10 lg(f)
$600 < f \leq 1\,000$	–	–	–	–	38,0 − 10 lg(f) [b]

[a] Return loss values at frequencies below 4 MHz are for information only.

[b] Calculated values below 10,0 dB revert to a 10,0 dB plateau.

Table 59 – Informative values of return loss for balanced cords at key frequencies

Frequency MHz	Return Loss dB				
	Cord category				
	5	**6**	**6_A**	**7**	**7_A**
1	19,8	19,8	19,8	19,8	19,8
100	18,0	18,0	18,0	18,0	18,0
250	–	14,0	14,0	14,0	14,0
500	–	–	9,5	11,0	11,0
600	–	–	–	10,2	10,2
1 000	–	–	–	–	10,0

13.4 NEXT

Balanced cords shall meet the requirement of Equation (9) when measured in accordance with IEC 61935-2.

$$NEXT_{\text{cord}} = -10\,\lg\left(10^{\frac{-NEXT_{\text{connectors}}}{10}} + 10^{\frac{-\left(NEXT_{\text{cable,L}} + 2\cdot IL_{\text{connector}}\right)}{10}}\right) - RFEXT \qquad (9)$$

where

$NEXT_{\text{cord}}$ is the *NEXT* of the cord;

$NEXT_{\text{connectors}}$ is the *NEXT* of both connectors in the cord, taking insertion loss into account;

$NEXT_{\text{cable, L}}$ is the *NEXT* of the cable adjusted for length;

$IL_{\text{connector}}$ is the insertion loss of one connector;

RFEXT is the reflected *FEXT*.

NOTE All variables are expressed in dB.

with

$$NEXT_{\text{connectors}} = -20\ \lg\left(10^{\frac{-NEXT_{\text{local}}}{20}} + 10^{\frac{-\left(NEXT_{\text{remote}} + 2\left(IL_{\text{cable}} + IL_{\text{connector}}\right)\right)}{20}}\right) \qquad (10)$$

$$NEXT_{\text{local}} = NEXT_{\text{remote}} = NEXT_{\text{connector}} \qquad (11)$$

$$IL_{\text{cable}} \approx \alpha_{\text{cable},100\ \text{m}} \left(\frac{L}{100}\right) \qquad (12)$$

where

$NEXT_{\text{local}}$	is the *NEXT* of the connector at the local end of the cord;
$NEXT_{\text{remote}}$	is the *NEXT* of the connector at the remote end of the cord;
IL_{cable}	is the insertion loss of the cable;
$IL_{\text{connector}}$	is the insertion loss of the connector;
$NEXT_{\text{connector}}$	is the *NEXT* of each connector as specified in Table 43, with the exception of category 5 which is equal to 87 – 20 lg*(f)*;
$\alpha_{\text{cable},100\ \text{m}}$	is the insertion loss of 100 m of the cable used for the cord;
L	is the length of the cable in the cord.

NOTE All variables are expressed in dB, except “*L*”, expressed in meters.

The length corrected near-end crosstalk of the cable of the cord is given by:

$$NEXT_{\text{cable,L}} = NEXT_{\text{cable, 100 m}} - 10\lg\left[\frac{1 - 10^{\frac{L}{100}\left(\frac{-\alpha_{\text{cable, 100 m}}}{5}\right)}}{1 - 10^{\left(\frac{-\alpha_{\text{cable, 100 m}}}{5}\right)}}\right] \qquad (13)$$

where

$NEXT_{\text{cable, 100 m}}$	is the *NEXT* of a 100 m long cable section.

Calculations yielding *NEXT* limits in excess of 65 dB shall revert to a minimum requirement of 65 dB. Tables 81 to 83 list informative values of *NEXT* at key frequencies for different length cords using the variable values outlined in Table 80.

Table 80 – Assumptions for cabling components used in the calculation of NEXT informative values

Variable	Component category [a, b]				
	5	6	6_A	7	7_A
α cable,100 m	$1,5\cdot(1,910\,8\sqrt{f} + 0,022\,2\,f + \frac{0,2}{\sqrt{f}})$	$1,5\cdot(1,82\sqrt{f} + 0,017\,f + \frac{0,25}{\sqrt{f}})$	$1,5\cdot(1,82\sqrt{f} + 0,009\,1\,f + \frac{0,25}{\sqrt{f}})$	$1,5\cdot(1,8\sqrt{f} + 0,01\,f + \frac{0,2}{\sqrt{f}})$	$1,5\cdot(1,8\sqrt{f} + 0,005\,f + \frac{0,25}{\sqrt{f}})$
NEXT cable, 100 m	$65,3 - 15\lg(f)$	$74,3 - 15\lg(f)$		$102,4 - 15\lg(f)$	$105,4 - 15\lg(f)$
IL connector	$0,04\sqrt{f}$	$0,02\sqrt{f}$			
NEXT connector	$87 - 20\lg(f)$	$94 - 20\lg(f)$	$94-20\lg(f)$, $f \leq 250$ MHz $46,04 - 30\lg(f/250)$ $f > 250$ MHz	$102,4-15\lg(f)$	$116,3-20\lg(f)$ $f \leq 600$ MHz $60,73 - 40\lg(f/600)$ $f > 600$ MHz
RFEXT	0	0,5			

[a] All equations apply from 1 MHz to the upper frequency of the category unless otherwise indicated.

[b] Values used for calculations may differ from the values specified in IEC 61156-5 an IEC 61156-6.

Table 81 – Informative values of NEXT for 2 m balanced cords at key frequencies

Frequency MHz	NEXT dB Cord category				
	5	6	6_A	7	7_A
1	65,0	65,0	65,0	65,0	65,0
100	39,0	46,2	46,2	65,0	65,0
250	–	38,7	38,7	60,7	62,6
500	–	–	31,0	56,5	57,1
600	–	–	–	55,4	55,6
1 000	–	–	–	–	47,4

Table 82 – Informative values of NEXT for 5 m balanced cords at key frequencies

Frequency MHz	NEXT dB Cord category				
	5	6	6_A	7	7_A
1	65,0	65,0	65,0	65,0	65,0
100	37,4	45,1	45,1	65,0	65,0
250	–	38,0	38,0	61,2	63,3
500	–	–	31,3	57,2	58,0
600	–	–	–	56,2	56,7
1 000	–	–	–	–	48,9

Table 83 – Informative values of NEXT for 10 m balanced cords at key frequencies

Frequency MHz	**NEXT** dB				
	Cord Category				
	5	**6**	**6**$_A$	**7**	**7**$_A$
1	65,0	65,0	65,0	65,0	65,0
100	36,4	44,2	44,2	65,0	65,0
250	–	37,6	37,6	61,9	64,1
500	–	–	31,7	58,0	59,1
600	–	–	–	57,0	57,8
1 000	–	–	–	–	50,2

Annex A
(normative)

Balanced permanent link and CP link performance

Replace, in ISO/IEC 11801:2002, the entire text, including figures and tables, of this annex by the following:

A.1 General

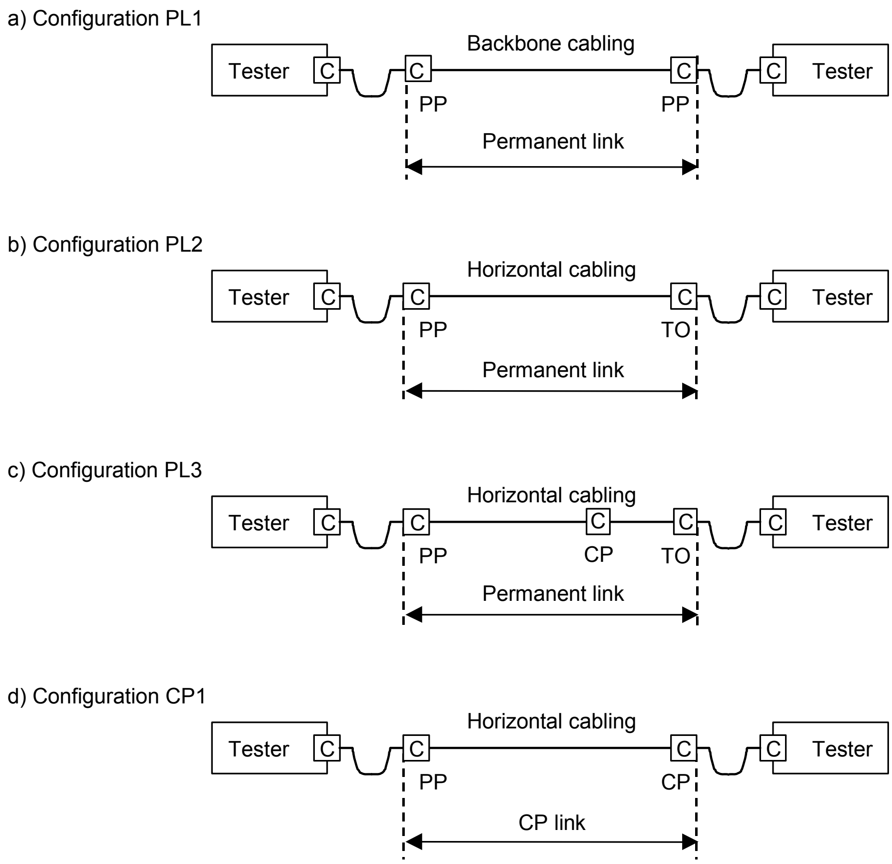
This annex contains performance requirements for balanced permanent links and CP links as shown in Figure A.1.

The cabling under test in configurations PL1, PL2 and PL3 is termed the permanent link. The configurations PL1 and PL2 comprise fixed cabling only. Configuration PL3 comprises fixed cabling and a CP cable between the CP and the TO. If the CP cable is changed, performance of this configuration will change. The cabling under test in configuration CP1 contains fixed cabling only and is termed the CP link. The difference between the CP link and the PL2 link is that the CP link is assumed to be extended, in the future, to a permanent link by the addition of cabling components. The difference between PL2 and PL3 specifications are related to the mathematical model length assumptions of Table 31[16], and the addition of cords to create a channel.

In all configurations the test reference plane of a permanent link or CP link is within the test cord. The test cord connector which mates with the termination point of the permanent link or CP link under test is part of the link under test.

Consideration should be given to calculating worst case performance at the worst case temperatures, when measuring performance at other temperatures.

16 Refers to Table 31 as added by Amendment 1 and not Table 31 (Insertion loss, renumbered as Table 42 by Amendment 1:2008) in ISO/IEC 11801:2002.



PP = patch panel; C = connection; CP = consolidation point;
TO = telecommunications outlet;

Figure A.1 – Link options

A.2 Balanced cabling

A.2.1 General

The parameters specified in this annex apply to balanced permanent links and CP links with screened or unscreened cable elements, with or without an overall screen, unless explicitly stated otherwise. When required, permanent link and CP link measurements (including those required for permanent link and CP link calculations) shall be measured according to IEC 61935-1, unless otherwise specified in this annex.

The nominal impedance of balanced permanent links and CP links is 100 Ω. This impedance is achieved by suitable design, and an appropriate choice of cabling components (irrespective of their nominal impedance).

The requirements in this annex are given by limits computed, to one decimal place, using the equation for a defined frequency range. The limits for the propagation delay and delay skew are computed to three decimal places. Where relevant, in the informative tables for maximum implementation at key frequencies, the values of L, Y and n are: L = 90, Y = 1 and n = 3. Permanent link and CP link requirements for unbalance attenuation and coupling attenuation are f.f.s.

A.2.2 Return loss

The *RL* of each pair of a permanent link or CP link shall meet the requirements derived by the equation in Table A.1.

The *RL* of each pair of a permanent link at key frequencies is given in Table A.2 for information only.

The *RL* requirements shall be met at both ends of the cabling.

Terminations of 100 Ω shall be connected to the cabling elements under test at the remote end of the link.

Table A.1 – Return loss for permanent link or CP link

Class	**Frequency** MHz	**Minimum return loss** [a] dB
C	$1 \leq f \leq 16$	15,0
D	$1 \leq f \leq 20$	19,0
	$20 < f \leq 100$	32 – 10 lg(*f*)
E	$1 \leq f \leq 10$	21,0
	$10 < f \leq 40$	26 – 5 lg(*f*)
	$40 < f \leq 250$	34 – 10 lg(*f*)
E_A	$1 \leq f \leq 10$	21,0
	$10 < f \leq 40$	26 – 5 lg(*f*)
	$40 < f \leq 398,1$	34 – 10 lg(*f*)
	$398,1 < f \leq 500$	8,0
F	$1 \leq f \leq 10$	21,0
	$10 < f \leq 40$	26 – 5 lg(*f*)
	$40 < f \leq 251,2$	34 – 10 lg(*f*)
	$251,2 < f \leq 600$	10,0
F_A	$1 \leq f \leq 10$	21,0
	$10 < f \leq 40$	26 – 5 lg(*f*)
	$40 < f \leq 251,2$	34 – 10 lg(*f*)
	$251,2 < f \leq 631$	10,0
	$631 < f \leq 1\ 000$	38 – 10 lg(*f*)

[a] *RL* values at frequencies where the insertion loss is below 3,0 dB are for information only.

Table A.2 – Informative return loss values for permanent link at key frequencies

Frequency MHz	**Minimum return loss** dB					
	Class C	**Class D**	**Class E**	**Class E_A**	**Class F**	**Class F_A**
1	15,0	19,0	21,0	21,0	21,0	21,0
16	15,0	19,0	20,0	20,0	20,0	20,0
100	–	12,0	14,0	14,0	14,0	14,0
250	–	–	10,0	10,0	10,0	10,0
500	–	–	–	8,0	10,0	10,0
600	–	–	–	–	10,0	10,0
1 000	–	–	–	–	–	8,0

A.2.3 Insertion loss/attenuation

The insertion loss of each pair of a permanent link or CP link shall meet the requirements derived by the equation in Table A.3.

A method of establishing conformant link performance is to demonstrate that the margin between the measured value and the channel limits of Table 4 are adequate to accommodate any additional cabling components used to create a channel.

The insertion loss of each pair of a permanent link, with maximum implementation, at key frequencies is given in Table A.4 for information only.

Table A.3 – Insertion loss for permanent link or CP link

Class	**Frequency** MHz	**Maximum insertion loss** [a] dB
A	f = 0,1	16,0
B	f = 0,1	5,5
	f = 1	5,8
C	$1 \le f \le 16$	$0{,}9\times\left(3{,}23\sqrt{f}\right)+3\times 0{,}2$
D	$1 \le f \le 100$	$(L/100)\times\left(1{,}910\,8\sqrt{f}+0{,}022\,2\times f+0{,}2/\sqrt{f}\right)+n\times 0{,}04\times\sqrt{f}$
E	$1 \le f \le 250$	$(L/100)\times\left(1{,}82\sqrt{f}+0{,}016\,9\times f+0{,}25/\sqrt{f}\right)+n\times 0{,}02\times\sqrt{f}$
E_A	$1 \le f \le 500$	$(L/100)\times\left(1{,}82\sqrt{f}+0{,}009\,1\times f+0{,}25/\sqrt{f}\right)+n\times 0{,}02\times\sqrt{f}$
F	$1 \le f \le 600$	$(L/100)\times\left(1{,}8\sqrt{f}+0{,}01\times f+0{,}2/\sqrt{f}\right)+n\times 0{,}02\times\sqrt{f}$
F_A	$1 \le f \le 1\,000$	$(L/100)\times\left(1{,}8\sqrt{f}+0{,}005\times f+0{,}25/\sqrt{f}\right)+n\times 0{,}02\times\sqrt{f}$

NOTE

$L = L_{FC} + L_{CP}\ Y$

L_{FC} = length of fixed cable (m)

L_{CP} = length of CP cord (where present) (m)

Y = the ratio of CP cable insertion loss (dB/m) to fixed horizontal cable insertion loss (dB/m) (see 7.2.2.2)

n = 2 for configurations PL1, PL2 and CP1 (see Figure A.1, section a, b, and d)

n = 3 for configuration PL3 (see Figure A.1, section c)

[a] Insertion loss (*IL*) at frequencies that correspond to calculated values of less than 4,0 dB shall revert to a maximum requirement of 4,0 dB.

Table A.4 – Informative insertion loss values for permanent link with maximum implementation at key frequencies

Frequency MHz	**Maximum insertion loss** dB							
	Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class E_A**	**Class F**	**Class F_A**
0,1	16,0	5,5	–	–	–	–	–	–
1	–	5,8	4,0	4,0	4,0	4,0	4,0	4,0
16	–	–	12,2	7,7	7,1	7,0	6,9	6,8
100	–	–	–	20,4	18,5	17,8	17,7	17,3
250	–	–	–	–	30,7	28,9	28,8	27,7
500	–	–	–	–	–	42,1	42,1	39,8
600	–	–	–	–	–	–	46,6	43,9
1 000	–	–	–	–	–	–	–	57,6

A.2.4 NEXT

A.2.4.1 Pair-to-pair NEXT

The NEXT of each pair combination of a permanent link or CP link shall meet the requirements derived by the equation in Table A.5.

The *NEXT* of each pair combination of a permanent link, with maximum implementation, at key frequencies is given in Table A.6 for information only.

The *NEXT* requirements shall be met at both ends of the cabling.

Table A.5 – NEXT for permanent link or CP link

Class	**Frequency** MHz	**Minimum NEXT** [a, b, h] dB
A	f = 0,1	27,0
B	0,1 ≤ f ≤ 1	$25 - 5\lg(f)$
C	1 ≤ f ≤ 16	$40{,}1 - 15{,}8\lg(f)$
D	1 ≤ f ≤ 100	$-20\lg\left(10^{\frac{65{,}3-15\lg(f)}{-20}}+10^{\frac{83-20\lg(f)}{-20}}\right)$
E	1 ≤ f ≤ 250	$-20\lg\left(10^{\frac{74{,}3-15\lg(f)}{-20}}+10^{\frac{94-20\lg(f)}{-20}}\right)$
E_A [h]	1 ≤ f ≤ 300	$-20\lg\left(10^{\frac{74{,}3-15\lg(f)}{-20}}+10^{\frac{94-20\lg(f)}{-20}}\right)$
	300 < f ≤ 500	$87{,}46 - 21{,}57\lg(f)$ [c, d]
F	1 ≤ f ≤ 600	$-20\lg\left(10^{\frac{102{,}4-15\lg(f)}{-20}}+10^{\frac{102{,}4-15\lg(f)}{-20}}\right)$
F_A [g]	1 ≤ f ≤ 600	$106{,}1 - 18{,}5\lg(f)$
	600 < f ≤ 1 000	$124{,}85 - 25{,}25\lg(f)$ [e, f]

[a] *NEXT* at frequencies that correspond to calculated values of greater than 65,0 dB shall revert to a minimum requirement of 65,0 dB.

[b] *NEXT* values at frequencies where the insertion loss (*IL*) is below 4,0 dB are for information only.

[c] For configuration PL3 (see Figure A.1, section c) this equation is $102{,}22 - 27{,}54\lg(f)$

[d] For configurations PL1, PL2, and CP1, whenever the class E_A permanent link insertion loss at 450 MHz is less than 12 dB, subtract the term $1{,}4((f - 450)/50)$ to the equation stated above for the range of 450 MHz to 500 MHz.

[e] For configuration PL3 (see Figure A.1, section c) this equation is $139{,}7 - 30{,}6\lg(f)$

[f] For configurations PL1, PL2, and CP1, whenever the class F_A permanent link insertion loss at 900 MHz is less than 17 dB, subtract the term $2{,}8((f - 900)/100)$ to the equation stated above for the range of 900 MHz to 1 000 MHz.

[g] When using connecting hardware with enhanced performance at the CP (see 10.2.4.3), the CP link limits do not represent appropriate minimum performance requirements, and therefore do not apply. In this case, the PL3 shall be tested for compliance instead.

[h] The terms in the equations are not intended to imply component performance.

Table A.6 – Informative NEXT values for permanent link with maximum implementation at key frequencies

Frequency MHz	**Minimum NEXT** dB							
	Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class E_A**	**Class F**	**Class F_A**
0,1	27,0	40,0	–	–	–	–	–	–
1	–	25,0	40,1	64,2	65,0	65,0	65,0	65,0
16	–	–	21,1	45,2	54,6	54,6	65,0	65,0
100	–	–	–	32,3	41,8	41,8	65,0	65,0
250	–	–	–	–	35,3	35,3	60,4	61,7
500	–	–	–	–	–	29,2 (27,9)[a]	55,9	56,1
600	–	–	–	–	–	–	54,7	54,7
1 000	–	–	–	–	–	–	–	49,1 (47,9)[a]

[a] Value applicable to configuration PL3 (see Figure A.1, section c).

A.2.4.2 Power sum NEXT (PS NEXT)

The P*S NEXT* requirements are applicable only to classes D, E, E_A, F and F_A.

The *PS NEXT* of each pair of a permanent link or CP link shall meet the requirements derived by the equation in Table A.7.

The *PS NEXT* of each pair of a permanent link, with maximum implementation, at key frequencies is given in Table A.8 for information only.

The *PS NEXT* requirements shall be met at both ends of the cabling.

$PS\ NEXT_k$ of pair *k* is computed as follows:

$$PS\ NEXT_k = -10 \lg \sum_{i=1, i \neq k}^{n} 10^{\frac{-NEXT_{ik}}{10}} \quad \text{(A.1)}$$

where

i is the number of the disturbing pair;

k is the number of the disturbed pair;

n is the total number of pairs;

$NEXT_{ik}$ is the near end crosstalk loss coupled from pair i into pair k.

Table A.7 – PS NEXT for permanent link or CP link

Class	**Frequency** MHz	**Minimum PS NEXT** [a, b, h] dB
D	$1 \le f \le 100$	$-20\lg\left(10^{\frac{62,3-15\lg(f)}{-20}}+10^{\frac{80-20\lg(f)}{-20}}\right)$
E	$1 \le f \le 250$	$-20\lg\left(10^{\frac{72,3-15\lg(f)}{-20}}+10^{\frac{90-20\lg(f)}{-20}}\right)$
E_A [h]	$1 \le f \le 300$	$-20\lg\left(10^{\frac{72,3-15\lg(f)}{-20}}+10^{\frac{90-20\lg(f)}{-20}}\right)$
	$300 < f \le 500$	$87,56 - 22,67\lg(f)$ [c, d]
F	$1 \le f \le 600$	$-20\lg\left(10^{\frac{99,4-15\lg(f)}{-20}}+10^{\frac{99,4-15\lg(f)}{-20}}\right)$
F_A [g]	$1 \le f \le 600$	$103,1 - 18,5\lg(f)$
	$600 < f \le 1\,000$	$121,85 - 25,25\lg(f)$ [e, f]

[a] *PS NEXT* at frequencies that correspond to calculated values of greater than 62,0 dB shall revert to a minimum requirement of 62,0 dB.

[b] *PS NEXT* values at frequencies where the insertion loss *(IL)* is below 4,0 dB are for information only.

[c] For configuration PL3 (see Figure A.1, section c) this equation is $104,65 - 29,57\lg(f)$.

[d] For Configurations PL1, PL2, and CP1, whenever the class E_A permanent link insertion loss at 450 MHz is less than 12 dB, subtract the term 1,4((*f*• 450)/50) to the equation stated above for the range of 450 MHz to 500 MHz.

[e] For configuration PL3 (see Figure A.1, section c) this equation is $136,7 - 30,6\lg(f)$.

[f] For Configurations PL1, PL2, and CP1, whenever the class F_A permanent link insertion loss at 900 MHz is less than 17 dB, subtract the term 2,8((*f*• 900)/100) to the equation stated above for the range of 900 MHz to 1 000 MHz.

[g] When using connecting hardware with enhanced performance at the CP (see 10.2.4.3), the CP link limits do not represent appropriate minimum performance requirements, and therefore do not apply. In this case, the PL3 shall be tested for compliance instead.

[h] The terms in the equations are not intended to imply component performance.

Table A.8 – Informative PS NEXT values for permanent link with maximum implementation at key frequencies

Frequency MHz	Minimum PS NEXT dB				
	Class D	**Class E**	**Class E_A**	**Class F**	**Class F_A**
1	57,0	62,0	62,0	62,0	62,0
16	42,2	52,2	52,2	62,0	62,0
100	29,3	39,3	39,3	62,0	62,0
250	–	32,7	32,7	57,4	58,7
500	–	–	26,4 (24,8)[a]	52,9	53,1
600	–	–	–	51,7	51,7
1 000	–	–	–	–	46,1 (44,9)[a]

[a] Value applicable to configuration PL3 (see Figure A.1, section c).

A.2.5 Attenuation to crosstalk ratio at the near-end (ACR-N)

A.2.5.1 General

The *ACR-N* requirements are applicable only to Classes D, E, E_A, F, and F_A.

A.2.5.2 Pair-to-pair ACR-N

Pair-to-pair *ACR-N* is the difference between the pair-to-pair *NEXT* and the insertion loss of the cabling in dB.

The *ACR-N* of each pair combination of a permanent link or CP link shall meet the difference of the *NEXT* requirement of Table A.5 and the insertion loss requirement of Table A.3 of the respective class.

The *ACR-N* of each pair combination of a permanent link, with maximum implementation, at key frequencies is given in Table A.9 for information only.

The *ACR-N* requirements shall be met where the *NEXT* requirements apply, and at both ends of the cabling.

$ACR\text{-}N_{ik}$ of pairs *i* and *k* is computed as follows:

$$ACR\text{-}N_{ik} = NEXT_{ik} - IL_k \qquad \text{(A.2)}$$

where

i is the number of the disturbing pair;

k is the number of the disturbed pair;

$NEXT_{ik}$ is the near end crosstalk loss coupled from pair i into pair k;

IL_k is the insertion loss of pair k.

Table A.9 – Informative ACR-N values for permanent link with maximum implementation at key frequencies

Frequency MHz	**Minimum ACR-N** dB				
	Class D	**Class E**	**Class E_A**	**Class F**	**Class F_A**
1	60,2	61,0	61,0	61,0	61,0
16	37,5	47,5	47,6	58,1	58,2
100	11,9	23,3	24,0	47,3	47,7
250	–	4,7	6,4	31,6	34,0
500	–	–	−12,9 (-14,2)[a]	13,8	16,4
600	–	–	–	8,1	10,8
1 000	–	–	–	–	−8,5 (-9,7)[a]

[a] Value applicable to Configuration PL3 (see Figure A.1, section c).

A.2.5.3 Power sum ACR-N (PS ACR-N)

The *PS ACR-N* of each pair of a permanent link or CP link shall meet the difference of the *PS NEXT* requirement of Table A.7 and the insertion loss requirement of Table A.3 of the respective class.

The *PS ACR-N* of each pair of a permanent link, with maximum implementation, at key frequencies is given in Table A.10 for information only.

The *PS ACR-N* requirements shall be met where the *PS NEXT* requirements apply, and at both ends of the cabling.

$PS\ ACR\text{-}N_k$ of pair k is computed as follows:

$$PS\ ACR\text{-}N_k = PS\ NEXT_k - IL_k \tag{A.3}$$

where

k is the number of the disturbed pair;

$PS\ NEXT_k$ is the power sum near end crosstalk loss of pair k;

IL_k is the insertion loss of pair k.

Table A.10 – Informative PS ACR-N values for permanent link with maximum implementation at key frequencies

Frequency MHz	Minimum PS ACR-N dB				
	Class D	Class E	Class E_A	Class F	Class F_A
1	53,0	58,0	58,0	58,0	58,0
16	34,5	45,1	45,2	55,1	55,2
100	8,9	20,8	21,5	44,3	44,7
250	–	2,0	3,8	28,6	31,0
500	–	–	−15,7 (−16,3)[a]	10,8	13,4
600	–	–	–	5,1	7,8
1 000	–	–	–	–	−11,5 (−12,7)[a]

[a] Value applicable to Configuration PL3 (see Figure A.1, section c).

A.2.6 Attenuation to crosstalk ratio at the far-end (ACR-F)

A.2.6.1 General

The *ACR-F* requirements are applicable only to Classes D, E, E_A, F, and F_A.

A.2.6.2 Pair-to-pair ACR-F

The ACR-F of each pair combination of a permanent link or CP link shall meet the requirements derived by the Equation (A.4).

The *ACR-F* of each pair combination of a permanent link, with maximum implementation, at key frequencies is given in Table A.12 for information only.

$ACR\text{-}F_{ik}$ of pairs *i* and *k* is computed as follows:

$$ACR\text{-}F_{ik} = FEXT_{ik} - IL_k \qquad \text{(A.4)}$$

where

i is the number of the disturbing pair;

k is the number of the disturbed pair;

$FEXT_{ik}$ is the far end crosstalk loss coupled from pair i into pair k;

IL_k is the insertion loss of pair k.

NOTE The difference of input-to-output *FEXT* and the insertion loss of the disturbed pair is relevant to the signal-to-noise consideration. The results computed to the formal definition above cover all possible combinations of insertion loss of pairs and corresponding input-to-output *FEXT*.

Table A.11 – ACR-F for permanent link or CP link

Class	Frequency MHz	Minimum ACR-F [a, b, c] dB
D	$1 \leq f \leq 100$	$-20\lg\left(10^{\frac{63{,}8-20\lg(f)}{-20}}+n\times 10^{\frac{75{,}1-20\lg(f)}{-20}}\right)$
E	$1 \leq f \leq 250$	$-20\lg\left(10^{\frac{67{,}8-20\lg(f)}{-20}}+n\times 10^{\frac{83{,}1-20\lg(f)}{-20}}\right)$
E_A	$1 \leq f \leq 500$	$-20\lg\left(10^{\frac{67{,}8-20\lg(f)}{-20}}+n\times 10^{\frac{83{,}1-20\lg(f)}{-20}}\right)$
F	$1 \leq f \leq 600$	$-20\lg\left(10^{\frac{94-20\lg(f)}{-20}}+n\times 10^{\frac{90-15\lg(f)}{-20}}\right)$
F_A	$1 \leq f \leq 1\,000$	$-20\lg\left(10^{\frac{95{,}3-20\lg(f)}{-20}}+n\times 10^{\frac{103{,}9-20\lg(f)}{-20}}\right)$

NOTE n = 2 for configurations PL1, PL2 and CP1 (see Figure A.1, sections a, b, and d)
n = 3 for configuration PL3 (see Figure A.1, sections c).

[a] *ACR-F* at frequencies that correspond to measured FEXT values of greater than 70,0 dB are for information only.

[b] *ACR-F* at frequencies that correspond to calculated values of greater than 65,0 dB shall revert to a minimum requirement of 65,0 dB.

[c] The terms in the equations are not intended to imply component performance.

Table A.12 – Informative ACR-F values for permanent link with maximum implementation at key frequencies

Frequency MHz	Minimum ACR-F dB				
	Class D	Class E	Class E_A	Class F	Class F_A
1	58,6	64,2	64,2	65,0	65,0
16	34,5	40,1	40,1	59,3	64,7
100	18,6	24,2	24,2	46,0	48,8
250	–	16,2	16,2	39,2	40,8
500	–	–	10,2	34,0	34,8
600	–	–	–	32,6	33,2
1 000	–	–	–	–	28,8

A.2.6.3 Power sum ACR-F (PS ACR-F)

The *PS ACR-F* of each pair of a permanent link or CP link shall meet the requirements derived by the equations in Table A.13.

The *PS ACR-F* of each pair of a permanent link, with maximum implementation, at key frequencies is given in Table A.14 for information only.

PS ACR-F$_k$ of pair *k* is computed as follows:

$$PS\ ACR-F_k = (-10\lg \sum_{i=1, i\neq k}^{n} 10^{\frac{-FEXT_{ik}}{10}}) - IL_k \quad \text{(A.5)}$$

where

i	is the number of the disturbing pair;
k	is the number of the disturbed pair;
n	is the total number of pairs;
$FEXT_{ik}$	is the far end crosstalk loss coupled from pair i into pair k;
IL_k	is the insertion loss of pair k.

Table A.13 – PS ACR-F for permanent link or CP link

Class	**Frequency** MHz	**Minimum PS ACR-F** [a, b, c] dB
D	$1 \le f \le 100$	$-20\lg\left(10^{\frac{60,8-20\lg(f)}{-20}} + n \times 10^{\frac{72,1-20\lg(f)}{-20}}\right)$
E	$1 \le f \le 250$	$-20\lg\left(10^{\frac{64,8-20\lg(f)}{-20}} + n \times 10^{\frac{80,1-20\lg(f)}{-20}}\right)$
E_A	$1 \le f \le 500$	$-20\lg\left(10^{\frac{64,8-20\lg(f)}{-20}} + n \times 10^{\frac{80,1-20\lg(f)}{-20}}\right)$
F	$1 \le f \le 600$	$-20\lg\left(10^{\frac{91-20\lg(f)}{-20}} + n \times 10^{\frac{87-15\lg(f)}{-20}}\right)$
F_A	$1 \le f \le 1\,000$	$-20\lg\left(10^{\frac{92,3-20\lg(f)}{-20}} + n \times 10^{\frac{100,9-20\lg(f)}{-20}}\right)$

NOTE n = 2 for configurations PL1, PL2 and CP1 (see Figure A.1, sections a, b, and d)
n = 3 for configuration PL3 (see Figure A.1, section c)

[a] *PS ACR-F* at frequencies that correspond to measured *PS FEXT* values of greater than 70,0 dB are for information only.

[b] *PS ACR-F* at frequencies that correspond to calculated values of greater than 62,0 dB shall revert to a minimum requirement of 62,0 dB.

[c] The terms in the equations are not intended to imply component performance.

Table A.14 – Informative PS ACR-F values for permanent link with maximum implementation at key frequencies

Frequency MHz	**Minimum PS ACR-F** dB				
	Class D	**Class E**	**Class E_A**	**Class F**	**Class F_A**
1	55,6	61,2	61,2	62,0	62,0
16	31,5	37,1	37,1	56,3	61,7
100	15,6	21,2	21,2	43,0	45,8
250	–	13,2	13,2	36,2	37,8
500	–	–	7,2	31,0	31,8
600	–	–	–	29,6	30,2
1 000	–	–	–	–	25,8

A.2.7 Direct current (d.c.) loop resistance

The d.c. loop resistance of each pair of a permanent link or CP link shall meet the requirements derived by the equation in Table A.15.

A method of establishing conformant link performance is to demonstrate that the margin between the measured value and the channel limits of Table 16 are adequate to accommodate any additional cabling components used to create a channel. This is fulfilled if the insertion loss requirement and the delay skew requirement for the permanent link or CP link are met and test verification of a d.c. connection for each cabling conductor have been performed.

The d.c. loop resistance of each pair of a permanent link with maximum implementation length is given in Table A.16.

Table A.15 – Direct current (d.c.) loop resistance for permanent link or CP link

Class	**Maximum d.c. loop resistance** Ω
A	530
B	140
C	34
D	$(L/100) \times 22 + n \times 0{,}4$
E	$(L/100) \times 22 + n \times 0{,}4$
E_A	$(L/100) \times 22 + n \times 0{,}4$
F	$(L/100) \times 22 + n \times 0{,}4$
F_A	$(L/100) \times 22 + n \times 0{,}4$

where

L $L_{FC} + L_{CP} \times Y$

L_{FC} length of fixed cable (m)

L_{CP} length of CP cord (where present) (m)

Y the ratio of CP cable insertion loss (dB/m) to fixed horizontal cable insertion loss (dB/m) (see 7.2.2.2.)

n 2 for Configurations PL1, PL2 and CP1 (see Figure A.1, sections a, b, and d)

n 3 for Configuration PL3 (see Figure A.1, section c)

Table A.16 – Informative d.c. loop resistance for permanent link with maximum implementation

Maximum d.c. loop resistance Ω							
Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class E_A**	**Class F**	**Class F_A**
530	140	34	21	21	21	21	21

A.2.8 Direct current (d.c.) resistance unbalance

The d.c. resistance unbalance between the two conductors within each pair of a permanent link or CP link shall not exceed the greater of 3 % or 0,150 Ω for all Classes. This shall be achieved by design.

A.2.9 Propagation delay

The propagation delay of each pair of a permanent link or CP link shall meet the requirements derived by the equations in Table A.17.

A method of establishing conformant link performance is to demonstrate that the margin between the measured value and the channel limits of Table 17 are adequate to accommodate any additional cabling components used to create a channel. This is fulfilled if the insertion loss requirement and the delay skew requirement for the permanent link or CP link are met.

The propagation delay of each pair of a permanent link, with maximum implementation, at key frequencies is given in Table A.18 for information only.

Table A.17 – Propagation delay for permanent link or CP link

Class	**Frequency** MHz	**Maximum propagation delay** µs
A	$f = 0,1$	19,400
B	$0,1 \leq f \leq 1$	4,400
C	$1 \leq f \leq 16$	$(L/100) \times \left(0,534 + 0,036/\sqrt{f}\right) + n \times 0,002\,5$
D	$1 \leq f \leq 100$	$(L/100) \times \left(0,534 + 0,036/\sqrt{f}\right) + n \times 0,002\,5$
E	$1 \leq f \leq 250$	$(L/100) \times \left(0,534 + 0,036/\sqrt{f}\right) + n \times 0,002\,5$
E_A	$1 \leq f \leq 500$	$(L/100) \times \left(0,534 + 0,036/\sqrt{f}\right) + n \times 0,002\,5$
F	$1 \leq f \leq 600$	$(L/100) \times \left(0,534 + 0,036/\sqrt{f}\right) + n \times 0,002\,5$
F_A	$1 \leq f \leq 1\,000$	$(L/100) \times \left(0,534 + 0,036/\sqrt{f}\right) + n \times 0,002\,5$

where

L $L_{FC} + L_{CP}$

L_{FC} length of fixed cable (m)

L_{CP} length of CP cord (where present) (m)

n 2 for configurations PL1, PL2 and CP1 (see Figure A.1, sections a, b, and d)

n 3 for configuration PL3 (see Figure A.1, section c)

Table A.18 – Informative propagation delay values for permanent link with maximum implementation at key frequencies

Frequency MHz	Maximum propagation delay µs							
	Class A	Class B	Class C	Class D	Class E	Class E_A	Class F	Class F_A
0,1	19,400	4,400	–	–	–	–	–	–
1	–	4,400	0,521	0,521	0,521	0,521	0,521	0,521
16	–	–	0,496	0,496	0,496	0,496	0,496	0,496
100	–	–	–	0,491	0,491	0,491	0,491	0,491
250	–	–	–	–	0,490	0,490	0,490	0,490
500	–	–	–	–	–	0,490	0,490	0,490
600	–	–	–	–	–	–	0,489	0,489
1 000	–	–	–	–	–	–	–	0,489

A.2.10 Delay skew

The delay skew between all pairs of a permanent link or CP link shall meet the requirements derived by the equations in Table A.19.

A method of establishing a conformant link performance is to demonstrate that the margin between the measured value and the channel limits of Table 19 are adequate to accommodate any additional cabling components used to create a channel. This is fulfilled if the insertion loss requirement and the propagation delay requirement for the permanent link or CP link are met.

The delay skew between all pairs of a permanent link, with maximum implementation, at key frequencies is given in Table A.20 for information only.

Table A.19 – Delay skew for permanent link or CP link

Class	Frequency MHz	Maximum delay skew µs
A	f = 0,1	N/A
B	0,1 ≤ f ≤ 1	N/A
C	1 ≤ f ≤ 16	$(L/100)\times 0{,}045 + n \times 0{,}001\,25$
D	1 ≤ f ≤ 100	$(L/100)\times 0{,}045 + n \times 0{,}001\,25$
E	1 ≤ f ≤ 250	$(L/100)\times 0{,}045 + n \times 0{,}001\,25$
E_A	1 ≤ f ≤ 500	$(L/100)\times 0{,}045 + n \times 0{,}001\,25$
F	1 ≤ f ≤ 600	$(L/100)\times 0{,}025 + n \times 0{,}001\,25$
F_A	1 ≤ f ≤ 1 000	$(L/100)\times 0{,}025 + n \times 0{,}001\,25$

where

L L_{FC} + L_{CP}

L_{FC} length of fixed cable (m)

L_{CP} length of CP cord (where present) (m)

n 2 for configurations PL1, PL2 and CP1 (see Figure A.1, sections a, b, and d)

n 3 for configuration PL3 (see Figure A.1, section c)

Table A.20 – Informative delay skew for permanent link with maximum implementation

Class	Frequency MHz	Maximum delay skew µs
A	f = 0,1	N/A
B	0,1 ≤ f ≤ 1	N/A
C	1 ≤ f ≤ 16	0,044 [a]
D	1 ≤ f ≤ 100	0,044 [a]
E	1 ≤ f ≤ 250	0,044 [a]
E_A	1 ≤ f ≤ 500	0,044 [a]
F	1 ≤ f ≤ 600	0,026 [b]
F_A	1 ≤ f ≤ 1 000	0,026 [b]

[a] This is the result of the calculation 0,9 × 0,045+3 × 0,001 25.

[b] This is the result of the calculation 0,9 × 0,025+3 × 0,001 25.

A.2.11 Alien crosstalk

A.2.11.1 General

The following alien crosstalk requirements are applicable to Classes E_A and F_A only. Alien crosstalk of Class F is considered to be as good as the alien crosstalk performance specified for Class E_A. For information on alien crosstalk performance of Class E cabling, see ISO/IEC TR 24750.

If the coupling attenuation of Class E_A or F permanent links or CP links is at least 10 dB better than the corresponding channel coupling attenuation requirements (see Clause 6), and Class F_A permanent links or CP links are at least 25 dB better than the corresponding channel coupling attenuation requirements (see Clause 6), then the requirements of A.2.11 are met by design.

A.2.11.2 Power sum alien NEXT (PS ANEXT)

The *PS ANEXT* of each pair of a permanent link or CP link shall meet the requirements derived by the equations in Table A.21.

The *PS ANEXT* requirements shall be met at both ends of the cabling.

$PS\ ANEXT_k$ of pair k is computed as follows:

$$PS\ ANEXT_k = -10\lg\left[\sum_{l=1}^{N}\sum_{i=1}^{n} 10^{\frac{-ANEXT_{l,i,k}}{10}}\right] \quad \text{(A.7)}$$

where

k is the number of the disturbed pair in the disturbed link;

i is the number of the disturbing pair in a disturbing link l;

l is the number of the disturbing link;

N is the total number of disturbing links;

n is the number of disturbing pairs in disturbing link l;

$ANEXT_{l,i,k}$ is the alien near end crosstalk loss coupled from pair i of disturbing link l to the pair k of the disturbed link.

Table A.21 – PS ANEXT for permanent link or CP link

Class	Frequency MHz	Minimum PS ANEXT [a] dB
E_A [b]	$1 \le f < 100$	$80 - 10\lg(f)$
	$100 \le f \le 500$	$90 - 15\lg(f)$
F_A	$1 \le f < 100$	$95 - 10\lg(f)$
	$100 \le f \le 1\,000$	$105 - 15\lg(f)$

[a] *PS ANEXT* at frequencies that correspond to calculated values of greater than 67,0 dB shall revert to a minimum requirement of 67,0 dB.

[b] If the average insertion loss of all disturbed pairs at 100 MHz, $IL_{100\text{MHz,avg}}$ is less than 7 dB, then subtract the following for $f \ge 100$ MHz:

$$\text{minimum}\left\{7\times\frac{f-100}{400}\times\frac{7-IL_{100\text{MHz,avg}}}{IL_{100\text{MHz,avg}}},\ 6\times\frac{f-100}{400}\right\}$$

where

f is the frequency in MHz;

$$IL_{100\text{MHz,avg}} = \frac{1}{4}\sum_{i=1}^{4} IL_{100\text{MHz},\,i};$$

$IL_{100\text{MHz},\,i}$ is the insertion loss of a pair i at 100 MHz.

Table A.22 – Informative PS ANEXT values for permanent link at key frequencies

Frequency MHz	**Minimum PS ANEXT** dB	
	Class E_A	**Class F_A**
1	67,0	67,0
100	60,0	67,0
250	54,0	67,0
500	49,5	64,5
1 000	–	60,0

A.2.11.3 PS $ANEXT_{avg}$

The $PS\ ANEXT_{avg}$ of each permanent link or CP link shall meet the requirements derived by the equations in Table A.23.

The $PS\ ANEXT_{avg}$ requirements shall be met at both ends of the cabling.

$PS\ ANEXT_{avg}$ is computed as follows:

$$PS\ ANEXT_{avg} = \frac{1}{n}\left[\sum_{k=1}^{n} PS\ ANEXT_k\right] \qquad (A.8)$$

where

k is the number of the disturbed pair in the disturbed link;

n is the number of pairs in the disturbed link.

Table A.23 – PS ANEXT$_{avg}$ for permanent link or CP link

Class	Frequency MHz	Minimum PS ANEXT$_{avg}$ [a, b, c] dB
E_A	$1 \le f < 100$	$82{,}25 - 10 \lg (f)$
	$100 \le f \le 500$	$92{,}25 - 15 \lg (f)$

[a] PS $ANEXT_{avg}$ at frequencies that correspond to calculated values of greater than 67,0 dB shall revert to a minimum requirement of 67,0 dB.

[b] If the average insertion loss of all disturbed pairs at 100 MHz, $IL_{100MHz,avg}$, is less than 7 dB, then subtract the following for $f \ge 100$ MHz:

$$\text{minimum}\left\{7 \times \frac{f-100}{400} \times \frac{7-IL_{100MHz,avg}}{IL_{100MHz,avg}},\ 6 \times \frac{f-100}{400}\right\}$$

where

f is the frequency in MHz;

$$IL_{100MHz,avg} = \frac{1}{4}\sum_{i=1}^{4} IL_{100MHz,i};$$

$IL_{100MHz,i}$ is the insertion loss of a pair i at 100 MHz.

[c] $PS\ ANEXT_{avg}$ for Class F_A links is met if the Class F_A *PS ANEXT* specification limits in Table A.21 are met.

Table A.24 – Informative PS ANEXT$_{avg}$ values for permanent link at key frequencies

Frequency MHz	Minimum Class E_A PS ANEXT$_{avg}$ dB
1	67,0
100	62,3
250	56,3
500	51,8

A.2.11.4 PS AFEXT for Class E_A permanent links or CP links

The *PS AFEXT* for Class E_A is computed as follows:

$AFEXT_{norm}$ is computed from Equations A.9 to A.12 as follows

If

$$IL_k - IL_{l,i} > 0 \tag{A.9}$$

then

$$AFEXT_{norm\,l,i,k} = AFEXT_{l,i,k} - IL_{l,i} + IL_k - 10\lg\left(\frac{IL_k}{IL_{l,i}}\right) \tag{A.10}$$

The measured pair-to-pair alien *FEXT* values of a pair *k* in a disturbed link from the disturbing link *l* are normalized by the difference of the insertion losses of disturbing and disturbed link.

If

$$IL_k - IL_{l,i} \leq 0 \tag{A.11}$$

then

$$AFEXT_{\text{norm}\,l,i,k} = AFEXT_{l,i,k} \tag{A.12}$$

where

k	is the number of the disturbed pair in the disturbed link;
i	is the number of the disturbing pair in a disturbing link l;
l	is the number of the disturbing link;
$AFEXT_{l,i,k}$	is the alien far end crosstalk loss coupled from pairs i into pair k;
IL_k	is the measured insertion loss of pair k in the disturbed link;
$IL_{l,i}$	is the measured insertion loss of pair i of disturbing link l.

The *PS AFEXT* is determined according to Equation (A.13).

$$PS\,AFEXT_k = -10\lg\left(\sum_{l=1}^{N}\sum_{i=1}^{n}10^{\frac{-\left(AFEXT_{\text{norm}\,l,i,k}\right)}{10}}\right) \tag{A.13}$$

where

N is the total number of disturbing links;

n is the number of disturbing pairs in disturbing link l;

k is the number of the disturbed pair in the disturbed link;

i is the number of the disturbing pair in a disturbing link l;

l is the number of the disturbing link.

A.2.11.5 PS AFEXT for Class F_A permanent links or CP links

The *PS AFEXT* is determined according to Equation A.14.

$$PS\,AFEXT_k = -10\lg\left(\sum_{l=1}^{N}\sum_{i=1}^{n}10^{\frac{-\left(AFEXT_{l,i,k}\right)}{10}}\right) \tag{A.14}$$

where

N is the total number of disturbing links;

n is the number of disturbing pairs in disturbing link l;

k is the number of the disturbed pair in the disturbed link;

i is the number of the disturbing pair in a disturbing link l;

l is the number of the disturbing link.

A.2.11.6 Power sum alien ACR-F (PS AACR-F) for Class E_A and Class F_A permanent links or CP links

The *PS AACR-F* of each pair of a permanent link or CP link shall meet the requirements derived by the equation in Table A.25.

The *PS AACR-F* shall be met at both ends of the cabling.

The *PS AACR-F* is computed based on *AFEXT*, and insertion losses of disturbing and disturbed links.

The $PS\ AACR\text{-}F_k$ of disturbed pair k is determined according to Equation (A.15).

$$PS\ AACR\text{-}F_k = PS\ AFEXT_k - IL_k \quad (A.15)$$

Table A.25 – PS AACR-F for permanent link or CP link

Class	**Frequency** MHz	**Minimum PS AACR-F** [a, b] dB
E_A	$1 \le f \le 500$	$77 - 20\lg(f)$
F_A	$1 \le f \le 1\,000$	$92 - 20\lg(f)$

[a] *PS AACR–F* at frequencies that correspond to calculated PS AFEXT values of greater than 67,0 dB or 102 − 15 lg(f) dB shall be for information only.

[b] *PS AACR-F* at frequencies that correspond to calculated values of greater than 67,0 dB shall revert to a minimum requirement of 67,0 dB.

Table A.26– Informative PS AACR-F values for permanent link at key frequencies

Frequency MHz	**Minimum PS AACR-F** dB	
	Class E_A	**Class F_A**
1	67,0	67,0
100	37,0	52,0
250	29,0	44,0
500	23,0	38,0
1 000	–	32,0

A.2.11.7 PS AACR-F_{avg} for Class E_A and Class F_A permanent links or CP links

The $PS\ AACR\text{-}F_{avg}$ of each permanent link or CP link shall meet the requirements derived by the equations in Table A.27.

The $PS\ AACR\text{-}F_{avg}$ requirements shall be met at both ends of the cabling.

$PS\ AACR\text{-}F_{avg}$ is computed as follows:

$$PS\ AACR\text{-}F_{avg} = \frac{1}{n}\left[\sum_{k=1}^{n} PS\ AACR\text{-}F_k\right] \quad (A.16)$$

where

k is the number of the disturbed pair in the disturbed link;

n is the number of pairs in the disturbed link.

Table A.27 – PS AACR-F_{avg} for permanent link or CP link

Class	Frequency MHz	Minimum PS AACR-F_{avg} [a, b, c] dB
E_A	$1 \leq f \leq 500$	$81 - 20\lg(f)$

[a] *PS AACR–F_{avg}* at frequencies that correspond to calculated *PS AFEXT$_{avg}$* values of greater than 67,0 dB or 102 − 15 lg(*f*) dB shall be for information only.

[b] *PS AACR–F_{avg}* at frequencies that correspond to calculated values of greater than 67,0 dB shall revert to a minimum requirement of 67,0 dB.

[c] *PS AACR–F_{avg}* for Class F_A links is met if the Class F_A *PS AACR-F* specification limits in Table 25 are met.

Table A.28– Informative PS AACR-F_{avg} values for permanent link at key frequencies

Frequency MHz	Minimum Class E_A PS AACR-F_{avg} dB
1	67,0
100	41,0
250	33,0
500	27,0

Annex B
(normative)

Test procedures

Replace, in ISO/IEC 11801:2002, the entire text, including tables and NOTES, of this annex by the following:

B.1 General

This annex contains requirements and recommendations for testing of channels, permanent links and CP links in order to determine their conformance to this International Standard.

B.2 Channel and link performance testing

B.2.1 General

Performance testing can be undertaken either

- in a laboratory, where channels, permanent links or CP links contain specific cabling components in a specific implementation, or
- in the field, after installation, using test equipment.

This testing is independent from any requirements for acceptance testing contained within an installation specification, as in ISO/IEC 14763-2.

There are two kinds of conformance testing:

a) reference conformance testing;

   This testing is performed on a sample of installed cabling in a laboratory where an assessment against the conformance criteria of Clause 4 is required. The assessment documentation will include details of the number of channels or links tested, test evaluation criteria, supplier's declarations and certification, laboratory accreditation and calibration certification, etc.

   This testing can also be used for

   - the comparison of measurements performed with laboratory and field test instruments,
   - assessing cabling models in a laboratory environment,
   - assessing parameters that cannot be tested in an installation.

b) installation conformance testing;

   This testing is performed on a complete installation of cabling in the field where an assessment against the conformance criteria of Clause 4 is required.

Conformance testing of both kinds may be performed by independent or third party organisations in order to give greater guarantees of compliance. Reference testing is also known as type testing.

B.2.2 Installation conformance testing of balanced cabling channels, permanent links and CP links

Testing to determine conformance with the requirements of Clause 6 is optional. Testing should be performed in the following cases:

a) channels, permanent links, or CP links with lengths exceeding, or having more components than, those specified in reference implementations of Clause 7;

b) permanent links or CP links using components whose transmission performance is lower than those described in Clauses 9 and 10;

c) channels using components whose transmission performance is lower than those described in Clauses 9, 10 and 13;

d) channels created by adding more than one cord to either end of a link meeting the requirements of Clause 6 and Annex A;

e) evaluation of cabling to determine its capacity to support a certain group of applications;

f) confirmation of performance of cabling designed in accordance with Clause 7, using Clauses 9, 10 and 13.

g) Channels containing cable segments with lengths that are outside the assumed ranges in Table 31[17].

The test procedures for balanced cabling channels, permanent links and CP links are specified in IEC 61935-1.

B.2.3 Installation conformance testing of optical fibre cabling channels

Testing to determine conformance with the requirements of Clause 8 is optional. Testing should be performed in the following cases:

a) evaluation of cabling to determine its ability to support a certain group of applications;

b) confirmation of performance of cabling designed in accordance with Clauses 8, 9 and 10.

The test procedures for optical fibre cabling channels and permanent links are specified in ISO/IEC 14763-3.

B.3 Overview of test regimes

A test regime for each of the two kinds of conformance testing (see B.2.1) is defined for each transmission parameter. The test regime for balanced cabling reference conformance and installation conformance testing is shown in Table B.1. The test regime for optical fibre cabling reference conformance and installation conformance testing is shown in Table B.2.

[17] Refers to Table 31 as added by Amendment 1 and not Table 31 (Insertion loss, renumbered as Table 42 by Amenendment 1:2008) in ISO/IEC 11801:2002.

Table B.1 – Test regime for reference conformance and installation conformance – Balanced cabling

Transmission parameter [b]	Reference conformance testing	Installation conformance testing
Return loss	N	N
Insertion loss	N	N
Pair-to-pair NEXT	N	N
PS NEXT	C	C
Pair-to-pair ACR-N	C	C
PS ACR-N	C	C
Pair-to-pair ACR-F	N	N
PS ACR-F	C	C
Direct current (d.c.) loop resistance	N	N
Direct current (d.c.) resistance unbalance	N	I
Propagation delay	N	N
Delay skew	N	N
Unbalance attenuation, near-end (TCL)	N	I
Unbalance attenuation, far-end (ELTCTL)	N	I
Coupling attenuation	N	I
PS ANEXT	N	N_S
PS $ANEXT_{avg}$	C	C
PS AACR-F	N	N_S
PS AACR-F_{avg}	C	C
Wire-map	N	N
Continuity: • signal conductors; • screen conductors (if present); • short circuits; • open circuits.	N	N
Length [a]	I	I

where

C is the calculated value;

I is the informative (optional) testing;

N is the normative (100 %) testing, if not met by design;

N_S is the normative (sampled) testing, if not met by design. The sample size to be tested should be in accordance with ISO/IEC 14763-2.

NOTE The term "met by design" refers to a requirement which may be met by the selection of appropriate materials and installation techniques.

[a] Length is not a pass/fail criterion.

[b] Only those parameters specified for each Class of cabling need to be tested, as required in Amendment 1:2008 and Annex A.

Table B.2 – Test regime for reference conformance and installation conformance – Optical fibre cabling

Transmission parameter	Reference conformance testing	Installation conformance testing
Attenuation	N	N
Propagation delay [a]	I	I
Polarity	N	N
Length	I	I
Return loss	N	N
where I = Informative (optional) testing. N = Normative (100 %) testing.		
[a] Propagation delay is not a pass/fail criterion.		

Annex C
(normative)

Mechanical and environmental performance testing of connecting hardware for balanced cabling

Replace, in ISO/IEC 11801:2002, the entire text, including tables, of this annex by the following:

C.1 Overview

The mechanical and environmental performance of connecting hardware is vital to the cabling system. Changes in contact resistance because of operational and environmental stress can negatively affect the transmission characteristics of the cabling system. Product acceptance testing is accomplished by subjecting the product to a number of mechanical and environmental conditions and measuring any resistance deviations at prescribed intervals and after completion of each conditioning sequence. In addition, the product shall not show evidence of degradation with respect to the ease of mechanical termination, safety or other functional attributes during or after environmental conditioning.

Connecting hardware often contains a combination of solderless connections and a separable contact interface (free connector/fixed connector interface). All connections shall be tested. Where a combination of connections and/or separable contact interfaces are tested together, care should be taken to ensure the use of the most stringent test schedule as the test schedules vary by type of connection.

This annex provides mechanical connection performance requirements for connections that are not covered by a specific IEC connector standard. This annex is intended to be replaced by reference to international standards, as soon as they become available.

NOTE Connection interfaces that conform to the mechanical and environmental performance requirements of IEC 60603-7 (unscreened) or IEC 60603-7-1 (screened) comply with this annex as these standards specify appropriate tests. Connection interfaces that are covered by international standards other than the IEC 60603-7 series must comply with at least the equivalent mechanical and environmental performance requirements specified in this annex.

C.2 Solderless connections

To ensure reliable solderless terminations of balanced cable with insulated conductors, and to ensure reliable solderless connections between component parts within connecting hardware, solderless connections shall meet the requirements of the applicable standards specified in Table C.1.

Table C.1 – Standards for solderless connections

Connection type	Standard
Crimped connection	IEC 60352-2
Accessible IDC	IEC 60352-3
Non-accessible IDC	IEC 60352-4
Press-in connection	IEC 60352-5
IPC	IEC 60352-6
Spring clamp connection	IEC 60352-7
Compression mount	IEC 60352-8

The default criteria and conditions in the relevant standards in Table C.1 apply, except as specified in the remainder of this clause.

The maximum initial contact resistance for an insulation displacement connection shall be 2,5 mΩ and the maximum change in contact resistance during and after conditioning shall be 5 mΩ from the initial value.

The following test conditions are specified, as detailed by the type test requirements of the IEC 60352 series of standards.

- Vibration test severity: 10 Hz to 500 Hz.
- Low temperature (LCT): –40 °C.
- Electrical load and temperature, test current: 1 A d.c.

C.3 Free and fixed connectors (modular plugs and jacks)

Fixed and free connectors (modular plugs and jacks) shall comply with the reliability requirements of the applicable standard specified in Table C.2.

Table C.2 – Standards for free and fixed connectors (modular plugs and jacks)

Category and type	Standard
Category 3, unscreened	IEC 60603-7
Category 3, screened	IEC 60603-7-1
Category 5, unscreened	IEC 60603-7-2
Category 5, screened	IEC 60603-7-3
Category 6, unscreened	IEC 60603-7-4
Category 6, screened	IEC 60603-7-5
Category 6_A, unscreened	IEC 60603-7-41
Category 6_A, screened	IEC 60603-7-51
Category 7, screened	IEC 60603-7-7
Category 7_A, screened	IEC 60603-7-71, IEC 61076-3-104 or IEC 61076-3-110 as appropriate

The default criteria and conditions in the relevant standards in Table C.2 apply, except as specified in the remainder of this clause.

The number of mating cycles (insertions and withdrawals) for free and fixed connectors (modular plugs and jacks), and the number of conductor re-terminations per solderless connection shall comply with the specifications in Table C.3.

Table C.3 – Free and fixed connectors (modular plugs and jacks) operations matrix

Connecting hardware type	Insertion and withdrawal, and conductor re-termination, operations	Minimum number of operations
Free connector (modular plug)	Insertion / withdrawal with fixed connector (modular jack)	750
	Cable re-termination	0
Fixed connector (modular jack)	Insertion / withdrawal with free connector (modular plug)	750
	Cable re-termination	20 [a, b]

[a] Unless not intended for re-termination, in which case this value equals 0.

[b] The range of conductor size and type shall be in accordance with the manufacturer's instructions.

Between terminations, the solderless connection should be inspected for debris and extraneous material should be removed.

C.4 Other connecting hardware

Examples of other connecting hardware include:

- cross-connect blocks and plugs;
- pin and socket connectors.

The reliability of connecting hardware, other than free and fixed connectors (modular plugs and jacks), shall be demonstrated by complying with the applicable requirements of the standards specified in Table C.4. The connecting hardware shall be terminated, mounted, and operated in accordance with the manufacturer's instructions for use. A minimum of 100 individual electrical contact paths (e.g. connecting hardware, input to output) shall be tested without failure.

The following tests shall be as per the manufacturer's specification:

- examination of dimensions and mass;
- insertion and withdrawal force requirements;
- effectiveness of any connector coupling device requirements;
- gauging and gauging continuity requirements;
- arrangement for contact resistance test;
- arrangement for vibration (dynamic stress) test.

Table C.4 – Reference for reliability testing of other connecting hardware

Category and type	Standard	
All Categories, unscreened	IEC 60603-7	Clause 6 and Clause 7 [a]
All Categories, screened	IEC 60603-7 and IEC 60603-7-1	

[a] Excluding subclauses addressing pin and pair grouping assignment, creepage and clearance distances, transmission characteristics, transfer impedance, and test group EP (transmission testing).

The default criteria and conditions in the relevant standards in Table C.4 apply, unless otherwise specified in this clause.

The number of mating cycles (insertions and withdrawals) for other connecting hardware, and the number of conductor re-terminations per solderless connection shall comply with the specifications in Table C.5.

Table C.5 – Other connecting hardware operations matrix

Connecting hardware type	Insertion and withdrawal, and conductor re-termination, operations	Minimum number of operations
Other connecting hardware “free connector”	Insertion / withdrawal operations with “fixed connector”	200
	Cable re-termination	0
Other connecting hardware “fixed connector”	Insertion / withdrawal operations with “free connector”	200
	Cable re-termination	20 [a, b]
	Jumper re-termination	200

[a] Unless not intended for re-termination, in which case this value equals 0.

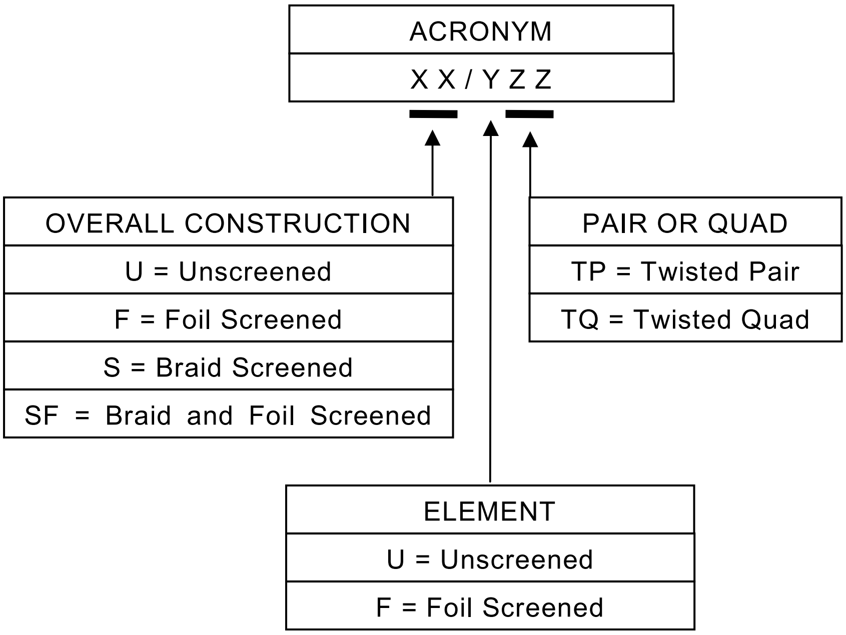
[b] The range of conductor size and type shall be in accordance with the manufacturer’s instructions.

Between terminations, the solderless connection should be inspected for debris and extraneous material should be removed.

Annex E
(informative)

Acronyms for balanced cables

Replace, in ISO/IEC 11801:2002, the existing Figure E.1, including example text, by the following:



For example:

U/UTP = overall unscreened cable with unscreened twisted pairs (often referred to as UTP)

F/UTP = overall screened cable with unscreened twisted pairs (often referred to as FTP)

S/FTP = overall braid screened cable with foil screened twisted pairs (often referred to as STP or PiMF)

SF/UTP = overall braid and foil screened cable with unscreened twisted pairs

Figure E.1 – Cable naming schema

Replace, in ISO/IEC 11801:2002, the existing Figure E.2 by the following:

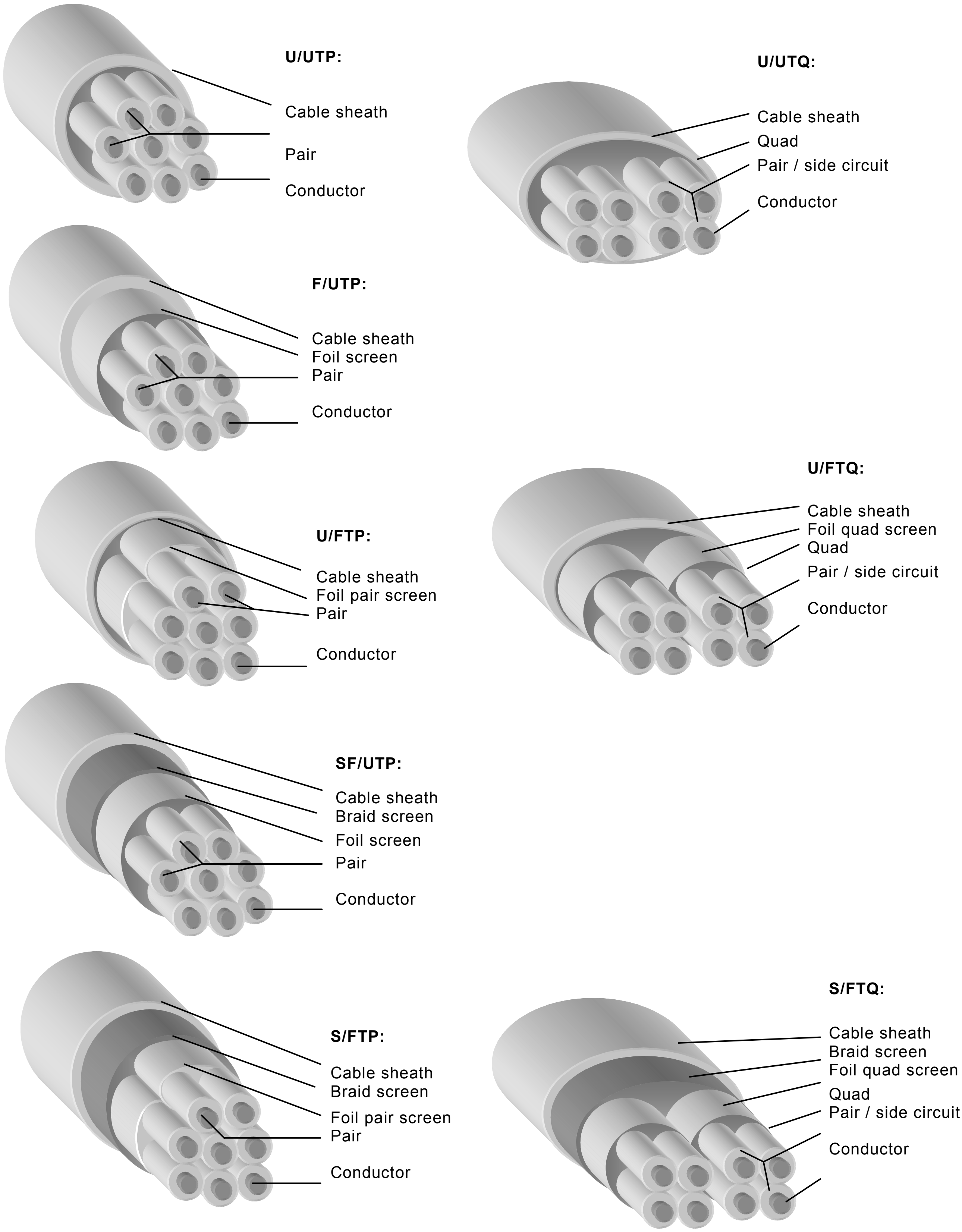


Figure E.2 – Examples of cable types

Annex F
(informative)

Supported applications

F.1 Supported applications for balanced cabling

Replace, in ISO/IEC 11801:2002, Tables F.1 and F.2 by the following:

Table F.1 – Applications using balanced cabling

Application	Specification reference	Date	Additional name / reference
Class A (defined up to 0,1 MHz)			
PBX	National requirements		
X.21	ITU-T Rec. X.21	1992	
V.11	ITU-T Rec. X.21	1996	
Class B (defined up to 1 MHz)			
S0-Bus (extended)	ITU-T Rec. I.430	1993	ISDN Basic Access (Physical Layer)
S0 Point-to-Point	ITU-T Rec. I.430	1993	ISD2 Basic Access (Physical Layer)
S1/S2	ITU-T Rec. I.431	1993	ISDN Primary Access (Physical Layer)
Class C (defined up to 16 MHz)			
Ethernet 10BASE-T	IEEE 802.3, Clause 14 [a]	2005	CSMA/CD IEEE 802.3i
Token Ring 4 Mbit/s	ISO/IEC 8802-5	1998	
ATM LAN 25,60 Mbit/s	ATM Forum af-phy-0040.000	1995	ATM-25/Category 3
ATM LAN 51,84 Mbit/s	ATM Forum af-phy-0018.000	1994	ATM-52/Category 3
ATM LAN 155,52 Mbit/s	ATM Forum af-phy-0047.000	1995	ATM-155/Category 3
Class D 1995 (defined up to 100 MHz)			
Token Ring 16 Mbit/s	ISO/IEC 8802-5	1998	IEEE 802.5:1998
ATM LAN 155,52 Mbit/s	ATM Forum af-phy-0015.000	1994	ATM-155/Category 5
Ethernet 100BASE-TX [a,b]	IEEE 802.3, Clause 25 [a]	2005	Fast Ethernet IEEE 802.3u
Token Ring 100 Mbit/s	IEEE 8802-5t	2000	
PoE	IEEE 802.3 af	2005	Power over Ethernet, IEEE 802.3af
Class D 2002 (defined up to 100 MHz)			
Ethernet 1000BASE-T	IEEE 802.3, Clause 40 [a]	2005	Gigabit Ethernet, IEEE 802.3ab
Fibre Channel 1 Gbit/s	ISO/IEC 14165-115	2007	Twisted-pair Fibre Channel 1G
Firewire 100 Mbit/s	IEEE 1394b	2002	Firewire/Category 5
PoE+	IEEE 802.3 at [b]	2009	Power over Ethernet Plus
Class E 2002 (defined up to 250 MHz)			
ATM LAN 1,2 Gbit/s	ATM Forum af-phy-0162.000	2001	ATM-1 200/Category 6

Class E_A 2008 (defined up to 500 MHz)			
Ethernet 10GBASE-T	IEEE 802.3, Clause 44	2006	10Gigabit Ethernet, IEEE 802.3an
Fibre Channel 2 Gbit/s	INCITS 435	2007	Twisted-pair Fibre Channel 2G-FCBASE-T
Fibre Channel 4 Gbit/s	INCITS 435	2007	Twisted-pair Fibre Channel 4G-FCBASE-T
Class F 2002 (defined up to 600 MHz)			
FC-100GB/s	ISO/IEC 14165-114	2005	FC-100-DF-EL-S
Class F_A 2008 (defined up to 1 000 MHz)			

[a] Including support for remote power feeding defined by IEEE 802.3af:2003 and IEEE 802.3at:2009.

[b] For channels used to support applications requiring remote power, see ISO/IEC TR 29125.

NOTE 1 Applications supported by a given class are also supported by higher classes. Some applications may run on a lower class in cases where the specific channel in question meets the performance criteria of the application.

NOTE 2 The minimum performance of Class E 2002 channels does not support 10GBase-T. Channels implemented using Category 6 2002 components will support 10GBase-T provided they meet the additional requirements specified in ISO/IEC TR 24750. Such support may be limited to channels shorter than 100 m. Class E_A or better is recommended for new installations.

Table F.2 – Modular connector pin assignment for applications

Application	Pins 1 and 2	Pins 3 and 6	Pins 4 and 5	Pins 7 and 8
PBX	Class A [a]	Class A [a]	Class A	Class A [a]
X.21		Class A	Class A	
V.11		Class A	Class A	
S0-Bus (extended)	[b]	Class B	Class B	[b]
S0 Point-to-Point	[b]	Class B	Class B	[b]
S1/S2	Class B	[c]	Class B	[b]
Ethernet 10BASE-T	Class C	Class C	[b]	[b]
Token Ring 4 Mbit/s		Class C	Class C	
ATM-25 Category 3	Class C			Class C
ATM-51 Category 3	Class C			Class C
ATM -155 Category 3	Class C			Class C
Token Ring 16 Mbit/s		Class D	Class D	
ATM-155 Category 5	Class D			Class D
Ethernet 100BASE-TX	Class D	Class D		
Token Ring 100 Mbit/s		Class D	Class D	
Ethernet 1000BASE-T	Class D	Class D	Class D	Class D
1G FCBASE-T	Class D	Class D	Class D	Class D
ATM-1200 Category 6	Class E	Class E	Class E	Class E
Ethernet 10GBASE-T	Class E_A	Class E_A	Class E_A	Class E_A
2G FCBase-T	Class E_A	Class E_A	Class E_A	Class E_A
4G FCBase-T	Class E_A	Class E_A	Class E_A	Class E_A
FC-100-DF-EL-S [d]	Class F	Class F		

[a] Option dependent on supplier.

[b] Optional power sources.

[c] Option for continuity of cable screen.

[d] Option outside TO as ISO/IEC 14165-114 specifies IEC 61076-3-104.

F.2 Supported applications for optical fibre cabling

Replace, in ISO/IEC 11801:2002, the existing third paragraph of Clause F.2 by the following:

Details of application support are provided for each cabled optical fibre Category included in Clause 9, and additional information is provided in Table F.3 and Table F.4 concerning maximum channel lengths. Cabled optical fibre categories OM1, OM2, OM3, OM4, OS1 and OS2 are described in Clause 9.

Replace, in ISO/IEC 11801:2002, the existing Tables F.3, F.4, and F.5 by the following:

Table F.3 – Supported applications using optical fibre cabling

Network application	Max. channel insertion loss (dB)			ISO/IEC 11801 channel supported by cabled optical fibre Category							
	Multimode [a]		Single-mode	OM1		OM2		OM3/OM4		OS1/OS2	
	850 nm	1 300 nm	1 310 nm	850 nm	1 300 nm	850 nm	1 300 nm	850 nm	1 300 nm	1 310 nm	1 550 nm
IEEE 802-3: 10BASE-FLand FB [b]	12,5(6,8)	–	–	OF-2000		OF-2000		OF-2000			
ISO/IEC TR 11802-4: 4 and 16 Mbit/s Token Ring [b]	13,0(8,0)	–	–	OF-2000		OF-2000		OF-2000			
ATM at 52 Mbit/s [c]	NA	10,0(5,3)	10,0		OF-2000		OF-2000		OF-2000	OF-2000	
ATM at 155 Mbit/s [c]	7,2	10,0(5,3)	7,0	OF-500	OF-2000	OF-500	OF-2000	OF-500	OF-2000	OF-2000	
ATM at 622 Mbit/s [b, c, d]	4,0	6,0(2,0)	7,0	OF-300	OF-500	OF-300	OF-500	OF-300	OF-500	OF-2000	
ISO/IEC 14165-111: Fibre Channel (FC-PH) at 1 062 Mbit/s [c, d]	4,0	–	6,0	OF-300		OF-500		OF-500		OF-2000	
IEEE 802-3: 1000BASE-SX [d]	2,6(3,56)	–	–	[e]		OF-500		OF-500			
IEEE 802-3: 1000BASE-LX [c, d]	–	2,35	4,56		OF-500		OF-500		OF-500	OF-2000	
ISO/IEC 9314-3: FDDI PMD [b]	–	11,0(6,0)	–		OF-2000		OF-2000		OF-2000		
ISO/IEC 9314-4: FDDI SMF-PMD [c]	–	–	10,0							OF-2000	
ISO/IEC 8802-3: 100BASE-FX [b]		11,0(6,0)	–		OF-2000		OF-2000		OF-2000		
IEEE 802.3: 10GBASE-LX4		2,00	6,20		OF-300		OF-300		OF-300	OF-2000	
IEEE 802.3: 10GBASE-ER/EW											OF-2000
IEEE 802.3: 10GBASE-SR/SW	1,60 (62,5) 1,80 (OM-2 50) 2,60 (OM-3)	–	–					OF-300			
IEEE 802.3: 10GBASE-LR/LW [c]	–	–	6,20							OF-2000	
IEEE 802.3: 40GBASE-LR4	–	–	f.f.s.							OF-2000	
IEEE 802.3: 100GBASE-LR4	–	–	6,3							OF-2000	
IEEE 802.3: 100GBASE-ER4	–	–	18,0							OF-2000	
1 Gbps FC (1.0625 GBd)	3,85 (OM-2) 2,62 (OM-3)	–	7,8			OF-500		OF-500		OF-2000	
2 Gbps FC (2,125 GBd)	2,1 (OM-1) 2,62 (OM-2) 3,31 (OM-3)	–	7,8			OF-300		OF-300		OF-2000	
4 Gbps FC (4,25 GBd)	1,78 (OM-1) 2,06 (OM-2) 4,48 (OM-3)–	–	4,8					OF-300		OF-2000	

Network application	Max. channel insertion loss (dB)			ISO/IEC 11801 channel supported by cabled optical fibre Category							
	Multimode [a]		Single-mode	OM1		OM2		OM3/OM4		OS1/OS2	
	850 nm	1 300 nm	1 310 nm	850 nm	1 300 nm	850 nm	1 300 nm	850 nm	1 300 nm	1 310 nm	1 550 nm
8 Gbps FC (8,5 GBd)	1,62 (OM-1) 1,77 (OM-2) 2,32 (OM-3)	–	6,4							OF-2000	

[a] The values shown are for both 62,5/125 and 50/125 MMF, where the values differ the 50/125 values are shown in parentheses.

[b] The channel length may be limited on 50 µm optical fibre. See the relevant application standard for details.

[c] The channel length on single-mode optical fibre may be longer but lies outside the scope of this standard. See the relevant application standard for details.

[d] A bandwidth-limited application at the channel lengths shown. The use of lower attenuation components to produce channels exceeding the values shown cannot be recommended.

[e] See Table F.4.

Table F.4 – Maximum channel lengths supported by optical fibre applications for multimode optical fibre

Network application	Nominal transmission wavelength nm	Maximum channel length m	
		50/125 µm optical fibre	62,5/125 µm optical fibre
IEEE 802-3: FOIRL	850	514	1 000
IEEE 802-3:10BASE-FL & FB	850	1 514	2 000
ISO/IEC TR 11802-4: 4 & 16 Mbit/s Token Ring	850	1 857	2 000
ATM at 155 Mbit/s	850	1 000 [b]	1 000 [a]
ATM at 622 Mbit/s	850	300 [b]	300 [a]
ISO/IEC 14165-111: Fibre Channel (FC-PH) at 1 062 Mbit/s [d]	850	500 [b]	300 [a]
IEEE 802.3: 1000BASE-SX [d]	850	550 [b]	275 [a]
IEEE 802.3: 10GBASE-SR [d]	850	300 [c]	
IEEE 802.3: 40GBASE-SR4 [d]	850	100 [c] , 125 [e]	
IEEE 802.3: 100GBASE-SR10 [d]	850	100 [c] , 125 [e]	
1 Gbps FC (1,0625 GBd) [d]	850	500 [a]	300 [b]
2 Gbps FC (2,125 GBd) [d]	850	300 [c]	
4 Gbps FC (4,25 GBd) [d]	850	150[b], 380[c], 400[e]	70
8 Gbps FC (8,5 GBd) [d]	850	50[b], 150[c], 200[e]	21
16 Gbps FC (14,025 GBd) [d]	850	35[b], 100[c], 130[e]	15
ISO/IEC 9314-3: FDDI PMD	1 300	2 000	2 000
IEEE 802-3: 100BASE-FX	1 300	2 000	2 000
IEEE 802.5t: 100 Mbit/s Token Ring	1 300	2 000	2 000
ATM at 52 Mbit/s	1 300	2 000	2 000
ATM at 155 Mbit/s	1 300	2 000	2 000
ATM at 622 Mbit/s	1 300	330	500
IEEE 802.3: 1000BASE-LX [d]	1 300	550 [b]	550 [a]
IEEE 802.3: 10GBASE-LX4 [d]	1 300	300 [a]	300 [a]

[a] Minimum cabled optical fibre performance of category OM1 is specified.

[b] Minimum cabled optical fibre performance of category OM2 is specified.

[c] Minimum cabled optical fibre performance of Category OM3 is specified.

[d] These applications are bandwidth limited at the channel lengths shown. The use of lower attenuation components to produce channels exceeding the values shown cannot be recommended.

[e] Minimum cabled optical fibre performance of category OM4 is specified.

Table F.5 – Maximum channel length supported by optical fibre applications for single-mode optical fibre

Network application	Nominal transmission wavelength nm	Maximum channel length m
ISO/IEC 9314-4: FDDI SMF-PMD	1 310	2 000
ATM at 52 Mbit/s	1 310	2 000
ATM at 155 Mbit/s	1 310	2 000
ATM at 622 Mbit/s	1 310	2 000
ISO/IEC 14165-111: Fibre Channel (FC-PH) at 1 062 Mbit/s	1 310	2 000
IEEE 802.3: 1000BASE-LX	1 310	2 000
IEEE 802.3: 40GBASE-LR4	1 310	2 000
IEEE 802.3: 100GBASE-LR4	1 310	2 000
IEEE 802.3: 100GBASE-ER4	1 310	2 000
1 Gbps/s FC (1,0625 GBd)	1 310	2 000
2 Gbps/s FC (2,125 GBd)	1 310	2 000
4 Gbps/s FC (4,25 GBd)	1 310	2 000
8 Gbps/s (8,5 GBd)	1 310	2 000
10 Gbps/s FC	1 310	f.f.s.
IEEE 802.3: 10GBASE-LR/LW	1 310	2 000
1 Gbps/s FC	1 550	2 000
2 Gbps/s FC	1 550	2 000
IEEE 802.3: 10GBASE-ER/EW	1 550	2 000
IEEE 802.3: 40GBASE-LR4	1 271, 1 291, 1 311, 1 310	2 000
IEEE 802:3: 100GBASE-LR4	1 295, 1 300, 1 305, 1 310	2 000
IEEE 802.3: 100GBASE-ER4	1 295, 1 300, 1 305, 1 310	2 000

Annex G
(informative)

Channel and permanent link models for balanced cabling

Replace, in ISO/IEC 11801:2002, all occurrences of “pass/fail limits” *and* “test limits” *in this annex by* “limits”.

G.3.3.2 Additional assumptions for NEXT

Replace, in ISO/IEC 11801:2002, the existing subclause G.3.3.2 by the following:

The following information can be applied to the channel and permanent link models for *NEXT*.

- *FEXT* and *ACR-F* in combination with reflections that occur within the channel and link can add *NEXT*. The major reflections are from connectors and impedance mismatches between connected cables. These reflections add to the *NEXT* that reaches the channel, permanent link or cord endpoints. This effect can be estimated with an approach similar to that demonstrated in G.3.3.1. Cable segment *ACR-F* can be scaled using the equation in G.4.3. Cable segment *NEXT* is scaled with Equation (G.10). The effect is more significant at higher frequencies because of the 20 dB per decade slope of *FEXT* and *RL* of connecting hardware, and *ACR-F* of cable. The near end components have the greatest influence.
- Additional *NEXT* contributions that result from unbalanced signals and differential-to-common and common-to-differential mode coupling are not included in the model and are f.f.s.
- In modelling calculations, various combinations of a given statistically variable parameter (*FEXT*, *NEXT* or return loss) may be added in either Voltage Sum or Power Sum, or combinations of each summation type. Each method is used for simplified representations of different distributions of component performance and of distributions in phase delays. Voltage sum represents the worst case and assumes that all components are at the limit. At some frequencies all the phases will add in phase and this worst case may occur. To avoid this worst case theoretical scenario Voltage Sum was used but a statistical approach was chosen where all the components have an average value better than the limit and a three sigma normal distribution. The three sigma worst case is at the component limit line. Then a statistical simulation (250 runs) was applied. The assumption is that not only components that just meet the limit will be included in a link. The input values used are seen in Table G.3 for class E_A and in Table G.4 for class F_A in Clause G.8

Replace, in ISO/IEC 11801:2002, the existing Clause G.4 by the following:

G.4 ACR-F

G.4.1 ACR-F of the channel configuration

The limit for *ACR-F* of the channel configuration, for all classes, is computed by adding as a voltage sum the *ACR-F* for 100 m cable and four times (4) the *FEXT* for connecting hardware as shown in the following formula:

$$ACR-F_{\text{CH}} = -20 \lg \left(10^{\frac{-ACR-F_{\text{cable 100 m}}}{20}} + 4 \times 10^{\frac{-FEXT_{\text{connector}}}{20}} \right) \quad \text{(G.18)}$$

where

$ACR\text{-}F_{\mathrm{CH}}$	is the limit for *ACR-F* of the channel in dB;
$ACR\text{-}F_{\mathrm{cable\ 100\ m}}$	is the *ACR-F* specified for 100 m cable in dB;
$FEXT_{\mathrm{connector}}$	is the *FEXT* limit specified for a single connector in dB.

G.4.2 ACR-F for the permanent link configurations

The limit for *ACR-F* of all permanent link configurations, for all class types, equals the voltage sum total of the *ACR-F* for 100 m cable and three (3) times the *FEXT* for connecting hardware as shown in the following equation (*FEXT* and insertion loss measurements are significantly affected by all connectors in the permanent link):

$$ACR-F_{\mathrm{PL}} = -20\lg\left(10^{\frac{-ACR-F_{\mathrm{cable\ 100\ m}}}{20}} + 3\times 10^{\frac{-FEXT_{\mathrm{connector}}}{20}}\right) \text{ in dB} \qquad \text{(G.19)}$$

where

$ACR\text{-}F_{\mathrm{PL}}$	is the limit for *ACR-F* of the permanent link in dB.

G.4.3 Assumptions for ACR-F

The following assumptions are applicable to the channel and permanent link models for *ACR-F*:

– *ACR-F* of a cable segment depends on its length L by:

  $-10\lg\left(\frac{L}{100}\right)$ (the *ACR-F* improves as the cable segment is reduced in length).

– This provides a slight measurement margin for a permanent link:

  $-10\lg\left(\frac{90}{100}\right)$ = 0,46 dB.

– The method to compute channel and permanent link performance is quite precise as all *FEXT* coupled signals travel approximately the same distance. At high frequencies, delay skew causes phase differences and thereby nulls in the response.

– There is no *ACR-F* margin present in channels. However, in practice, the *ACR-F* of cable is generally better than the specified requirements.

– Excess *FEXT* contributions that may be due to unbalanced signals and the resulting cross modal crosstalk coupling are ignored.

– Reflected crosstalk and tertiary crosstalk are ignored.

– The crosstalk mechanism involves cross-modal crosstalk phenomena. Hence, common mode terminations affect the crosstalk coupling substantially.

Add, in ISO/IEC 11801:2002, after Clause G.5, the following new clauses and subclauses:

G.6 PS ANEXT link modelling

G.6.1 General

The *PS ANEXT* model is similar to the model used for *NEXT*.

Each pair-to-pair *ANEXT* contribution is modelled in the same manner as internal link *NEXT*; see Clause G.3.

Simple models assume equal lengths of disturbed and disturbing links and co-location of connecting hardware (patch panels). In situations where the lengths of disturbed and disturbing are different, corrections need to be applied which depend on the length over which alien crosstalk coupling occurs.

G.6.2 PS ANEXT between connectors

The *PS ANEXT* between connectors is modelled as:

$$PS\,ANEXT_{\text{connector,dB}} = PS\,ANEXT_{\text{connector,const,dB}} - 20\lg(f/100) \qquad \text{(G.30)}$$

G.6.3 PS ANEXT between cable segments

The *PS ANEXT* between cables is modelled as:

$$PS\,ANEXT_{\text{cable, dB}} = PS\,ANEXT_{\text{cable, const, dB}} - 15\lg(f/100) - 10\lg\left(\frac{1-10^{-\frac{\frac{L_{\text{d}}}{100}\alpha_{\text{cable, 100 m, dB}}}{5}}}{1-10^{-\frac{-\alpha_{\text{cable, 100 m, dB}}}{5}}}\right) \qquad \text{(G.31)}$$

where

$PS\,ANEXT_{\text{cable,const,dB}}$	is the *PS ANEXT* for 100 m of cable at 100 MHz;
L_{d}	is the length over which the *ANEXT* coupling takes place.

Refer to G.3.3.1 for a description of the length dependency portion of Equation (G.31).

G.6.4 Principles of link modelling

Worst case conditions occur where *ANEXT* coupling occurs over the full length of disturbing and disturbed cabling and where all connections within each link are co-located. If *ANEXT* coupling does not occur right from the beginning of the point of measurement, the impact is reduced by the sum insertion loss of the uncoupled cabling segments of disturbing and disturbed links. The highest influence on the overall *ANEXT* coupling originates from the beginning of the cabling.

PS ANEXT computations for the link are analogous to the *PS NEXT* computations in Clause G.3

Additional *ANEXT* contributions that result from unbalanced signals and differential-to-common and common-to-differential mode coupling are f.f.s. These can be significant at high frequencies.

G.7 PS AACR-F link modelling

G.7.1 General

The *PS AACR-F* model is similar to the model used for *ACR-F*.

Each pair-to-pair *AACR-F* contribution is modelled in the same manner as internal link *ACR-F*; see Clause G.4.

Simple models assume equal lengths of disturbed and disturbing links and co-location of connecting hardware (patch panels). In situations where the lengths of disturbed and disturbing are different, corrections need to be applied which depend on the length over which alien crosstalk coupling occurs.

The length dependency is as described in G.4.3. The *PS AACR-F* between links is obtained by subtracting the insertion loss of the disturbed pair from the *PS AFEXT* coupling into that pair.

G.7.2 PS AFEXT between connectors

The *PS AFEXT* between connectors is modelled as:

$$PS\ AFEXT_{\mathrm{Conn,dB}} = PS\ AFEXT_{\mathrm{Conn,const,dB}} - 20\lg(f/100) \tag{G.32}$$

where

$PS\ AFEXT_{\mathrm{Conn,const,dB}}$ is the *PS AFEXT* of connecting hardware at 100 MHz.

G.7.3 PS AACR-F between cable segments

The *PS AACR-F* between cables is modelled as:

$$PS\ AACR\text{-}F_{\mathrm{cable,dB}} = PS\ AACR\text{-}F_{\mathrm{Cable,const,dB}} - 20\ \lg(f/100) - 10\ \lg\left(\frac{L_{\mathrm{d}}}{100}\right) \tag{G.33}$$

where

$PS\ AACR\text{-}F_{\mathrm{Cable,const,dB}}$	is the *PS AACR-F* for 100 m cable at 100 MHz;
L_{d}	is the length over which the *AACR-F* coupling takes place.

Refer to G.4.3 for a description of the length dependency portion of Equation (G.33).

G.7.4 Principles of link modelling

Worst case conditions occur where *AFEXT* coupling occurs over the full length of disturbing and disturbed cabling, or a short cabling section runs in parallel over its length with a long cabling section, and where all connections within each link are co-located.

PS AACR-F computations for the link are analogous to the *PS ACR-F* computations in Clause G.4.

Additional *AFEXT* contributions that result from unbalanced signals and differential-to-common and common-to-differential mode coupling are f.f.s. These can be significant at high frequencies.

G.7.5 Impact of PS AACR-F in channels and links with substantially different lengths

G.7.5.1 General

The impact of *AFEXT* can be substantially increased when considering a short channel or link running in parallel with a long channel or link. This can be the case when considering the conditions at a patch panel where one link terminates from a nearby location and another channel or link terminates from a distant location (see Figure G.3). The disturbing channel or link j has pairs i from 1 to 4, and is disturbing the selected channel or link, pair k. The intent is to evaluate the performance of the cabling based on the coupling length. This coupling length is effectively determined by the minimum insertion loss of the disturbing channel or link IL_j and disturbed channel or link IL_k.

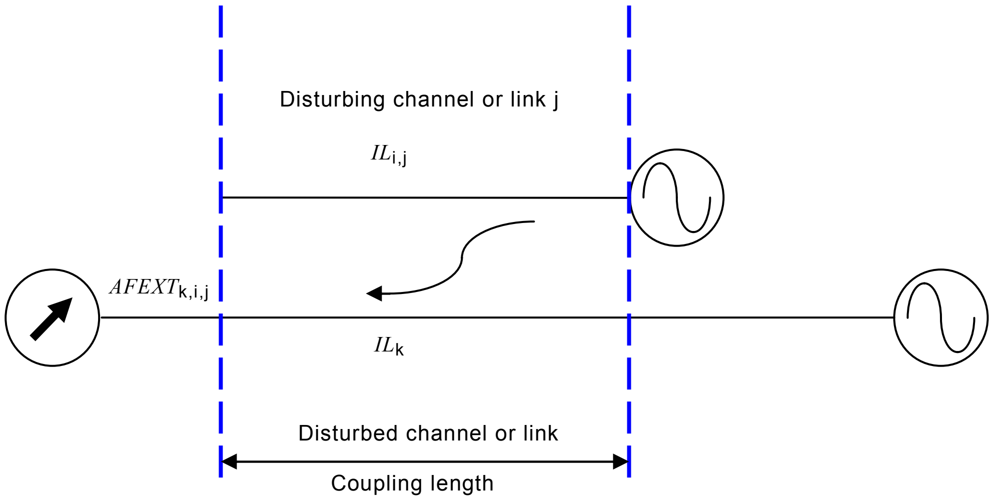


Figure G.3 – Example of increased impact of PS AFEXT.

G.7.5.2 Normalization for the coupling length

It is assumed that the coupling properties of cabling are consistent over length.

Over the coupling length, the *AACR-F* is defined as:

$$AACR\text{-}Fcoupled_{i,k} = AFEXT_{i,k} - Il_k \tag{G.34}$$

where

$AACR\text{-}Fcoupled_{i,k}$	is the *AACR-F* coupled between pair i of a disturbing channel or link and pair k of a disturbed channel or link;
i	is a pair in a disturbing channel or link;
k	is a pair in a disturbed channel or link;
$AFEXT_{i,k}$	is the AFEXT coupling between pair i of a disturbing channel or link and pair k of a disturbed channel or link;
IL_k	is the insertion loss of pair k of the disturbed channel or link.

Assuming that the length L_k of pair k of the disturbed channel or link is longer than the length L_i of pair i of the disturbing channel or link, the coupled length is given by the length L_i of the disturbing channel or link.

For nominally compliant cabling, the scaled *AACR-F* over the coupled length *AACR-Fcoupled* between pairs i of the disturbing channel or link and pair k of the disturbed channel or link is given by:

$$AACR\text{-}Fcoupled_{i,k} = AACR\text{-}F_{100\text{m}} - 10 \lg \left(\frac{L_i}{100}\right) \tag{G.35}$$

where

L_i is the length of pair i of the disturbing link or channel.

Therefore

$$AACR\text{-}F_{100\text{m}} = AACR\text{-}Fcoupled_{i,k} + 10 \lg \left(\frac{L_i}{100}\right) \quad (G.36)$$

If the coupling were to take place over the length L_k of the disturbed channel or link, the relationship for nominally compliant cabling will be

$$AACR\text{-}Fnormalized_{i,k} = AACR\text{-}F_{100\text{m}} - 10 \lg \left(\frac{L_k}{100}\right) \quad (G.37)$$

where

L_k is the length of pair k of the disturbed channel or link.

Substituting for $AACR\text{-}F_{100\text{m}}$ gives:

$$AACR\text{-}Fnormalized_{i,k} = AACR\text{-}Fcoupled_{i,k} + 10 \lg \left(\frac{L_i}{100}\right) - 10 \lg \left(\frac{L_k}{100}\right) \quad (G.38)$$

$$AACR\text{-}Fnormalized_{i,k} = AACR\text{-}Fcoupled_{i,k} - 10 \lg \left(\frac{IL_k}{IL_i}\right) \quad (G.39)$$

The logarithmic ratio of lengths can be converted to a logarithmic ratio of insertion losses. For simplification, the average insertion loss of all pairs at 250 MHz may be used to compute the ratio.

G.7.5.3 Normalization for signal strengths

To correct for the coupling length, assuming that pair k of the disturbed channel or link is longer than pair i of the disturbing channel or link and the insertion loss of the coupling length (in this case the insertion loss of the disturbing link) is to be evaluated, requires a normalization that is equal to the difference in signal strengths, which equals the difference of insertion losses of the disturbed and disturbing pairs:

$$IL_k - IL_i \quad (G.40)$$

The $AACR\text{-}Fcoupled_{i,k}$ is then computed as in Equations (G.41) through (G.43)

$$AACR\text{-}Fcoupled_{i,k} = AFEXT_{i,k} - {}_{ILi} - IL_k + IL_k \quad (G.41)$$

$$AACR\text{-}Fcoupled_{i,k} = AFEXT_{i,k} - IL_k - (IL_i - IL_k) \quad (G.42)$$

$$AACR\text{-}Fcoupled_{i,k} = AACR\text{-}F_{i,k} + (IL_k - IL_i) \quad (G.43)$$

where

IL_k is the insertion loss in dB of pair k of the disturbed channel or link;

IL_i is the insertion loss in dB of pair i of the disturbing channel or link.

In other words, the measured $AFEXT$ needs to be adjusted by the difference of the insertion losses of disturbed and disturbing links in order to reflect the $AFEXT$ of the coupled length.

G.7.5.4 Total normalization

By combining the normalization for coupling length and the scaling for length, the correction to be applied to every $AFEXT$ result between a disturbed and a disturbing link becomes:

$$AFEXTnorm_{i,k} = AFEXT_{i,k} - IL_i + IL_k - 10 \lg \left(\frac{L_k}{L_i}\right) \quad (G.44)$$

The logarithmic ratio of lengths can be converted to a logarithmic ratio of insertion losses. For simplification, the average insertion loss of all pairs at 250 MHz may be used to compute the ratio.

$$AFEXTnorm_{i,k} = AFEXT_{i,k}(f) - IL_i(f) + IL_k(f) - 10\ \lg\left(\frac{IL_k(f)}{IL_i(f)}\right) \quad \text{(G.45)}$$

The power sum is computed from all disturbing pairs of the same disturbing channel or link, and to compute the *PS AACR-F* of pair *k* (which were all normalized to the *IL* of pair *k* of the disturbed link) is obtained in the usual manner:

$$PS\ AACR\text{-}F_k = \left(\sum_{i=1}^{4} AFEXTnorm_{i,k}\right) - IL_k \quad \text{(G.46)}$$

G.8 Component assumptions for modelling purposes

For connecting hardware, assumptions for modelling purposes are as described in Clause 10. For cable, assumptions for modelling purposes are shown in Table G.2. The statistical assumptions of components for modelling purposes are shown in Table G.3 and Table G.4.

Table G.2 – Modelling assumptions for cable transmission parameters

	Component category [a]				
Electrical characteristic	**5**	**6**	**6_A**	**7**	**7_A**
Return loss [c,d] (horizontal cable)	$25 - 7\lg\left(\frac{f}{20}\right)$	$25 - 7\lg\left(\frac{f}{20}\right)$	$25 - 7\lg\left(\frac{f}{20}\right)$	$25 - 7\lg\left(\frac{f}{20}\right)$	$25 - 7\lg\left(\frac{f}{20}\right)$
Return loss [c,e] (cord cable)	$25 - 8{,}6\ \lg\left(\frac{f}{20}\right)$	$25 - 8{,}6\ \lg\left(\frac{f}{20}\right)$	$25 - 8{,}6\ \lg\left(\frac{f}{20}\right)$	$25 - 8{,}6\ \lg\left(\frac{f}{20}\right)$	$25 - 8{,}6\ \lg\left(\frac{f}{20}\right)$
Insertion Loss [b]	$1{,}910\ 8\sqrt{f} + 0{,}022\ 2\ f + \frac{0{,}2}{\sqrt{f}}$	$1{,}82\sqrt{f} + 0{,}017\ f + \frac{0{,}25}{\sqrt{f}}$	$1{,}82\sqrt{f} + 0{,}0091\ f + \frac{0{,}25}{\sqrt{f}}$	$1{,}8\sqrt{f} + 0{,}01\ f + \frac{0{,}25}{\sqrt{f}}$	$1{,}8\sqrt{f} + 0{,}005\ f + \frac{0{,}25}{\sqrt{f}}$
NEXT	65,3 – 15 lg (*f*)	74,3 – 15 lg (*f*)	74,3 – 15 lg (*f*)	102,4 – 15 lg (*f*)	108,4 – 15 lg (*f*)
PS NEXT	62,3 – 15 lg (*f*)	72,3 – 15 lg (*f*)	72,3 – 15 lg (*f*)	99,4 – 15 lg (*f*)	105,4 – 15 lg (*f*)
ACR-F	63,8 – 20 lg (*f*)	67,8 – 20 lg (*f*)	67,8 – 20 lg (*f*)	94,0 – 20 lg (*f*)	105,3 – 20 lg (*f*)
PS ACR-F	60,8 – 20 lg (*f*)	64,8 – 20 lg (*f*)	64,8 – 20 lg (*f*)	91,0 – 20 lg (*f*)	102,3 – 20 lg (*f*)

[a] All equations apply from 1 MHz to the upper frequency of the category unless otherwise indicated.

[b] The insertion loss of cord cables may be up to 50 % higher than the insertion loss of the corresponding category horizontal cable that is shown in this table.

[c] The return loss requirements up to 20 MHz are: $4 \le f \le$ 10MHz: 20 + 5lg(*f*) and $10 < f \le 20$: 25 dB.

[d] The minimum return loss value for horizontal cable for frequencies over 250 MHz is 17,3 dB

[e] The minimum return loss value for cord cable for frequencies over 250 MHz is 15,6 dB

Table G.3 – Model input assumptions used in the statistical calculation (Class E_A)

Cabling element	Parameter	Mean	Sigma (σ)	Mean +/- 3 σ
Equipment, patch, and work area cable segments	IL Factor	1,185	0,005	1,20
	NEXT [a]	46,55	0,75	44,30
	ACR-F [a]	30,05	0,75	27,80
FD-CP and CP-TO cable segments	IL Factor	0,985	0,005	1,00
	NEXT [a]	46,55	0,75	44,30
	ACR-F [a]	30,05	0,75	27,80
Fixed connector (jack)	NEXT [a]	55,50	0,50	54,00
	FEXT [a]	44,60	0,50	43,10
	RL [a]	31,00	1,00	28,00
Equipment cord to patch cord	Cable segment mismatch (Ω)	2,00	0,50	3,50
Patch cord to horizontal cable	Cable segment mismatch (Ω)	2,00	1,00	5,00
Horizontal cable to CP cable	Cable segment mismatch (Ω)	2,00	0,50	3,50
CP cable to work area cord	Cable segment mismatch (Ω)	2,00	1,00	5,00

[a] Values shown are with reference to 100 MHz.

Table G.4 – Model input assumptions used in the statistical calculation (Class F_A)

Cabling element	Parameter	Mean	Sigma (σ)	Mean ± 3 σ
Equipment, patch, CP-TO, and work area cable segments	IL Factor	1,485	0,005	1,50
	NEXT [a]	80,65	0,75	78,40
	ACR-F [a]	67,55	0,75	65,30
FD-CP cable segment	IL Factor	0,985	0,005	1,00
	NEXT [a]	80,65	0,75	78,40
	ACR-F [a]	67,55	0,75	65,30
Fixed connector (jack)	NEXT [a]	77,80	0,50	76,30
	FEXT [a]	65,40	0,50	63,90
	RL [a]	31,00	1,00	28,00
Equipment cord to patch cord	Cable segment mismatch (Ω)	2,00	0,50	3,50
Patch cord to horizontal cable	Cable segment mismatch (Ω)	2,00	1,00	5,00
Horizontal cable to CP cable	Cable segment mismatch (Ω)	2,00	1,00	5,00
CP cable to work area cord	Cable segment mismatch (Ω)	2,00	0,50	3,50

[a] Values shown are with reference to 100 MHz.

Annex H
(informative)

Class F channel and permanent link with two connections

Delete, in ISO/IEC 11801:2002, the entire text of this annex, including the Figure and Table, and insert “Void”.

Annex I
(informative)

Significant changes to balanced cabling requirements with respect to earlier editions of this International Standard

I.3 Structural elements

Replace, in ISO/IEC 11801:2002, the existing text of this subclause by the following:

The TP (transition point), which had no effect on the link and channel performance, has been removed and the CP (consolidation point) was introduced. The effects of the CP on the link and channel performance are taken into account.

Bibliography

Delete, in ISO/IEC 11801:2002, the following references:

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Tests B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2: Tests – Tests Fc: Vibration (sinusoidal)*

IEC 60068-2-60, *Environmental testing – Part 2: Tests – Test Ke: Flowing mixed gas corrosion test*

IEC 61076-3-104, *Connectors for electronic equipment – Part 3-104: Detail specification for 8-way, shielded free and fixed connectors, for data transmissions with frequencies up to 600 MHz* (under consideration)

Insert, in ISO/IEC 11801:2002, the following references:

IEC 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-38, *Environmental testing – Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test*

IEC 60512-1-1, *Connectors for electronic equipment – Tests and measurements – Part 1-1: General examination – Test 1a: Visual examination*

IEC 60512-1-2, *Connectors for electronic equipment – Tests and measurements – Part 1-2: General examination – Test 1b: Examination of dimension and mass*

IEC 60512-2:1985, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 2: General examination, electrical continuity and contact resistance tests, insulation tests and voltage stress tests*
Amendment 1 (1994)

IEC 60512-2-5, *Connectors for electronic equipment – Tests and measurements – Part 2-5: Electrical continuity and contact resistance tests – Test 2e: Contact disturbance*

IEC 60512-6-4, *Connectors for electronic equipment – Tests and measurements – Part 6-4: Dynamic stress tests – Test 6d: Vibration (sinusoidal)*

IEC 60512-9, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 9: Miscellaneous tests*

IEC 60512-11-7, *Connectors for electronic equipment – Tests and measurements – Part 11-7: Climatic tests – Test 11g: Flowing mixed gas corrosion test*

IEC 60512-13-1, *Connectors for electronic equipment – Tests and measurements – Part 13-1: Mechanical operation tests – Test 13a: Engaging and separating forces*

IEC 60512-15-6, *Connectors for electronic equipment – Tests and measurements – Part 15-6: Connector tests (mechanical) – Test 15f: Effectiveness of connector coupling devices*

IEC 60512-15-8, *Electromechanical components for electronic equipment – Basic testing procedures and measuring methods – Part 15: Mechanical tests on contacts and terminations – Section 8: Test 15h – Contact retention system resistance to tool application*

IEC 60793-1-41, *Optical fibres – Part 1-41: Measurement methods and test procedures – Bandwidth*

IEC 60794-3 (all parts), *Optical fibre cables – Part 3: Outdoor cables*

IEC 60874-1:1999, *Connectors for optical fibres and cables – Part 1: Generic specification*

IEC 61753-1-1:2000, *Fibre optic interconnecting devices and passive components performance standard – Part 1-1: General and guidance – Interconnecting devices (connectors)*

IEC/TR 62000 TR Ed 2.0, *Guidance for inter-fibre compatibility*[18]

ISO/IEC 8802-2, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical link control*

ISO/IEC 14763-1, *Information technology – Implementation and operation of customer premises cabling – Part 1: Administration*

ISO/IEC 14763-2, *Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation*

ISO/IEC TR 29125, *Information technology – Telecommunications cabling guidelines for remote powering of data terminal equipment*[19]

ITU-T Recommendation G.652:1993, *Characteristics of a single-mode optical fibre cable*

IEEE 802.3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Special requirements – Part 3: carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications including Amendments*

IEEE 1394b:2002, *IEEE Standard for Higher-Performance Serial Bus*

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[18] Second edition in preparation.

[19] Under cosideration.

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