ISO/IEC JTC 1/SC 25/WG 3 N 755

Date: 2005-05-18

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ISO/IEC JTC 1/SC 25/WG 3

Customer Premises Cabling

Secretariat: Germany (DIN)

DOC TYPE:	**Liaison document**
TITLE:	**Letter to the chairman of IEEE 802.3 on a WD for an amendment to ISO/IEC 11801:2002, Generic cabling for customer premises**
SOURCE:	**WG 3 Secretariat**
PROJECT:	**25.03.02.xx: Generic cabling for customer premises**
STATUS:	**SC 25/WG 3 N 753 will be distributed for internal review by the WG 3 soon, an excerpt of this document, the specification of the channels, is forwarded to IEEE 802.3.**
ACTION ID:	**FYI**
DUE DATE:	**n/a**
REQUESTED: ACTION	**For information The attached draft is forwarded to IEEE 802.3 as preliminary information, for consideration and if wished for comment.**
MEDIUM:	**Def**
No of Pages:	**24 (including cover)**

DISTRIBUTION:

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Secretary - ISO/IEC JTC 1 / SC 25/WG 3 - Dr.-Ing. Walter P. von Pattay
ZVEI FV 7 & FV 8, Gotthelfstraße 24, D- 81677 München, Germany
Tel.: +49/89/923 967 57, Tfx,: +49/89/923 967 59 (on request only)
EM: Walter@Pattay.com

Ftp address SC 25: "ftp.iec.ch", login: "sc25mem", password: see SC 25 N 791
Home page SC 25: "http:/www.iec.ch/sc25"

To: IEEE 802.3 Bob Grow

copy to Brad Booth, Alan Flatman

From: IEC/JTC1/SC25/WG 3 Secretariat

Date: 2005-05-17

Letter to the chairman of IEEE 802.3 on a WD for an amendment to ISO/IEC 11801:2002, Generic cabling for customer premises

Dear Bob,

since you have your meeting just before the distribution of a Draft Amendment to ISO/IEC 11801 for internal review by SC 25/WG 3 I send you an excerpt of that working draft. The channel values specified in this draft are matured to the point, where they are a fairly stable basis for your consideration, and where your comments already could be helpful.

Feel free to provide your comments.

Please note that we are only at the very early stage as how to break down the channel characteristics to minimum performance requirements for different components. Presently we are working on a mathematical model that allows to calculate the channel performance as soon as the components performance is known and put in. Presently we do not have sufficient confidence that the channel performance calculated is in line with the channel performance measured and still working on the minimum set of cabling characteristics that needs to be verified before one may be sure that also the other characteristics would be in line with the specified requirements.

Please also note, that the specification of these channels is primarily driven by the progress in component development and the objective that channels installed at a certain point of time would also support applications - developed by your committee are others - that may not be known at the time of installation.

Based on experience from the past, where we had to add characteristics like delay skew, FEXT, alien crosstalk, it would be most helpful to know, whether you foresee channel characteristics, that are not specified in this amendment but may have an impact on future applications.

Kind regards

Walter

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.

Attention is drawn to the possibility that some of the elements in this amendment may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

General

Update references to tables, the numbers of which have been changed.

Pages 14-16

2 Normative references

Replace:

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 60512-25-5, – *Connectors for electronic equipment – Basic tests and measurements – Part 25-5: Test 25e – Return loss*[1]

IEC/PAS 60793-1-49:2002, *Optical fibres – Part 1-49: Measurement methods and test procedures – Differential mode delay*

IEC/PAS 61076-3-104:2002, *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*

IEC 61156-1:1994, *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*[2]
Amendment 1:1999
Amendment 2:2001

IEC 61156-2:1995, *Multicore and symmetrical pair/quad cables for digital communications – Part 2: Horizontal floor wiring – Sectional specification*[3]
Amendment 1:1999
Amendment 2:2001

1 To be published.

2 There exists a consolidated edition 1.2 (2001) of IEC 61156-1 that includes edition 1.0 (1994) and its amendments 1 (1999) and 2 (2001).

3 There exists a consolidated edition 1.2 (2001) of IEC 61156-2 that includes edition 1.0 (1995) and its amendments 1 (1999) and 2 (2001).

IEC 61156-3:1995, *Multicore and symmetrical pair/quad cables for digital communications – Part 3: Multicore and symmetrical pair/quad cables for digital communications – Part 3: Work area wiring – Sectional specification*[4]

Amendment 1:1999
Amendment 2:2001

IEC 61156-4:1995, *Multicore and symmetrical pair/quad cables for digital communications – Part 4: Riser cables – Sectional specification*[5]

Amendment 1:1999
Amendment 2:2001

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*

IEC 61156-6:2002, *Multicore and symmetrical pair/quad cables for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 600 MHz – Work area wiring – Sectional specification*

IEC 61935-1:2000, *Generic cabling systems – Specifications for the testing of balanced communication cabling in accordance with ISO/IEC 11801 – Part 1: Installed cabling*
Amendment 1 (under consideration)

IEC 61935-2, – *Generic cabling systems – Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 – Part 2: Patch cords and work area cords*[1]

ISO/IEC TR 14763-1, *Information technology – Implementation and operation of customer premises cabling – Part 1: Administration*

ISO/IEC 18010:2002, *Information technology – Pathways and spaces for customer premises cabling*

By:

IEC 60512-1-1:2002, *Connectors for electronic equipment - Tests and measurements - Part 1-1: General examination - Test 1a: Visual examination*

IEC 60512-1-2:2002, *Connectors for electronic equipment - Tests and measurements - Part 1-2: General examination - Test 1b: Examination of dimension and mass*

IEC 60512-2-1:2002, *Connectors for electronic equipment - Tests and measurements - Part 2-1: Electrical continuity and contact resistance tests - Test 2a: Contact resistance - Millivolt level method*

IEC 60512-2-5:2003, *Connectors for electronic equipment - Tests and measurements - Part 2-5: Electrical continuity and contact resistance tests - Test 2e: Contact disturbance*

IEC 60512-3-1:2002, *Connectors for electronic equipment - Tests and measurements - Part 3-1: Insulation tests - Test 3a: Insulation resistance*

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4 There exists a consolidated edition 1.2 (2001) of IEC 61156-3 that includes edition 1.0 (1995) and its amendments 1 (1999) and 2 (2001).

5 There exists a consolidated edition 1.2 (2001) of IEC 61156-4 that includes edition 1.0 (1995) and its amendments 1 (1999) and 2 (2001).

IEC 60512-4-1:2003, *Connectors for electronic equipment - Tests and measurements - Part 4-1: Voltage stress tests - Test 4a: Voltage proof*

IEC 60512-5-2:2002, *Connectors for electronic equipment - Tests and measurements - Part 5-2: Current-carrying capacity tests - Test 5b: Current-temperature derating*

IEC 60512-6-4:2002, *Connectors for electronic equipment - Tests and measurements - Part 6-4: Dynamic stress tests - Test 6d: Vibration (sinusoidal)*

IEC 60512-9:1992, *Electromechanical components for electronic equipment; basic testing procedures and measuring methods - Part 9: Miscellaneous tests*

IEC 60512-11-7:2003, *Connectors for electronic equipment - Tests and measurements - Part 11-7: Climatic tests - Test 11g: Flowing mixed gas corrosion test*

IEC 60512-13-1:1996, *Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 13: Mechanical operating tests - Section 1: Test 13a: Engaging and separating forces*

IEC 60512-15-6[1], *Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 15: Mechanical tests on contacts and terminations - Section 8: Test 15F: Effectiveness of connector coupling devices (under consideration*

IEC 60512-15-8:1995, *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 60512-25-5:2004, *Connectors for electronic equipment - Tests and measurements - Part 25-5: Test 25e - Return loss*

IEC 60793-1-49:2003, *Optical fibres – Part 1-49: Measurement methods and test procedures – Differential mode delay <Editor's note: The update to this reference is approved according to corrigendum document 25N881.>*

IEC 60603-7-7:2006[1], *Connectors for electronic equipment – Part 7-7: Detail specification for 8-way, shielded, free and fixed connectors, for data transmission with frequencies up to 1000 MHz (category 7, shielded)*[6]

IEC 61076-3-104-1:2006[1], *Connectors for electronic equipment – Part 3-104: Detail specification for 8-way, shielded free and fixed connectors, for data transmissions with frequencies up to 1000 MHz*[7] ***<Editor's note: The update to this reference is approved according to corrigendum document 25N881.>***

IEC 61156-1:2006[1], *Multicore and symmetrical pair/quad cables for digital communications – Part 1: Generic specification*[8]

IEC 61156-2:2006[1], *Multicore and symmetrical pair/quad cables for digital communications – Part 2: Horizontal floor wiring – Sectional specification*[9]

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6 This standard is currently at edition 1.0› published 2002. Edition 2.0 of IEC 60603-7-7 is targeted for publication in 2006.

7 This standard is currently at edition 1.0› published 2003. Edition 2.0 of IEC 61076-3-104 is targeted for publication in 2006.

8 This standard is currently at edition 2.0, published 2002. Edition 3 of IEC 61156-1 is targeted for publication in 2006

9 This standard is currently at edition 2.0, published 2003. Edition 3 of IEC 61156-2 is targeted for publication in 2006

IEC 61156-3:2006[1], *Multicore and symmetrical pair/quad cables for digital communications – Part 3: Multicore and symmetrical pair/quad cables for digital communications – Part 3: Work area wiring – Sectional specification*[10]

IEC 61156-4:2006[1], *Multicore and symmetrical pair/quad cables for digital communications – Part 4: Riser cables – Sectional specification*[11]

IEC 61156-5:2006[1], *Multicore and symmetrical pair/quad cables for digital communications – Part 5: Symmetrical pair/quad cables with transmission characteristics up to 1000 MHz – Horizontal floor wiring – Sectional specification*[12]

IEC 61156-6:2006[1], *Multicore and symmetrical pair/quad cables for digital communications – Part 6: Symmetrical pair/quad cables with transmission characteristics up to 1000 MHz – Work area wiring – Sectional specification*[13]

IEC 61935-1:2006[1], *Generic cabling systems – Specifications for the testing of balanced communication cabling in accordance with ISO/IEC 11801 – Part 1: Installed cabling*)[14]

IEC 61935-2:2006[1], *– Generic cabling systems – Specification for the testing of balanced communication cabling in accordance with ISO/IEC 11801 – Part 2: Patch cords and work area cords*[15]

ISO/IEC 14763-1, *Information technology – Implementation and operation of customer premises cabling – Part 1: Administration*[16] ***<Editor's note: Existing reference incorrectly lists this standard as a technical report.>***

ISO/IEC 18010, *Information technology – Pathways and spaces for customer premises cabling* ***<Editor's note: Remove year to encompass the pending amendment and future editions.>***

Insert, in the existing list, the titles of the following standards and amendments:

IEC 60068-2-14:1984, *Environmental testing - Part 2: Tests. Test N: Change of temperature*

IEC 60068-2-38:1974, *Environmental testing - Part 2: Tests. Test Z/AD: Composite temperature/humidity cyclic test*

IEC 60512-25-8:2006[1], *Connectors for electronic equipment - Tests and measurements - Part 25-8: Test 25h: – Balance of symmetrical signals*

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10 This standard is currently at edition 2.0, published 2003. Edition 3 of IEC 61156-3 is targeted for publication in 2006

11 This standard is currently at edition 2.0, published 2003. Edition 3 of IEC 61156-4 is targeted for publication in 2006

12 This standard is currently at edition 2.0, published 2002 as referenced in 11801. Edition 3 of IEC 61156-5 is targeted for publication in 2006

13 This standard is currently at edition 2.0, published 2002 as referenced in 11801. Edition 3 of IEC 61156-6 is targeted for publication in 2006

14 his standard is currently at edition 1.1, published 2002. Edition 2 of IEC 61935-1 or an amendment is needed to support measurements to 1000 MHz. Publication date pending confirmation from IEC TC46.

15 This standard is currently at edition 1.0, published 2002. Edition 2 of IEC 61935-1 or an amendment is needed to support measurements to 1000 MHz. Publication date pending confirmation from IEC TC46.

16 Includes ISO/IEC 14763-1-am1:2004, Amendment 1 - Information technology - Implementation and operation of customer premises cabling - Part 1: Administration, and any other amendments or editions that follow.

IEC 60512-25-XX:2006[1], *Connectors for electronic equipment – Tests and measurements – Part 25-XX: Signal integrity tests – Test 25-X – Alien crosstalk*

ISO/IEC TR 14763-1:2004, Amendment 1 – *Information technology – Implementation and operation of customer premises cabling – Part 1: Administration*

IEC 60603-7-4:2005, *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*

IEC 60603-7-4-1:2006[1], *Connectors for electronic equipment - Part 7-4, Amendment 1: Detail specification for 8-way, unshielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

IEC 60603-7-5:2005[1], *Connectors for electronic equipment - Part 7-4: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 250 MHz*

IEC 60603-7-5-1:2006[1], *Connectors for electronic equipment - Part 7-4, Amendment 1: Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz*

Pages 17-22

3.1 Definitions

Replace:

3.1.35
insertion loss
dB

loss resulting from the insertion of a device into a transmission system

NOTE The ratio of the power delivered to that part of the system following the device before insertion of the device, to the power delivered to this part after insertion of the device. The insertion loss is expressed in decibels.

3.1.36
insertion loss deviation
difference between the measured insertion loss of cascaded components and the insertion loss determined by the sum of the component's losses

3.1.41
link
either a CP link or permanent link, see CP link and permanent link

By:

3.1.35
insertion loss
loss resulting from the insertion of a device into a transmission system

NOTE The ratio of the power delivered to that part of the system following the device before insertion of the device, to the power delivered to this part after insertion of the device. The insertion loss is expressed in decibels. For the purposes of this standard, insertion loss is measured with the source and load impedances equal to the nominal impedance.

3.1.36
insertion loss deviation
difference between the measured insertion loss of cascaded components and the insertion loss determined by the sum of the individual component insertion losses

<Editor’s note: The preceding two revised definitions are from document 3ixt55)>

3.1.41
link
transmission path between two cabling system interfaces
[ISO/IEC/TR 24704]

<Editor’s note: The preceding definition is from ISO/IEC TR24704.>

***Insert**, in the existing list, the following new definitions in alphabetical order and renumber accordingly:*

3.1.XX
alien crosstalk
signal coupling from disturbing pairs to pairs in a separate cabling channel

3.1.XX
alien far-end crosstalk (AFEXT)
signal coupling from a near-end disturbing pair to a disturbed pair of a separate cabling channel, measured at the far-end.

3.1.XX
alien near-end crosstalk (ANEXT)
signal coupling from a near-end disturbing pair into a disturbed pair of a separate cabling channel, measured at the near-end.

3.1.XX
power sum alien far-end crosstalk (PSAFEXT)
a computation of signal coupling from multiple near-end disturbing pairs into a disturbed pair of a separate cabling channel, measured at the far-end.

3.1.XX
power sum alien near-end crosstalk (PSANEXT)
a computation of signal coupling from multiple near-end disturbing pairs into a disturbed pair of a separate cabling channel, measured at the near-end.

<Editor’s note: The preceding definitions are based on text from documents 3N731 (TIA drafts) and 3N746 (WD for ISO/IEC TR 24750). Confirm use of term “alien” or “exogenous”, under consideration by IEC 46C.

Page 23

3.2 Abbreviations

Replace:

ISO	International Standardisation Organisation

ELFEXT	Equal level far end crosstalk attenuation (loss)
PS NEXT	Power sum NEXT attenuation (loss)
PS ELFEXT	Power sum ELFEXT attenuation (loss)
PS FEXT	Power sum FEXT attenuation (loss)

By:

ISO	International Organization for Standardization

<Editor’s note: This change is approved according to corrigendum document 25N881.>

ELFEXT	Equal level FEXT (loss)
PS NEXT	Power sum NEXT (loss)
PS ELFEXT	Power sum ELFEXT (loss)
PS FEXT	Power sum FEXT (loss)

<Editor’s note: This change improves consistency and eliminates redundancy in the term “attenuation” since it is already used in the descriptions for NEXT and FEXT (e.g., “Far end crosstalk attenuation (loss)”).>

Insert, in the existing table, the following new abbreviations in alphabetical sequence:

AFEXT	Alien FEXT
ANEXT	Alien NEXT
ELTCTL	Equal level TCTL
PS AFEXT	Power sum AFEXT
PS ANEXT	Power sum ANEXT

<Editor’s note: The preceding abbreviations are from document 3N746 (WD for ISO/IEC TR 24750). The format of the descriptions is taken from 11801 as modified by the proposed change to the existing crosstalk abbreviations listed above.>

Page 30

5.5 Accommodation of functional elements

Replace:

Telecommunications outlets are located in the work area.

By:

Telecommunications outlets are typically located in the work area.

<Editor’s note: This change is proposed by the editor because the existing text may imply that TO’s are only located in the work area. For commercial cabling, TO’s may be located anywhere an interface is required, including ERs, TRs, outside... Also, ISO/IEC TR 24750 now specifies use of TOs in coverage areas.>

Page 37 (and in the list of figures)

6.1 General

Replace figure 10 title:

Channel, permanent link and CP link of a balanced cabling

By:

Balanced cabling channel, permanent link and CP link

<Editor’s note: This change is approved according to corrigendum document 25N881.>

Pages 38-39

6.2 Layout

Replace third paragraph page 38

The performance limits for balanced cabling channels are given in 6.4. These limits are derived from the component performance limits of Clause 9 and 10 assuming the channel is composed of 90 m of solid conductor cable, 10 m of cord(s) and four connections (see figure10).

By:

The performance limits for balanced cabling channels are given in 6.4. These limits are derived from the component performance limits of Clause 9 and 10 assuming the channel is composed of 15 m (f.f.s.) to 90 m of solid conductor cable, 2 m (f.f.s.) to 10 m of cord(s) and two (f.f.s.) to four connections (see figure 10).

Replace first paragraph page 39

The performance limits for balanced cabling permanent links with maximum implementation are also given in Annex A. These limits are derived from the component performance limits of Clauses 9 and 10 assuming the permanent link is composed of 90 m of solid conductor cable and three connections (see figure 10).

By:

The performance limits for balanced cabling permanent links with maximum implementation are also given in Annex A. These limits are derived from the component performance limits of Clauses 9 and 10 assuming the permanent link is composed of 15 m (f.f.s.) to 90 m of solid conductor cable and two (f.f.s.) to three connections (see figure 10).

<Editor’s note: The editor proposes this change. Rationale is that the models used to support the performance limits given in 6.4 for some parameters require validation for minimum and maximum length channels. Using an extreme to illustrate this point, it would be difficult to meet the crosstalk requirements in a 4-connector channel with all cables/cord lengths at 1 m. Minimum limits for the peripheral cords and cables may also be required for proper assessment of alien crosstalk performance. As these specifications evolve, it becomes more important to clearly convey underlying assumptions and boundary conditions. See comment CA07 of SC25N1046.>

Page 39

6.3 Classification of balanced cabling

Replace:

Class E is specified up to 250 MHz.

Class F is specified up to 600 MHz.

By:

Class “E” is specified up to 500 MHz.

Class “F” is specified up to 1 000 MHz.

<Editor’s note: Quotes added here to highlight the need to decide naming convention for the cabling classes specified by amendment 2.1. Once decided, all references to these classes will be updates in drafts, as appropriate.>

Pages 39-50

6.4 Balanced cabling performance

Replace tables 2-19 in 6.4.2 through 6.4.13 with the following tables that have frequency limits of 500 MHz and 1000 MHz for class E and class F respectively (other changes highlighted in blue). Re-index all tables after 6.4.14:

Table 2 – Return loss for channel

Class	**Frequency** MHz	**Minimum return loss** dB
C	$1 \leq f \leq 16$	15,0
D	$1 \leq f < 20$	17,0
	$20 \leq f \leq 100$	$30 - 10\lg(f)$
E	$1 \leq f < 10$	19,0
	$10 \leq f < 40$	$24 - 5\lg(f)$
	$40 \leq f < 251{,}2$	$32 - 10\lg(f)$
	$251{,}2 \leq f \leq 500$	8,0
F	$1 \leq f < 10$	19,0
	$10 \leq f < 40$	$24 - 5\lg(f)$
	$40 \leq f < 251{,}2$	$32 - 10\lg(f)$
	$251{,}2 \leq f \leq 1000$	8,0

Table 3 – Informative return loss values for channel at key frequencies

Frequency MHz	**Minimum return loss** dB			
	Class C	**Class D**	**Class E**	**Class F**
1	15,0	17,0	19,0	19,0
16	15,0	17,0	18,0	18,0
100	N/A	10,0	12,0	12,0
250	N/A	N/A	8,0	8,0
500	N/A	N/A	8,0	8,0
1000	N/A	N/A	N/A	8,0

288 **Table 4 – Insertion loss for channel**

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	$1 \le f \le 16$	$1{,}05 \times \left(3{,}23\sqrt{f}\right) + 4 \times 0{,}2$
D	$1 \le f \le 100$	$1{,}05 \times \left(1{,}910\,8\sqrt{f} + 0{,}022\,2 \times f + 0{,}2/\sqrt{f}\right) + 4 \times 0{,}04 \times \sqrt{f}$
E	$1 \le f \le 500$	$1{,}05 \times \left(1{,}8\sqrt{f} + 0{,}01 \times f + 0{,}2/\sqrt{f}\right) + 4 \times 0{,}02 \times \sqrt{f}$
F	$1 \le f \le 1000$	$1{,}05 \times \left(1{,}645\sqrt{f} + 0{,}01 \times f + 0{,}25/\sqrt{f}\right) + 4 \times 0{,}02 \times \sqrt{f}$

[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.

289 **<Editors’ note: Propose to change the first coefficient for class D from 1,9108 to 1,91.**

290 **Table 5 – Informative insertion loss values for channel at key frequencies**

Frequency MHz	**Maximum insertion loss** dB					
	Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**
0,1	16,0	5,5	N/A	N/A	N/A	N/A
1	N/A	5,8	4,2	4,0	4,0	4,0
16	N/A	N/A	14,4	9,1	8,1	7,5
100	N/A	N/A	N/A	24,0	20,8	19,1
250	N/A	N/A	N/A	N/A	33,8	31,2
500	N/A	N/A	N/A	N/A	49,3	45,7
1000	N/A	N/A	N/A	N/A	N/A	67,7

291 **Table 6 – NEXT for channel**

Class	**Frequency** MHz	**Minimum NEXT** dB
A	$f = 0{,}1$	27,0
B	$0{,}1 \leq f \leq 1$	$25 - 15\lg(f)$
C	$1 \leq f \leq 16$	$39{,}1 - 16{,}4\lg(f)$
D	$1 \leq f \leq 100$	$-20\lg\left(10^{\frac{65{,}3-15\lg(f)}{-20}} + 2\times 10^{\frac{83-20\lg(f)}{-20}}\right)$ [a]
E	$1 \leq f \leq 500$	$-20\lg\left(10^{\frac{74{,}3-15\lg(f)}{-20}} + 2\times 10^{\frac{94-20\lg(f)}{-20}}\right)$ [b, c, d]
F	$1 \leq f \leq 1000$	$-20\lg\left(10^{\frac{102{,}4-15\lg(f)}{-20}} + 2\times 10^{\frac{102{,}4-15\lg(f)}{-20}}\right)$ [b, c, d]

[a] *NEXT* at frequencies that correspond to calculated values of greater than 60,0 dB shall revert to a minimum requirement of 60,0 dB.

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

[c] Cable and connecting hardware performance are not implied by these equations.

[d] Field-based *NEXT* testing on cabling channels above f.f.s. MHz is subject to progressively higher measurement uncertainty compared to laboratory testing. To account for the inherent difference between field and laboratory-based measurements above f.f.s. MHz, *NEXT* requirements for installed cabling are bounded by these equations and an additional term of <f.f.s.>.

<Editor's note: For NEXT & PS NEXT, note "d" is based on resolution of comments document 25N1046, which indicates the need to "consider implications of test accuracy (both field and laboratory-based) in amendment and technical report. Document 3N731 (TIA drafts), specifies a field test allowance equal to 3*(f-330/170) dB for the frequency range 330-500 MHz. Confirm that this note and term applies to both class E and F.>

<Editor's note: The 65 dB floor shown here and in ed 2.0 is less severe than 3N731 (TIA draft), which specifies a 70 dB noise floor. Propose to apply 65 dB noise floor to all classes and eliminate footnote "a".>

Table 7 – Informative NEXT values for channel at key frequencies

Frequency MHz	**Minimum channel NEXT** dB					
	Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**
0,1	27,0	40,0	N/A	N/A	N/A	N/A
1	N/A	25,0	39,1	60,0	65,0	65,0
16	N/A	N/A	19,4	43,6	53,2	65,0
100	N/A	N/A	N/A	30,1	39,9	62,9
250	N/A	N/A	N/A	N/A	33,1	56,9
500	N/A	N/A	N/A	N/A	27,9	52,4
1000	N/A	N/A	N/A	N/A	N/A	47,9

Table 8 – PS NEXT for channel

Class	**Frequency** MHz	**Minimum PS NEXT** dB
D	$1 \le f \le 100$	$-20\lg\left(10^{\frac{62,3-15\lg(f)}{-20}}+2\times10^{\frac{80-20\lg(f)}{-20}}\right)$ [a]
E	$1 \le f \le 500$	$-20\lg\left(10^{\frac{72,3-15\lg(f)}{-20}}+2\times10^{\frac{90-20\lg(f)}{-20}}\right)$ [b, c, d]
F	$1 \le f \le 1000$	$-20\lg\left(10^{\frac{99,4-15\lg(f)}{-20}}+2\times10^{\frac{99,4-15\lg(f)}{-20}}\right)$ [b, c, d]

[a] *PS NEXT* at frequencies that correspond to calculated values of greater than 57,0 dB shall revert to a minimum requirement of 57,0 dB.

[b] *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.

[c] Cable and connecting hardware performance are not implied by these equations.

[d] Field-based *PS NEXT* testing on cabling channels above f.f.s. MHz is subject to progressively higher measurement uncertainty compared to laboratory testing. To account for the inherent difference between field and laboratory-based measurements above f.f.s. MHz, *PS NEXT* requirements for installed cabling are bounded by these equations and an additional term of <f.f.s.>.

<Editor’s note: The 62 dB floor shown here and in ed 2.0 is less severe than 3N731 (TIA draft), which specifies a 70 dB noise floor.

Table 9 – Informative PS NEXT values for channel at key frequencies

Frequency MHz	**Minimum PS NEXT** dB		
	Class D	**Class E**	**Class F**
1	57,0	62,0	62,0
16	40,6	50,6	62,0
100	27,1	37,1	59,9
250	N/A	30,2	53,9
500	N/A	24,8	49,4
1000	N/A	N/A	44,9

Table 10 – Informative ACR values for channel at key frequencies

Frequency MHz	**Minimum ACR** dB		
	Class D	**Class E**	**Class F**
1	56,0	61,0	61,0
16	34,5	45,1	61,0
100	6,1	19,2	43,7
250	N/A	-0,7	25,7
500	N/A	–21,4	6,7
1000	N/A	N/A	–19,8

Table 11 – Informative PS ACR values for channel at key frequencies

Frequency MHz	**Minimum PS ACR** dB		
	Class D	**Class E**	**Class F**
1	53,0	58,0	58,0
16	31,5	42,5	54,5
100	3,1	16,3	40,7
250	N/A	-3,6	22,7
500	N/A	–24,5	3,7
1000	N/A	N/A	-22,8

Table 12 – ELFEXT for channel

Class	Frequency MHz	Minimum ELFEXT [a] dB
D	$1 \le f \le 100$	$-20\lg\left(10^{\frac{63,8-20\lg(f)}{-20}} + 4\times 10^{\frac{75,1-20\lg(f)}{-20}}\right)$ [b]
E	$1 \le f \le 500$	$-20\lg\left(10^{\frac{67,8-20\lg(f)}{-20}} + 4\times 10^{\frac{83,1-20\lg(f)}{-20}}\right)$ [c, d, e]
F	$1 \le f \le 1000$	$-20\lg\left(10^{\frac{94-20\lg(f)}{-20}} + 4\times 10^{\frac{90-15\lg(f)}{-20}}\right)$ [c, d, e]

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

[b] *ELFEXT* at frequencies that correspond to calculated values of greater than 60,0 dB shall revert to a minimum requirement of 60,0 dB.

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

[d] Cable and connecting hardware performance are not implied by these equations.

[e] Field-based *ELFEXT* testing on cabling channels above f.f.s. MHz is subject to progressively higher measurement uncertainty compared to laboratory testing. To account for the inherent difference between field and laboratory-based measurements above f.f.s. MHz, *ELFEXT* requirements for installed cabling are bounded by these equations and an additional term of <f.f.s.>.

<Editor’s note: The 65 dB floor shown here and in ed 2.0 is less severe than 3N731 (TIA draft), which specifies a 70 dB noise floor.

Table 13 – Informative ELFEXT values for channel at key frequencies

Frequency MHz	Minimum ELFEXT dB		
	Class D	Class E	Class F
1	57,4	63,3	65,0
16	33,3	39,2	57,5
100	17,4	23,3	44,4
250	N/A	15,3	37,8
500	N/A	9,3	32,6
1000	N/A	N/A	27,4

Table 14 – PS ELFEXT for channel

Class	**Frequency** MHz	**Minimum PS ELFEXT** [a] dB
D	$1 \le f \le 100$	$-20\lg\left(10^{\frac{60,8-20\lg(f)}{-20}} + 4\times 10^{\frac{72,1-20\lg(f)}{-20}}\right)$ [b]
E	$1 \le f \le 500$	$-20\lg\left(10^{\frac{64,8-20\lg(f)}{-20}} + 4\times 10^{\frac{80,1-20\lg(f)}{-20}}\right)$ [c, d, e]
F	$1 \le f \le 1000$	$-20\lg\left(10^{\frac{91-20\lg(f)}{-20}} + 4\times 10^{\frac{87-15\lg(f)}{-20}}\right)$ [c, d, e]

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

[b] *PS ELFEXT* at frequencies that correspond to calculated values of greater than 57,0 dB shall revert to a minimum requirement of 57,0 dB.

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

[d] Cable and connecting hardware performance are not implied by these equations.

[e] Field-based *PS ELFEXT* testing on cabling channels above f.f.s. MHz is subject to progressively higher measurement uncertainty compared to laboratory testing. To account for the inherent difference between field and laboratory-based measurements above f.f.s. MHz, *PS ELFEXT* requirements for installed cabling are bounded by these equations and an additional term of <f.f.s.>.

<Editor's note: The 62 dB floor shown here and in ed. 2.0 is less severe than 3N731 (TIA draft), which specifies a 70 dB noise floor.

Editor also proposes to delete footnote "b" to make noise floor the same for classes D, E and F.>

Table 15 – Informative PS ELFEXT values for channel at key frequencies

Frequency MHz	**Minimum PS ELFEXT** dB		
	Class D	**Class E**	**Class F**
1	54,4	60,3	62,0
16	30,3	36,2	54,5
100	14,4	20,3	41,4
250	N/A	12,3	34,8
500	N/A	6,3	29,6
1000	N/A	N/A	24,4

318 **Table 16 – Direct current (d.c.) loop resistance for channel**

Maximum d.c. loop resistance Ω					
Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**
560	170	40	25	25	25

319 **<Editor's note: No change to table 16.>**

320 **Table 17 – Propagation delay for channel**

Class	Frequency MHz	Maximum propagation delay µs
A	$f = 0{,}1$	20,000
B	$0{,}1 \leq f \leq 1$	5,000
C	$1 \leq f \leq 16$	$0{,}534 + 0{,}036/\sqrt{f} + 4 \times 0{,}002\,5$
D	$1 \leq f \leq 100$	$0{,}534 + 0{,}036/\sqrt{f} + 4 \times 0{,}002\,5$
E	$1 \leq f \leq 500$	$0{,}534 + 0{,}036/\sqrt{f} + 4 \times 0{,}002\,5$
F	$1 \leq f \leq 1000$	$0{,}534 + 0{,}036/\sqrt{f} + 4 \times 0{,}002\,5$

321 **Table 18 – Informative propagation delay values for channel at key frequencies**

Frequency MHz	Maximum propagation delay µs					
	Class A	**Class B**	**Class C**	**Class D**	**Class E**	**Class F**
0,1	20,000	5,000	N/A	N/A	N/A	N/A
1	N/A	5,000	0,580	0,580	0,580	0,580
16	N/A	N/A	0,553	0,553	0,553	0,553
100	N/A	N/A	N/A	0,548	0,548	0,548
250	N/A	N/A	N/A	N/A	0,546	0,546
500	N/A	N/A	N/A	N/A	0,546	0,546
1000	N/A	N/A	N/A	N/A	N/A	0,545

Table 19 – Delay skew for channel

Class	Frequency MHz	Maximum delay skew µs
A	f = 0,1	N/A
B	0,1 ≤ f ≤ 1	N/A
C	1 ≤ f ≤ 16	0,050 [a]
D	1 ≤ f ≤ 100	0,050 [a]
E	1 ≤ f ≤ 500	0,050 [a, c]
F	1 ≤ f ≤ 1000	0,030 [b, c]

[a] This is the result of the calculation 0,045 + 4 × 0,001 25.

[b] This is the result of the calculation 0,025 + 4 × 0,001 25.

[c] Delay skew of installed cabling shall not vary by more than 10ns within this requirement (such as due to environmental conditions).

<Editor’s note: Added note C based on 55.7.4.2 of 802.3an d1.2.>

Pages 49-50:

Replace 6.4.14 and 6.4.15 with the following new requirements.

<Editor’s note: The new requirements contained in 6.4.14 through 6.4.17.2 are taken from new work item proposal ‘25N981A, pages 8 and 24.>

6.4.14 Unbalance attenuation, near end

The unbalance attenuation near end is measured as transverse conversion loss (*TCL*). The TCL of a channel shall meet the requirements in Table 20. The TCL requirements shall be met at both ends of the cabling.

Performance requirements for TCL are applicable to unscreened class A, B, C, D and E channels and shall be achieved by the appropriate choice of cables and connecting hardware. Installation mitigation may be needed when components from a lower performance category are used in a higher performance system.

Table 20 – TCL for channel

Class	Frequency MHz	Minimum TCL dB
A	f = 0,1	30
B	f = 0,1 and 1	45 at 0,1 MHz; 20 at 1 MHz
C	1 ≤ f ≤ 16	$30 - 5\lg(f)$
D	1 ≤ f ≤ 100	$40 - 10\lg(f)$ f.f.s.
E	1 ≤ f ≤ 500	$40 - 10\lg(f)$ f.f.s.
F	1 ≤ f ≤ 1000	$40 - 10\lg(f)$ f.f.s.

<Editors’ note: No change to table 20 as shown. Confirm if this table is for “unscreened only” or all. Based on NWIP document 25N981A, the requirement is 64-20lg(*f*) dB for “E1” and 74-20lg(*f*) dB for “E2”. They are not inserted here because doing so would conflict with cable requirements in IEC 61156-5, 6 (same as table 20). If the E1 and E2

equations are adopted as presented in 25N981A, the editor proposes that the following foot notes be included:

[a] The unbalance attenuation requirements for class D corresponds with CISPR 22 “ISN cat 5”.

[b] The unbalance attenuation requirements for class E corresponds to CISPR “cat 6“. If class E is mitigated by another 10 dB of TCL, it can be used in more harsh electromagnetic environments.

[c] The equations provided are applicable to an average performance response. Peak worst-case performance may be as much as 15 dB lower.

[d] Calculated values of greater than 50,0 dB shall revert to a minimum requirement of 50,0 dB.

6.4.15 Unbalance attenuation, far end

The unbalance attenuation far end is measured as equal level transverse conversion transfer loss (EL*TCTL*). The ELTCTL of a channel shall meet the requirements in Table 21. The ELTCTL requirements shall be met at both ends of the cabling.

Performance requirements for ELTCTL are applicable to unscreened class D and E systems and shall be achieved by the appropriate choice of cables and connecting hardware. Installation mitigation may be needed when components from a lower performance category are used in a higher performance system.

Table 21 – ELTCTL for channel

Class	Frequency MHz	Minimum ELTCTL dB
D [a]	$1 \le f \le 30$	$30 - 20\lg(f)$
E [b]	$1 \le f \le 30$	$40 - 20\lg(f)$

[a] The unbalance attenuation requirements for class D corresponds with CISPR 22 “ISN cat 5”.

[b] The unbalance attenuation requirements for class E corresponds to CISPR “cat 6“.

<Editor’s note: Confirm if this table is UTP only or all. Need confirmation for class F requirement, if any. The equations and notes are based on NWIP document 25N981A. Class C was excluded for this parameter because it is new, whereas TCL was specified for class C in edition 2.0.>

6.4.16 Coupling attenuation

The coupling attenuation of a channel shall meet the requirements in Table 22 and shall be met at both ends of the cabling.

Coupling attenuation for unscreened channels is not specified. Performance requirements for coupling attenuation are applicable to screened class D, E and F systems, and shall be achieved by the appropriate choice of cables and connecting hardware. Coupling attenuation of a sample installation may be assessed by laboratory measurements of representative samples of channels assembled, using the components and connector termination practices in question.

Table 22 – Coupling attenuation for channel (screened only)

Class	Frequency MHz	Minimum Coupling Attenuation dB
D [a]	$30 \le f < 100$	39
E [b]	$30 \le f < 100$	40
	$100 \le f \le 500$	$80 - 20\lg(f)$
F	$30 \le f < 100$	55
	$100 \le f \le 1000$	$95 - 20\lg(f)$

<Editor's note: Confirm if this table is screened only or all. Based on NWIP document 25N981A, the requirement is 89-20lg(*f*) dB for "E2" and 99-20lg(*f*) dB for "E3". They are not inserted here because doing so would conflict with cable requirements in IEC 61156-5, 6 (same as table 22). If the E1 and E2 equations are adopted as presented in 25N981A, the editor proposes that the following footnotes be included:>

[a] The requirement for class D corresponds with CISPR 22 "ISN cat 5".

[b] The requirement for class E corresponds to CISPR "cat 6". If class E is mitigated by another 15 dB of coupling attenuation, it may be suitable for use in more harsh electromagnetic environments.

6.4.17 Alien crosstalk

The alien crosstalk requirements are applicable only to classes E and F.

6.4.17.1 Power sum alien NEXT (PS ANEXT)

The *PS ANEXT* of each pair of a channel shall meet the requirements derived by the equation in Table 23. This requirement shall be achieved by design.

The *PS ANEXT* requirements shall be met at both ends of the cabling. *ANEXT* values at frequencies where the insertion loss (*IL*) is below 4,0 dB (f.f.s.) are for information only.

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

$$PS\ ANEXT_k = -10\lg\left[\sum_{j=1}^{N}\left(\sum_{i=1}^{n} 10^{\frac{-ANEXT_{i,k}}{10}}\right)\right] \qquad (6)$$

where

i is the number of the disturbing pair;

k is the number of the disturbed pair;

N is the total number of adjacent cables

n is the total number of disturbing pairs in each of N cables;

$ANEXT_{i,k}$ is the alien near end crosstalk loss coupled from pair i into pair k.

Table 23 – PS ANEXT for channel

Class	**Frequency** MHz	**Minimum PS ANEXT** dB
E	$1 \le f < 100$	$80 - 10\lg(f)$ [a, b, c] f.f.s.
	$100 \le f \le 500$	$90 - 15\lg(f)$ [a, b, c] f.f.s.
F	$1 \le f < 100$	$95 - 10\lg(f)$ [b] f.f.s.
	$100 \le f \le 1000$	$105 - 15\lg(f)$ [b] f.f.s.

[a] The class E requirement is indicative of unshielded performance capability. PS *ANEXT* performance for screened class E systems is estimated to be 15,0 dB higher.

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

[c] For class E, average *PS ANEXT* shall be 1 dB higher than the minimum requirement.

<Editor's note: The 62 dB floor shown here is less severe than 3N731 (TIA draft), which specifies a 75 dB (TBD) noise floor – 5 dB higher than the noise floor for PS NEXT. Note c added to encompass minimum requirements of IEEE 802.3an d2.0.

Also, the statement, "This requirement shall be achieved by design." based on the lack of a field test specification. If such a specification is created, this statement can be removed or modified.>

Table 24 – Informative PS ANEXT values for channel at key frequencies

Frequency MHz	**Minimum PS ANEXT** dB	
	Class E	**Class F**
1	62,0	62,0
100	60,0	62,0
250	54,0	62,0
500	49,5	62,0
1000	N/A	60,0

<Editor's note: Requirements in 6.4.17.3-4 for PS AFEXT taken from *document 3N731 (TIA drafts), which specifies PS ELAFEXT. Entries for class F are 15 dB higher, in accordance with 25N981A.>*

6.4.17.4 Power sum AFEXT (PS AFEXT)

The *PS AFEXT* of each pair of a channel shall meet the requirements derived by the equation in Table 25. This requirement shall be achieved by design.

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

$$PS\ AFEXT_k = -10\lg\left[\sum_{j=1}^{N}\left(\sum_{i=1}^{n}10^{\frac{-AFEXT_{i,k}}{10}}\right)\right] \qquad (8)$$

where

i is the number of the disturbing pair;

k is the number of the disturbed pair;

N is the total number of adjacent cables

N is the total number of disturbing pairs in each of N cables;

$AFEXT_{ik}$ is the equal level far end alien crosstalk loss coupled from pair *i* into pair *k*.

Table 25 – PS AFEXT for channel

Class	**Frequency** MHz	**Minimum PS AFEXT** [a] **dB**
E	$1 \le f \le 500$	$77 - 20\lg(f)$ [a, b] f.f.s.
F	$1 \le f \le 1000$	$92 - 20\lg(f)$ [a] f.f.s.

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

[b] For class E, average *PS AFEXT* shall be 4 dB higher than the minimum requirement.

<Editor's note: The 62 dB floor shown here is less severe than 3N731 (TIA draft), which specifies a 75 dB (TBD) noise floor – 5 dB higher than the TIA noise floor for PS FEXT. Note b added to encompass minimum requirements of IEEE 802.3an d2.0.

Also, the statement, "This requirement shall be achieved by design." based on the lack of a field test specification. If such a specification is created, this statement can be removed or modified.>

Table 26 – Informative PS AFEXT values for channel at key frequencies

Frequency MHz	**Minimum PS AFEXT** dB	
	Class E	**Class F**
1	62,0	62,0
100	37,0	52,0
250	29,0	44,0
500	23,0	38,0
1000	N/A	32,0

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6.4.8 Direct current (d.c.) resistance unbalance

Replace:

The d.c. resistance unbalance between the two conductors within each pair of a channel shall not exceed 3 % for all classes. This shall be achieved by design.

By:

For all cabling classes, the d.c. resistance unbalance between the two conductors within each pair of a channel shall not exceed 3 % or 0,200 Ω, whichever is greater. This requirement shall be achieved by design.

<Editor’s note: Editor proposal. The addition of 200 milliohms as a bounding requirement is consistent with worst case configurations of connecting hardware (50 milliohms times four) and short length cables, while still satisfying the requirements of applications like 802.3af. See result 33.2 of document 3N682B.>

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7.2.2.2 Dimensions

Insert bullet at bottom of page:

- the total physical length of the horizontal cables from the FD to the TO should be at least 15 m (f.f.s.).

<Editor’s note: Editor proposal. Although a 15m guideline is mentioned on page 53 of ed 2.0 for when a CP is used, there is no guidance for when a CP is not present. Similar guidance to this proposal is provided in 7.2.3.2.>

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7.2.3.2 Dimensions

Replace footnote a in previous table 22, now Table 29:

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

By:

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

<Editor’s note: This change is approved according to corrigendum document 25N881.>