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{TIA staff to insert applicable text here.}

TRANSMISSION PERFORMANCE SPECIFICATIONS
FOR
4-PAIR 100 Ω AUGMENTED CATEGORY 6 CABLING

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FOREWORD

(This foreword is not part of the Standard)

In 2003, the Telecommunications Industry Association (TIA) developed objectives for augmented category 6 cabling intended to support 10 Gigabit applications over a distance of 100 meters. At the request of the Institute of Electrical and Electronics Engineers (IEEE) 802.3 Committee, TIA agreed to specify augmented category 6 cabling systems and components to 500 MHz in order to support 10GBASE-T. The project was assigned to TR-42.7 under Engineering Committee TR-42. The TR-42.7 Sub-Committee cooperated with several groups related to this activity.

(Note: Stuart plans to submit alternate wording)

a) TR-42.1 – Commercial Building Telecommunications Cabling Sub-Committee

b) TR-42.7.1 – Copper Connectors Working Group

c) TR-42.7.2 – Copper Cable Working Group

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This standard has been prepared by the TR-42.7 Subcommittee and approved by the Engineering Committee TR-42.

There are XXX annexes in this Standard. Annexes YYY are normative and considered a mandatory part of this Standard. Annexes ZZZ are informative and not considered a part of this Standard.

1 INTRODUCTION

Editor: Introductory text to be added here. Alternatively, text from the Purpose and Scope text could be copied here and clause 2 deleted. (This is in compliance with the Style Guide)

2 PURPOSE AND SCOPE

To develop cabling and component specifications and test procedures to support the operation of IEEE 802.3 10GBASE-T over 100 meters of structured balanced twisted-pair copper cabling. This addendum includes extending the frequency range and adding requirements to those specified in TIA-568-B.2-1.

3 NORMATIVE REFERENCES

The following standards contain requirements that, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision; parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated. ANSI and TIA maintain registers of currently valid national standards published by them.

Editor: Review the reference list before the first ballot. Should “ANSI” appear before “TIA/EIA”?

ANSI/ICEA S-80-576, *Communications Wire and Cable for Wiring Premises*, 1994

ANSI/ICEA S-90-661, *Individually Unshielded Twisted Pair Indoor Cable for Use in Communication Wiring Systems*, 1994

ANSI/TIA/EIA-568-B.1, *Commercial Building Telecommunications Standard Part 1: General Requirements*, 2001

ANSI/TIA/EIA-568-B.2, *Commercial Building Telecommunications Standard Part 2: Balanced Twisted-pair* Cabling *Components*, 2001

ANSI/TIA/EIA-568-B.2-1, *Commercial Building Telecommunications Standard Part 2:* Addendum 1: Transmission Performance Specifications for 4-Pair 100 Ohm category 6 cabling, 2002

ANSI/TIA/EIA-568-B.2-3, *Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination*, 2002

ANSI/TIA/EIA-568-B.2-9, *Additional Category 6 Balance Requirements and Measurement Procedures,* 2004

ANSI/TIA/EIA-568-B.3, *Commercial Building Telecommunications Standard Part 3: Optical Fiber Cabling Components*, 2000

ASTM D 4566-98, *Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable*, 1998

IEC 60603-7, *Connectors for frequencies below 3 MHz for use with printed boards – Part 7: Detail specification for connectors, 8-way, including fixed and free connectors with common mating features, with assessed quality*, 1996

4 DEFINITIONS, ACRONYMS & ABBREVIATIONS

4.1 Definitions

The generic definitions in this section have been formulated for use by the entire family of telecommunications infrastructure standards. As such, the definitions do not contain mandatory requirements of the Standard. Specific requirements are found in the normative sections of this Standard.

Alien crosstalk: Signal coupling from disturbing pairs into a disturbed pair of a neighboring channel or part thereof.

Alien near-end crosstalk (ANEXT) loss: Signal coupling from near-end disturbing channel pairs into a disturbed pair of a neighboring channel or part thereof, measured at the near-end.

Power sum alien near-end crosstalk (PSANEXT) loss: A computation of signal coupling from multiple near-end disturbing channel pairs into a disturbed pair of a neighboring channel or part thereof, measured at the near-end.

Alien far-end crosstalk (AFEXT) loss: Signal coupling from near-end disturbing channel pairs into a disturbed pair of a neighboring channel or part thereof, measured at the far-end.

Power sum alien far-end crosstalk (PSAFEXT) loss: A computation of signal coupling from multiple near-end disturbing channel pairs into a disturbed pair of a neighboring channel or part thereof, measured at the far-end.

4.2 Acronyms and abbreviations

ANEXT	Alien near-end crosstalk
PSANEXT	Power sum alien near-end crosstalk
AFEXT	Alien far-end crosstalk
PSAFEXT	Power sum alien far-end crosstalk

5 TEST CONFIGURATIONS

5.1 Component test configurations

Cable test configurations
Connecting hardware test configurations
Modular cord test configurations

Editor's Note: Trent Hayes to provide cable configurations for this clause. Masood Shariff to position appropriately within the document. Consider the difference between modeling and test configurations.

Editor's Note: Sterling Vaden to provide connecting hardware configurations for this clause. Masood Shariff to position appropriately within the document. Consider the difference between modeling and test configurations.

Editor's Note: Masood to add pointers to cable and connecting hardware ANEXT measurement methods in the correct annexes.

5.2 Cabling test configurations

Channel test configurations
Permanent link test configurations

Editor's Note: Shadi AbuGhazaleh to provide configurations for this clause. Masood Shariff to position appropriately within the document. Consider the difference between modeling and test configurations.

(Editor's Note: Minimum channel and permanent link configurations are needed. For example, see annex O of TIA/EIA-568-B.2.)

6 COMPONENTS

6.1 Recognized cable

The following category of twisted-pair cable is recognized in addition to those identified in clause 4.2.1 of TIA/EIA-568-B.2:

Augmented Category 6: This designation applies to 100 Ω cables whose transmission characteristics are specified up to 500 MHz.

6.1.1 Horizontal cable

Four-pair 100 Ω UTP and ScTP cables are recognized for use in augmented category 6 horizontal cabling systems. The cable shall consist of 22 AWG to 24 AWG thermoplastic insulated solid conductors that are formed into four individually twisted-pairs and enclosed by a thermoplastic jacket. The cable shall meet all of the mechanical requirements of ANSI/ICEA S-80-576 applicable to four-pair inside wiring cable for plenum or general cabling within a building. In addition to the applicable requirements of ANSI/ICEA S-90-661-1994, the physical design of horizontal cables shall meet the requirements of clauses 4.3.3.1 to 4.3.3.6 of TIA/EIA-568-B.2.

NOTE – Additional requirements for 100 Ω ScTP cables are located in annex K of TIA/EIA-568-B.2.

6.1.2 Cable for modular cords

No text available. This is covered in section 7 as different IL and RL requirements for stranded cable.

6.1.3 Backbone cable

Four-pair 100 Ω UTP and ScTP cables are recognized for use in augmented category 6 backbone cabling systems. The cable shall consist of 22 AWG to 24 AWG thermoplastic insulated solid conductors that are formed into four individually twisted-pairs and enclosed by a thermoplastic jacket. The cable shall meet all of the mechanical requirements of ANSI/ICEA S-80-576 applicable to four-pair inside wiring cable for plenum or general cabling within a building. In addition to the applicable requirements of ANSI/ICEA S-90-661-1994, the physical design of backbone cables shall meet the requirements of clauses 4.4.3.1 to 4.4.3.6 of TIA/EIA-568-B.2.

NOTE – Additional requirements for 100 Ω ScTP cables are located in annex K of ANSI/TIA/EIA-568-B.2.

6.1.4 Bundled and hybrid cable

Bundled and hybrid cables may be used for horizontal and backbone cabling provided that each cable type is recognized (see clause 6.1.1 of this Standard and clause 4.4 of ANSI/TIA/EIA-568-B.1) and meets the transmission and color-code specifications for that cable type as given in ANSI/TIA/EIA-568-B.2, ANSI/TIA/EIA-568-B.3, and clause 7 of this Standard.

NOTES,
1 Hybrid UTP cables (color coded per ANSI/TIA/EIA-568-B.2, clause 4.3.3.3) can be distinguished from multipair UTP backbone cables (color coded per TIA/EIA-568-B.2, clause 4.4.3.3) by the color coding scheme and by the transmission requirements.
2 Hybrid cables consisting of optical fiber and copper conductors are sometimes referred to as composite cables.

The individual cables within a bundled cable shall meet the applicable requirements in clause 4 of TIA/EIA-568-B.3, clause 4 of TIA/EIA-568-B.2, annex K of TIA/EIA-568-B.2, annex M of TIA/EIA-568-B.2, and clause 7 of this Standard after bundle formation.

6.2 Recognized connecting hardware

The following category of twisted-pair connecting hardware is recognized in addition to those identified in clause 5.4.1 of TIA/EIA-568-B.2:

Augmented Category 6: This designation applies to 100 Ω connecting hardware whose transmission characteristics are specified from 1 MHz to 500 MHz.

6.3 Cords

Patch cords, equipment cords, and work area cords used for system moves, adds, and changes are critical to transmission performance. Augmented category 6 cords and cordage shall meet the applicable requirements of clauses 6.1 through 6.3 of TIA/EIA-568-B.2 and clause 7 of this standard.

Editors Note: A task group lead by Sterling Vaden is developing NEXT and RL specifications for patch cords up to 500 MHz.

7 TRANSMISSION REQUIREMENTS

7.1 Insertion loss

7.1.1 Cable insertion loss

Editor: Text to come. Is it okay to copy existing text fromTIA/EIA-568-B.2-10?

$$InsertionLoss_{cable,100m} \leq TBD \ \ dB \qquad (1)$$

Table 1 - Augmented category 6 cable insertion loss @ 20 °C ± 3°C (68° F ± 5.5 °F)

Frequency (MHz)	Insertion loss (dB)
1.00	TBD
4.00	TBD
8.00	TBD
10.00	TBD
16.00	TBD
20.00	TBD
25.00	TBD
31.25	TBD
62.50	TBD
100.00	TBD
200.00	TBD
250.00	TBD
300.00	TBD
400.00	TBD
500.00	TBD

7.1.2 Connecting hardware insertion loss

Editor: Text to come.

$$InsertionLoss_{conn} \leq TBD \ \ dB \quad (2)$$

Table 2 – Augmented category 6 connecting hardware insertion loss

Frequency (MHz)	Insertion loss (dB)
1.00	TBD
4.00	TBD
8.00	TBD
10.00	TBD
16.00	TBD
20.00	TBD
25.00	TBD
31.25	TBD
62.50	TBD
100.00	TBD
200.00	TBD
250.00	TBD
300.00	TBD
400.00	TBD
500.00	TBD

7.1.3 Cabling insertion loss

For all frequencies from 1 MHz to 500 MHz, when measured according to the procedures in annex C of TIA/EIA-568-B.2-1, the channel insertion loss shall meet the values determined using equation (3). For the purposes of field measurements, calculated channel limits that result in insertion loss values less than 3 dB revert to a requirement of 3 dB maximum (see TIA/EIA-568-B.2-3). Insertion loss values in table 3 computed from equation (3) are provided for information only at certain frequencies of interest.

$$InsertionLoss_{channel} \leq 1.05 * (1.8 * \sqrt{f} + 0.01 * f + 0.2 / \sqrt{f}) + 4 * 0.02 * \sqrt{f} \ \ dB/100\ m\ (dB/328\ ft) \quad (3)$$

It is understood that equation (3) includes an ILD allowance.

Table 3 – Augmented category 6 channel insertion loss

Frequency (MHz)	Insertion loss (dB)
1.00	2.2
4.00	4.1
8.00	5.7
10.00	6.4
16.00	8.1
20.00	9.1
25.00	10.2
31.25	11.4
62.50	16.3
100.00	20.8
200.00	30.0
250.00	33.8
300.00	37.3
400.00	43.6
500.00	49.3

NOTES,

1 A 20 % increase in insertion loss is allowed over category 6 horizontal cable insertion loss for work area and patch cords as shown in equation (TBD).

2 The insertion loss of the channel does not take into consideration the 0.1 dB measurement floor of the connecting hardware insertion loss requirement.

3 The channel insertion loss requirement is derived using the insertion loss contribution of 4 connections.

4 For the purposes of field measurements, calculated channel limits that result in insertion loss values less than 3 dB revert to a requirement of 3 dB maximum (see TIA/EIA-568-B.2-3).

Editor: Applicable permanent link notes (see clause 7.1.3 of '568-B.2-10 for reference), equation reference, and table references need to be added here.

$$InsertionLoss_{perm\_link} \leq TBD\ dB \quad (4)$$

Table 4 – Augmented category 6 permanent link insertion loss

Frequency (MHz)	Insertion loss (dB)
1.00	TBD
4.00	TBD
8.00	TBD
10.00	TBD
16.00	TBD
20.00	TBD
25.00	TBD
31.25	TBD
62.50	TBD
100.00	TBD
200.00	TBD
250.00	TBD
300.00	TBD
400.00	TBD
500.00	TBD

NOTE – The permanent link insertion loss requirement is derived using the insertion loss contribution of 3 connections. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

Editor's Note: Need a contribution approved by the task group to implement any technical changes.

7.2 NEXT loss

NEXT loss is a measure of the unwanted signal coupling from a transmitter at the near-end into neighboring pairs measured at the near-end. NEXT loss is expressed in dB relative to the transmit signal level. NEXT loss shall be measured for all pair combinations of cables and cabling in accordance with annex C of TIA/EIA-568-B.2 and the ASTM D 4566 NEXT loss measurement procedure, except the test fixture shall provide for consistent common and differential mode impedance matching for the unjacketed twisted-pairs between the cable jacket and the balun terminations. Connecting hardware NEXT loss shall be measured for all pair combinations in accordance with annex E of TIA/EIA-568-B.1. Modular plug cord NEXT loss shall be measured for all pair combinations in accordance with annex J of TIA/EIA-568-B.1. In addition, since each duplex channel can be disturbed by more than one duplex channel, power sum near-end crosstalk (PSNEXT) loss is also specified for cabling and cables.

7.2.1 Pair-to-pair NEXT loss

7.2.1.1 Cable pair-to-pair NEXT loss

For all frequencies from 0.772 MHz to 500 MHz, augmented category 6 cable NEXT loss, for a length of 100 m (328 ft) or longer, shall meet the values determined using equation (5). The values in table 5 are provided for information only. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

$$NEXT_{cable} \geq 44.3 - 15\log(f/100) \ dB \quad (5)$$

Table 5 - Augmented category 6 cable NEXT loss @ 20 °C ± 3 °C (68 °F ± 5.5° F), worst pair-to-pair

Frequency (MHz)	NEXT loss (dB)
0.150	86.7
0.772	76.0
1.00	74.3
4.00	65.3
8.00	60.8
10.00	59.3
16.00	56.2
20.00	54.8
25.00	53.3
31.25	51.9
62.50	47.4
100.00	44.3
200.00	39.8
250.00	38.3
300.00	37.1
400.00	35.3
500.00	33.8

NOTE - 0.150 MHz is for reference purposes only. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

7.2.1.2 Connecting hardware pair-to-pair NEXT loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 connecting hardware NEXT loss shall meet the values determined using the equations specified in table 6 when mated to the range of test plugs specified in annex E.4 of TIA/EIA-568-B.2-1. Calculations that result in NEXT loss values greater than 75 dB shall revert to a requirement of 75 dB minimum. The values in table 7 are provided for information only. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

Table 6 – Augmented category 6 connecting hardware NEXT loss, worst pair-to-pair

Frequency (MHz)	NEXT loss (dB)
$1 \le f < 250$ $250 \le f < 500$	54-20log(f/100) (TBD) 46.04-40log(f/250) (TBD)

Table 7 – Augmented category 6 connecting hardware NEXT loss, worst pair-to-pair

Frequency (MHz)	NEXT loss (dB)
1.00	94.0 (TBD)
4.00	82.0 (TBD)
8.00	75.9 (TBD)
10.00	74.0 (TBD)
16.00	69.9 (TBD)
20.00	68.0 (TBD)
25.00	66.0 (TBD)
31.25	64.1 (TBD)
62.50	58.1 (TBD)
100.00	54.0 (TBD)
200.00	48.0 (TBD)
250.00	46.0 (TBD)
300.00	42.9 (TBD)
400.00	37.9 (TBD)
500.00	34.0 (TBD)

7.2.1.3 Work area, equipment, and patch cord pair-to-pair NEXT loss

Editor's Note: Seeking permission to copy the contents of clause 7.2.1.2 of TIA/EIA-568-B.2-1 into this clause as a placeholder for a starting point of discussions.

$$NEXT_{cord\_limit} \geq TBD\ dB \quad (6)$$

Table 8 – Augmented category 6 modular cord NEXT loss, worst pair-to-pair

Frequency (MHz)	NEXT loss (dB)
1.00	TBD
4.00	TBD
8.00	TBD
10.00	TBD
16.00	TBD
20.00	TBD
25.00	TBD
31.25	TBD
62.50	TBD
100.00	TBD
200.00	TBD
250.00	TBD
300.00	TBD
400.00	TBD
500.00	TBD

7.2.1.4 Cabling pair-to-pair NEXT loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 channel pair-to-pair NEXT loss shall meet the values determined using the equations in table 9. Calculations that result in NEXT loss values greater than 65 dB shall revert to a requirement of 65 dB minimum. The values in table 10 are provided for information only.

Table 9 – Augmented category 6 channel NEXT loss requirements, worst pair-to-pair

Frequency (MHz)	NEXT loss (dB)
$1 \leq f \leq 330$	$NEXT_{channel} \geq -20\log\left(10^{\frac{-(44.3-15\cdot\log(f/100))}{20}} + 2\cdot 10^{\frac{-(54-20\cdot\log(f/100))}{20}}\right)$
$330 < f \leq 500$	$NEXT_{channel} \geq 31 - 27.15\log(f/330)$

Table 10 – Augmented category 6 channel NEXT loss, worst pair-to-pair

Frequency (MHz)	NEXT loss (dB)
1.00	65.0
4.00	63.0
8.00	58.2
10.00	56.6
16.00	53.2
20.00	51.6
25.00	50.0
31.25	48.4
62.50	43.4
100.00	39.9
200.00	34.8
250.00	33.1
300.00	31.7
400.00	28.7
500.00	26.1

NOTE - For the purposes of field measurements, for all frequencies from 330 MHz to 500 MHz, augmented category 6 channel pair-to-pair NEXT loss values are determined using equation (7). (Editor: The remainder of the text on this page is intended to be a note. It is unknown whether equations and tables are allowed to appear in a note.)

$$NEXT_{channel} \geq -20\log\left(10^{\frac{-(44.3-15\cdot\log(f/100))}{20}} + 2\cdot 10^{\frac{-(54-20\cdot\log(f/100))}{20}}\right) - 3\cdot\frac{(f-330)}{170}\ dB \quad (7)$$

The values in the table 11 are provided for information only.

Table 11 – Augmented category 6 channel NEXT loss, worst pair-to-pair (field measurements)

Frequency (MHz)	NEXT loss (dB)
300.00	31.7
330.00	31.0
400.00	28.3
500.00	24.9

For all frequencies from 1 MHz to 500 MHz, augmented category 6 permanent link pair-to-pair NEXT loss shall meet the values determined using the equations in table 12. Calculations that result in NEXT loss values greater than 65 dB shall revert to a requirement of 65 dB minimum. The values in table 13 are provided for information only.

Table 12 – Augmented category 6 permanent link NEXT loss requirements, worst pair-to pair

Frequency (MHz)	**NEXT loss (dB)**
$1 \le f \le 300$	$NEXT_{PL} \ge -20\log\left(10^{\frac{-(44.3-15\cdot\log(f/100))}{20}} + 10^{\frac{-(54-20\cdot\log(f/100))}{20}}\right)$
$300 < f \le 500$	$NEXT_{PL} \ge 34 - 33.13\log(f/300)$

Table 13 – Augmented category 6 permanent link NEXT loss, worst pair-to pair

Frequency (MHz)	**NEXT loss (dB)**
1.00	65.0
4.00	64.1
8.00	59.4
10.00	57.8
16.00	54.6
20.00	53.1
25.00	51.5
31.25	50.0
62.50	45.2
100.00	41.8
200.00	36.9
250.00	35.3
300.00	34.0
400.00	29.9
500.00	26.7

7.2.2 Power sum NEXT loss

Power sum near-end crosstalk loss takes into account the combined crosstalk (statistical) on a receive pair from all near-end disturbers operating simultaneously. The power sum near-end crosstalk (PSNEXT) loss is calculated in accordance with ASTM D 4566 as a power sum on a selected pair from all other pairs as shown in equation (8) for the case of 4-pair cable.

$$PSNEXT = -10\log(10^{-X1/10} + 10^{-X2/10} + 10^{-X3/10})\ dB \quad (8)$$

where:

X1, X2, X3 are the pair-to-pair crosstalk measurements in dB between the selected pair and the other three pairs.

NOTE - For channel and permanent link power sum calculations, it is assumed that the pair-to-pair connecting hardware NEXT loss requirements of this Standard are equivalent to a PSNEXT loss performance of 50-20log(*f*/100) for all frequencies from 1 MHz to 500 MHz. PSNEXT loss for connecting hardware does not need to be separately verified.

7.2.2.1 Cable power sum NEXT loss

For all frequencies from 0.772 MHz to 500 MHz, augmented category 6 cable power sum NEXT loss, for a length of 100 m (328 ft) or longer, shall meet the values determined using equation (9). The values in table 14 are provided for information only. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

$$PSNEXT_{cable} \geq 42.3 - 15\log(f/100)\ dB \quad (9)$$

Table 14 - Augmented category 6 cable power sum NEXT loss @ 20 °C ± 3 °C (68 °F ± 5.5° F)

Frequency (MHz)	PSNEXT loss (dB)
0.150	84.7
0.772	74.0
1.00	72.3
4.00	63.3
8.00	58.8
10.00	57.3
16.00	54.2
20.00	52.8
25.00	51.3
31.25	49.9
62.50	45.4
100.00	42.3
200.00	37.8
250.00	36.3
300.00	35.1
400.00	33.3
500.00	31.8

NOTE - 0.150 MHz is for reference purposes only. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

7.2.2.2 Cabling power sum NEXT loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 channel power sum NEXT loss shall meet the values determined using the equations in table 15. Calculations that result in power sum NEXT loss values greater than 62 dB shall revert to a requirement of 62 dB minimum. The values in table 16 are provided for information only.

Table 15 – Augmented category 6 channel PSNEXT loss

Frequency (MHz)	PSNEXT loss (dB)
$1 \le f \le 330$	$PSNEXT_{channel} \ge -20\log(10^{\frac{-(42.3-15\cdot\log(f/100))}{20}} + 2\cdot 10^{\frac{-(50-20\cdot\log(f/100))}{20}})$
$330 < f \le 500$	$PSNEXT_{channel} \ge 28 - 26.43\log(f/330)$

Table 16 – Augmented category 6 channel PSNEXT loss

Frequency (MHz)	PSNEXT loss (dB)
1.00	62.0
4.00	60.5
8.00	55.6
10.00	54.0
16.00	50.6
20.00	49.0
25.00	47.3
31.25	45.7
62.50	40.6
100.00	37.1
200.00	31.9
250.00	30.2
300.00	28.8
400.00	25.8
500.00	23.2

NOTE - For the purposes of field measurements, for all frequencies from 330 MHz to 500 MHz, augmented category 6 channel power sum NEXT loss values are determined using equation (10). (Editor: The remainder of the text on this page and text inclusive of table 14 on the next page is intended to be a note. It is unknown whether equations and tables are allowed to appear in a note.)

$$PSNEXT_{channel} \ge -20\log(10^{\frac{-(42.3-15\cdot\log(f/100))}{20}} + 2\cdot 10^{\frac{-(50-20\cdot\log(f/100))}{20}}) - 3\cdot\frac{(f-330)}{170}\ dB \quad (10)$$

The values in the table 17 are provided for information only.

Table 17 – Augmented category 6 channel PSNEXT loss (field measurements)

Frequency (MHz)	PSNEXT loss (dB)
300.00	28.8
330.00	28.0
400.00	25.3
500.00	21.8

For all frequencies from 1 MHz to 500 MHz, augmented category 6 permanent link power sum NEXT loss shall meet the values determined using the equations in table 18. Calculations that result in power sum NEXT loss values greater than 62 dB shall revert to a requirement of 62 dB minimum. The values in table 19 are provided for information only.

Table 18 – Augmented category 6 permanent link power sum NEXT loss requirements

Frequency (MHz)	PSNEXT loss (dB)
$1 \le f \le 300$	$PSNEXT_{PL} \ge -20\log\left(10^{\frac{-(42.3-15\cdot\log(f/100))}{20}} + 10^{\frac{-(50-20\cdot\log(f/100))}{20}}\right)$
$330 < f \le 500$	$PSNEXT_{PL} \ge 31.4 - 34.44\log(f/300)$

Table 19 – Augmented category 6 permanent link power sum NEXT loss values

Frequency (MHz)	PSNEXT loss (dB)
1.00	62.0
4.00	61.8
8.00	57.0
10.00	55.5
16.00	52.2
20.00	50.7
25.00	49.1
31.25	47.5
62.50	42.7
100.00	39.3
200.00	34.3
250.00	32.7
300.00	31.4
400.00	27.1
500.00	23.8

7.3 ELFEXT and FEXT loss

FEXT loss is a measure of the unwanted signal coupling from a transmitter at the far-end into neighboring pairs measured at the near-end. FEXT loss is the ratio of the power coupled from a disturbing pair into the disturbed pair relative to the input power at the opposite end of the transmission lines determined from measured voltages. This ratio is expressed in dB. ELFEXT shall be calculated for all pair combinations of cables and cabling in accordance with annex C of TIA/EIA-568-B.2 and the ASTM D 4566 FEXT loss measurement procedure, except the test fixture shall provide for consistent common and differential mode impedance matching for the unjacketed twisted-pairs between the cable jacket and the balun terminations. Connecting hardware FEXT loss shall be measured for all pair combinations in accordance with annex E of TIA-568-B.2-1. In addition, since each duplex channel can be disturbed by more than one duplex channel, power sum equal level far-end crosstalk (PSELFEXT) is also specified for cabling and cables.

7.3.1 Pair-to-pair ELFEXT

FEXT loss is a measure of the unwanted signal coupling from a transmitter at the far-end into neighboring pairs measured at the near-end. FEXT loss is the ratio of the power coupled from a disturbing pair into the disturbed pair relative to the input power at the opposite end of the transmission lines determined from measured voltages. This ratio is expressed in dB. ELFEXT shall be calculated for all pair combinations of cables and cabling in accordance with annex C of ANSI/TIA/EIA-568-B.2 and the ASTM D 4566 FEXT loss measurement procedure, except the test fixture shall provide for consistent common and differential mode impedance matching for the unjacketed twisted-pairs between the cable jacket and the balun terminations. Connecting hardware FEXT loss shall be measured for all pair combinations in accordance with annex E of TIA-568-B.2-1. In addition, since each duplex channel can be disturbed by more than one duplex channel, power sum equal level far-end crosstalk (PSELFEXT) is also specified for cabling and cables. (Editor: Recommend to delete the text in this clause. It is a duplicate of the text above, does not appear inTIA/EIA-568-B.2-1, and is not necessary.)

7.3.1.1 Cable pair-to-pair ELFEXT

For all frequencies from 1 MHz to 500 MHz, augmented category 6 cable ELFEXT, for a length of 100 m (328 ft), shall meet the values determined using equation (11). The values in table 20 are provided for information only.

$$ELFEXT_{cable} \geq 27.8 - 20\log(f/100)\ \ dB \qquad (11)$$

Table 20 – Augmented category 6 cable ELFEXT @ 20 °C ± 3 °C (68 °F ± 5.5 °F), worst pair-to-pair

Frequency (MHz)	ELFEXT (dB)
0.772	76.0
1.00	74.3
4.00	65.3
8.00	60.8
10.00	59.3
16.00	56.2
20.00	54.8
25.00	53.3
31.25	51.9
62.50	47.4
100.00	44.3
200.00	39.8
250.00	38.3
300.00	37.1
400.00	35.3
500.00	33.8

NOTE - 0.772 MHz is for reference purposes only. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

7.3.1.2 Connecting hardware pair-to-pair FEXT loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 connecting hardware FEXT loss shall meet the values determined using equation (12). Calculations that result in FEXT loss values greater than 75 dB shall revert to a requirement of 75 dB minimum. The values in table 21 are provided for information only.

$$FEXT_{conn} \geq 43.1 - 20\log(f/100)\ \ dB \quad \text{(TBD)} \tag{12}$$

Table 21 – Augmented category 6 connecting hardware FEXT loss, worst pair-to-pair

Frequency (MHz)	FEXT loss (dB)
1.00	83.1 (TBD)
4.00	71.1 (TBD)
8.00	65.0 (TBD)
10.00	63.1 (TBD)
16.00	59.0 (TBD)
20.00	57.1 (TBD)
25.00	55.1 (TBD)
31.25	53.2 (TBD)
62.50	47.2 (TBD)
100.00	43.1 (TBD)
200.00	37.1 (TBD)
250.00	35.1 (TBD)
300.00	33.6 (TBD)
400.00	31.1 (TBD)
500.00	29.1 (TBD)

7.3.1.3 Cabling pair-to-pair ELFEXT

For all frequencies from 1 MHz to 500 MHz, augmented category 6 channel ELFEXT shall meet the values determined using the equation (13). Due to measurement considerations, ELFEXT values that correspond to measured FEXT values of greater than 70 dB are for information only. The values in table 22 are provided for information only.

$$ELFEXT_{channel} \geq -20\log\left(10^{\frac{-ELFEXT_{cable}}{20}} + 4 \cdot 10^{\frac{-FEXT_{conn}}{20}}\right)\ \ dB \tag{13}$$

Table 22 – Augmented category 6 channel ELFEXT, worst pair-to-pair

Frequency (MHz)	ELFEXT (dB)
1.00	63.3
4.00	51.2
8.00	45.2
10.00	43.3
16.00	39.2
20.00	37.2
25.00	35.3
31.25	33.4
62.50	27.3
100.00	23.3
200.00	17.2
250.00	15.30
300.00	13.7
400.00	11.2
500.00	9.3

For all frequencies from 1 MHz to 500 MHz, augmented category 6 permanent link ELFEXT shall meet the values determined using table 23. The values in table 24 are provided for information only.

Table 23 – Augmented category 6 permanent link ELFEXT, worst pair-to-pair

Frequency (MHz)	ELFEXT (dB)
$1 \le f \le$ 500	$ELFEXT_{PL} \ge -20\log(10^{\frac{-(27.8-20\log(f/100))}{20}} + 3*10^{\frac{-(43.1-20\log(f/100))}{20}})$ TBD

Editor: Need to calculate values in for table 24.

Table 24 – Augmented category 6 permanent link ELFEXT, worst pair-to-pair values

Frequency (MHz)	ELFEXT (dB)
1.00	
4.00	
8.00	
10.00	
16.00	
20.00	
25.00	
31.25	
62.50	
100.00	
200.00	
250.00	
300.00	
400.00	
500.00	

7.3.2 Power sum ELFEXT

Power sum equal level far-end crosstalk loss takes into account the combined crosstalk (statistical) on a receive pair from all far-end disturbers operating simultaneously. The power sum equal level far-end crosstalk (PSELFEXT) loss is calculated in accordance with ASTM D 4566 as a power sum on a selected pair from all other pairs as shown in equation (14) for the case of 4-pair cable.

$$PSELFEXT = -10\log(10^{-X1/10} + 10^{-X2/10} + 10^{-X3/10})\ dB \quad (14)$$

where:

X1, X2, X3 are the pair-to-pair crosstalk measurements in dB between the selected pair and the other three pairs.

NOTE – For channel and permanent link power sum calculations, it is assumed that the pair-to-pair connecting hardware FEXT loss requirements of this Standard are equivalent to a PSFEXT loss performance of 40.1-20log(*f*/100) (TBD) for all frequencies from 1 MHz to 500 MHz (TBD). PSFEXT loss for connecting hardware does not need to be separately verified.

7.3.2.1 Cable power sum ELFEXT

For all frequencies from 1 MHz to 500 MHz, augmented category 6 cable power sum ELFEXT, for a length of 100 m (328 ft), shall meet the values determined by equation (15). The values in table 25 are provided for information only.

$$PSELFEXT_{cable} \geq 24.8 - 20\log(f/100) \ \ dB \qquad (15)$$

Table 25 - Augmented category 6 cable PSELFEXT @ 20 °C ± 3 °C (68 °F ± 5.5 °F)

Frequency (MHz)	PSELFEXT (dB)
1.00	64.8
4.00	52.8
8.00	46.7
10.00	44.8
16.00	40.7
20.00	38.8
25.00	36.8
31.25	34.9
62.50	28.9
100.00	24.8
200.00	18.8
250.00	16.8
300.00	15.3
400.00	12.8
500.00	10.8

7.3.2.2 Cabling power sum ELFEXT

For all frequencies from 1 MHz to 500 MHz, augmented category 6 channel PSELFEXT shall meet the values determined using the equation (16). Due to measurement considerations, PSELFEXT values that correspond to measured FEXT values of greater than 70 dB are for information only. The values in table 26 are provided for information only.

$$PSELFEXT_{channel} \geq -20\log(10^{\frac{-PSELFEXT_{cable}}{20}} + 4 \cdot 10^{\frac{-PSFEXT_{conn}}{20}}) \ dB \qquad (16)$$

Table 26 – Augmented category 6 channel PSELFEXT

Frequency (MHz)	PSELFEXT (dB)
1.00	60.3
4.00	48.2
8.00	42.2
10.00	40.3
16.00	36.2
20.00	34.2
25.00	32.30
31.25	30.4
62.50	24.3
100.00	20.3
200.00	14.2
250.00	12.30
300.00	10.7
400.00	8.2
500.00	6.3

For all frequencies from 1 MHz to 500 MHz, augmented category 6 permanent link power sum ELFEXT shall meet the values determined using table 27. The values in table 28 are provided for information only.

Table 27 – Augmented category 6 permanent link PSELFEXT requirements

Frequency (MHz)	ELFEXT (dB)
$1 \leq f \leq$ 500	$PSELFEXT_{PL} \geq -20\log(10^{\frac{-(24.8-20\cdot\log(f/100))}{20}} + 3*10^{\frac{-(40.1-20\cdot\log(f/100))}{20}})$ TBD

Editor: Need to calculate values in for table 28.

Table 28 – Augmented category 6 permanent link power sum ELFEXT values

Frequency (MHz)	PSELFEXT (dB)
1.00	
4.00	
8.00	
10.00	
16.00	
20.00	
25.00	
31.25	
62.50	
100.00	
200.00	
250.00	
300.00	
400.00	
500.00	

7.4 Return loss

Return loss is a measure of the reflected energy caused by impedance mismatches in the cabling system and is especially important for applications that use simultaneous bi-directional transmission. Return loss is the ratio of the reflected signal power to the input power determined from measured voltages, expressed in dB. Cable and cabling return loss shall be measured in accordance with annex C of ANSI/TIA/EIA-568-B.2. Connecting hardware return loss shall be measured in accordance with annex D of ANSI/TIA/EIA-568-B.2 for all pairs. Modular plug cords shall be measured in accordance with annex J for all pairs.

7.4.1 Horizontal cable return loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 horizontal cable return loss, for a length of 100 m (328 ft), shall meet the values determined using the equations specified in table 29. The values in table 30 are provided for information only.

Table 29 - Augmented category 6 horizontal cable return loss @ 20°C ± 3°C (68° F ± 5.5° F), for a length of 100 m (328 ft)

Frequency (MHz)	Return loss (dB)
$1 \le f < 10$ $10 \le f < 20$ $20 \le f \le 500$	20+5log(f) 25 25-7log(f/20)

Table 30 - Augmented category 6 solid conductor cable return loss at 20 °C ± 3 °C (68 °F ± 5.5 °F), for a length of 100 m (328 ft)

Frequency (MHz)	Return loss (dB)
1.00	20.0
4.00	23.0
8.00	24.5
10.00	25.0
16.00	25.0
20.00	25.0
25.00	24.3
31.25	23.6
62.50	21.5
100.00	20.1
200.00	18.0
250.00	17.3
300.00	16.8
400.00	15.9
500.00	15.2

7.4.2 Stranded conductor cable return loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 stranded patch cable return loss, for a length of 100 m (328 ft), shall meet the values determined using the equations specified in table 31. The values in table 32 are provided for information only.

Table 31 - Augmented category 6 stranded conductor cable return loss requirements at 20 °C ± 3 °C (68 °F ± 5.5 °F), f**or a length of 100 m (328 ft)**

Frequency (MHz)	Return loss (dB)
$1 \leq f < 10$	$20+5\log(f)$
$10 \leq f < 20$	25
$20 \leq f \leq 500$	$25-8.6\log(f/20)$

Table 32 - Augmented category 6 stranded conductor cable return loss at 20 °C ± 3 °C (68 °F ± 5.5 °F),f **or a length of 100 m (328 ft)**

Frequency (MHz)	Return loss (dB)
1.00	20.0
4.00	23.0
8.00	24.5
10.00	25.0
16.00	25.0
20.00	25.0
25.00	24.2
31.25	23.3
62.50	20.7
100.00	19.0
200.00	16.4
250.00	15.6
300.00	14.9
400.00	13.8
500.00	13.0

7.4.3 Connecting hardware return loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 connecting hardware return loss shall meet the values determined using the equations specified in table 33. The values in table 34 are provided for information only. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

Table 33 – Augmented category 6 connecting hardware return loss

Frequency (MHz)	Return loss (dB)
$1 \le f < 79$ (TBD)	30
79 (TBD) $\le f \le 500$	28-20log(f/100) (TBD)

Table 34 - Augmented category 6 connecting hardware return loss

Frequency (MHz)	Return loss (dB)
1.00	30.0
4.00	30.0
8.00	30.0
10.00	30.0
16.00	30.0
20.00	30.0
25.00	30.0
31.25	30.0
62.50	30.0
100.00	28.0 (TBD)
200.00	22.0 (TBD)
250.00	20.0 (TBD)
300.00	18.5 (TBD)
400.00	16.0 (TBD)
500.00	14.0 (TBD)

For the purpose of establishing permanent link and channel return loss limits, a connection value of 26–20log(*f*/100) (TBD) is assumed to account for the variability of patch cord connections. (Editor's note: This text seems out of location and can likely be written more clearly.)

7.4.4 Work area, equipment, and patch cord return loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 work area, equipment, and patch cord return loss shall meet the values determined using the equations specified in table 35. The values in table 36 are provided for information only. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

Table 35 – Augmented category 6 modular patch cord return loss

Frequency (MHz)	Return loss (dB)
(TBD)	(TBD)

Table 36 - Augmented category 6 work area, equipment, and patch cord return loss

Frequency (MHz)	Return loss (dB)
1.00	
4.00	
8.00	
10.00	
16.00	
20.00	
25.00	
31.25	
62.50	
100.00	
200.00	
250.00	
300.00	
400.00	
500.00	

7.4.5 Cabling return loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 channel return loss shall meet or exceed the values determined using the equations specified in table 37 up to 500 MHz. The values in table 38 are provided for information only.

Table 37 – Augmented Category 6 channel return loss

Frequency (MHz)	Return loss (dB)
$1 \leq f < 10$	19
$10 \leq f < 40$	24-5log(f)
$40 \leq f \leq 500$	32-10log(f) (6 dB minimum)

Table 38 – Augmented category 6 channel return loss

Frequency (MHz)	Return loss (dB)
1.00	19.0
4.00	19.0
8.00	19.0
10.00	19.0
16.00	18.0
20.00	17.5
25.00	17.0
31.25	16.5
62.50	14.0
100.00	12.0
200.00	9.0
250.00	8.0
300.00	7.2
400.00	6.0
500.00	6.0

For all frequencies from 1 MHz to 250 MHz, augmented category 6 permanent link return loss shall meet the values determined using the equations specified in table 39. The values in table 40 are provided for information only.

Table 39 – Augmented category 6 permanent link return loss

Frequency (MHz)	Return loss (dB)
$1 \le f < 3$	21+4log(f/3)
$3 \le f < 10$	21
$10 \le f < 40$	26-5log(f)
$40 \le f < 250$	34-10log(f
$250 \le f \le 500$	10-20log(f/250) (TBD) (6 dB minimum) (TBD)

Table 40 – Augmented category 6 permanent link return loss

Frequency (MHz)	Return loss (dB)
1.00	19.1
4.00	21.0
8.00	21.0
10.00	21.0
16.00	20.0
20.00	19.5
25.00	19.0
31.25	18.5
62.50	16.0
100.00	14.0
200.00	11.0
250.00	10.0
300.00	8.4
400.00	6.0
500.00	6.0

7.5 Propagation delay/delay skew

Propagation delay is the time it takes for a signal to propagate from one end of a conducting pair in cabling, cables, or connecting hardware to the opposite end of that pair. Propagation delay skew is a measurement of the signaling delay difference from the fastest pair to the slowest. Propagation delay and propagation delay skew are expressed in nanoseconds (ns). Propagation delay shall be measured for all pairs of cables in accordance with the ASTM D 4566 phase constant measurement and the phase delay and velocity calculations, except the test fixture shall provide for consistent common and differential mode impedance matching for the unjacketed twisted-pairs between the cable jacket and the balun terminations. Delay skew shall be calculated from the propagation delay measurements. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

7.5.1 Cable propagation delay

For all frequencies from 1 MHz to 500 MHz, augmented category 6 cable propagation delay shall meet the values determined using equation (18). The values shown in table 41 are for information only. See annex L of ANSI/TIA/EIA-568-B.2 for the derivation of equation (17). (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

$$delay_{cable} \leq TBD \quad ns/100\ m \tag{17}$$

Table 41 - Propagation delay and delay skew for augmented category 6 cable at 20 °C ± 3 °C (68 °F ± 5.5 °F)

Freq. (MHz)	Max. Delay (ns/100 m)	Min. Velocity of Propagation (%)	Max. Delay Skew (ns/100 m)
1	TBD	TBD	TBD
10	TBD	TBD	TBD
100	TBD	TBD	TBD
250	TBD	TBD	TBD
500	TBD	TBD	TBD

7.5.2 Cabling propagation delay

In determining the augmented category 6 channel and permanent link propagation delay, the propagation delay contribution of each installed mated connection is assumed to not exceed 2.5 ns from 1 MHz to 500 MHz.

The maximum propagation delay for an augmented category 6 channel configuration shall be less than 555 ns measured at 10 MHz.

The maximum propagation delay for an augmented category 6 permanent link configuration shall be less than 498 ns measured at 10 MHz.

7.5.3 Cable propagation delay skew

For all frequencies from 1 MHz to 250 MHz, category 6 cable propagation delay skew shall not exceed TBD ns/100 m at 20 °C, 40 °C, and 60 °C. In addition, the propagation delay skew between all pairs shall not vary more than ± TBD ns from the measured value at 20 °C when measured at 40 °C and 60 °C. Compliance shall be determined using a minimum 100 m of cable. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

7.5.4 Cabling propagation delay skew

In determining the channel and permanent link propagation delay skew, the propagation delay skew of each installed mated connection is assumed not to exceed 1.25 ns.

The maximum propagation delay skew for an augmented category 6 channel configuration shall be less than 50 ns measured at 10 MHz.

The maximum propagation delay skew for an augmented category 6 permanent link configuration shall be less than 44 ns measured at 10 MHz.

7.6 Balance

Balance properties are related to the emission and immunity characteristics of the cabling. Balance parameters are expressed in dB as the ratio of the signal measured at the device under test (DUT) output port relative to the signal entering the DUT input port. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

7.6.1 Transverse conversion loss (TCL)

TCL shall be measured for all cable and connecting hardware pairs in accordance with annex A.

NOTE –TCL and LCL parameters are reciprocal. LCL can be determined using a TCL measurement.

(Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

7.6.1.1 Cable TCL

For all frequencies from 1 MHz to 500 MHz, augmented category 6 cable TCL shall meet the values determined using equation (18). Calculations that result in TCL values greater than 40 dB shall revert to a requirement of 40 dB minimum. The values in table 42 are provided for information only.

NOTE - When achievable, a 50 dB measurement plateau is recommended.

(Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

$$TCL_{cable} \geq TBD \ \ dB \qquad (18)$$

Table 42 – Augmented category 6 cable TCL

Frequency (MHz)	TCL (dB)
1.00	19.1
4.00	21.0
8.00	21.0
10.00	21.0
16.00	20.0
20.00	19.5
25.00	19.0
31.25	18.5
62.50	16.0
100.00	14.0
200.00	11.0
250.00	10.0
300.00	8.4
400.00	6.0
500.00	6.0

7.6.1.2 Connecting hardware TCL

For all frequencies from 1 MHz to 500 MHz, augmented category 6 connecting hardware TCL shall meet the values determined using equation (19). Calculations that result in TCL values greater than 40 dB shall revert to a requirement of 40 dB minimum. The values in table 43 are provided for information only. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

$$TCL_{conn} \geq TBD \ \ dB \qquad (19)$$

Table 43 – Augmented category 6 connecting hardware TCL

Frequency (MHz)	TCL (dB)
1.00	TBD
4.00	TBD
8.00	TBD
10.00	TBD
16.00	TBD
20.00	TBD
25.00	TBD
31.25	TBD
62.50	TBD
100.00	TBD
200.00	TBD
250.00	TBD
300.00	TBD
400.00	TBD
500.00	TBD

7.6.2 Equal Level transverse conversion transfer loss (ELTCTL)

TCTL shall be measured for all connecting hardware in accordance with annex A of TIA/EIA-568-B.2-9. TCTL shall be measured and ELTCTL shall be calculated for cables in accordance with annex A of TIA/EIA-568-B.2-9. TCTL and ELTCTL are specified for the opposite ends of the same pair. TCTL and ELTCTL between pairs are not specified. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

7.6.2.1 Cable ELTCTL

For all frequencies from 1 MHz to 500 MHz, cable TCTL shall be measured in accordance with annex A of TIA/EIA-568-B.2-9. ELTCTL shall be calculated in accordance with equation (20) and shall meet the values determined using the equations in table 44. The values in table 45 are provided for information only.

$$ELTCTL_{cable} = TCTL_{cable} - IL_{cable\_DM} \quad (20)$$

IL_{cable_DM} shall be measured in accordance with clause C.1 of TIA/EIA-568-B.2. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

Table 44 – Augmented category 6 cable ELTCTL

Frequency (MHz)	ELTCTL (dB)
TBD	(TBD)

Table 45 – Augmented category 6 cable ELTCTL

Frequency (MHz)	ELTCTL (dB)
1.00	TBD
4.00	TBD
8.00	TBD
10.00	TBD
16.00	TBD
20.00	TBD
25.00	TBD
31.25	TBD
62.50	TBD
100.00	TBD
200.00	TBD
250.00	TBD
300.00	TBD
400.00	TBD
500.00	TBD

7.6.2.2 Connecting hardware TCTL

For all frequencies from 1 MHz to 500 MHz, augmented connecting hardware TCTL shall meet the values determined using equation (21). The values in table 46 are provided for information only. Calculations that result in TCTL values in excess of 40 dB shall revert to a requirement of 40 dB minimum. (Editor's Note: This text was not approved by TR-42.7. The Editor put it in as a placeholder.)

$$TCTL_{conn} \geq TBD\ dB \qquad (21)$$

Table 46 – Augmented category 6 connecting hardware TCTL

Frequency (MHz)	ELTCTL (dB)
1.00	TBD
4.00	TBD
8.00	TBD
10.00	TBD
16.00	TBD
20.00	TBD
25.00	TBD
31.25	TBD
62.50	TBD
100.00	TBD
200.00	TBD
250.00	TBD
300.00	TBD
400.00	TBD
500.00	TBD

7.7 ANEXT loss

ANEXT loss is the coupling of cross-talk noise at the near end from external cabling pairs into a victim pair of the 4-pair cabling under test. PSANEXT loss is the calculated power sum of the ANEXT loss from all external cabling pairs into the victim pair. Cable ANEXT loss and AELFFEXT shall be measured in accordance with annex A.

7.7.1 Channel PSANEXT loss

For all frequencies from 1 MHz to 500 MHz, augmented category 6 channel power sum alien NEXT loss shall meet the values determined using the equations in table 47 when measured in accordance with annex XX, . Calculations that result in PSANEXT values greater than 75 dB TBD shall revert to a requirement of 75 dB TBD minimum. The values in table 48 are provided for information only.

Table 47 – Augmented category 6 channel PSANEXT loss requirements at 20 °C ± 3 °C (68 °F ± 5.5 °F)

Frequency (MHz)	PSANEXT loss (dB)
$1 \leq f$ =< 100 $100 \leq f \leq 50$	60-10log(f/100) 60-55log(f/100)

Table 48 – Augmented category 6 channel PSANEXT loss at 20 °C ± 3 °C (68 °F ± 5.5 °F)

Frequency (MHz)	PSANEXT loss (dB)
1.00	75.0
4.00	74.0
8.00	71.0
10.00	70.0
16.00	68.0
20.00	67.0
25.00	66.0
31.25	65.1
62.50	62.0
100.00	60.0
200.00	55.5
250.00	54.0
300.00	52.8
400.00	51.0
500.00	49.5

7.7.2 Channel PSAELFEXT

For all frequencies from 1 MHz to 500 MHz, augmented category 6 channel PSAELFEXT shall meet the values determined using the equation (22) when measured in accordance with annex XX. Calculations that result in PSAELFEXT values greater than 75 dB TBD shall revert to a requirement of 75 dB TBD minimum. The values in table 49 are provided for information only.

$$PSAELFEXT_{channel} \geq 37 - 20\log(f/100) \text{ (TBD) } dB \quad (22)$$

Table 49 – Augmented category 6 channel PSAELFEXT at 20 °C ± 3 °C (68 °F ± 5.5 °F)

Frequency (MHz)	PSAELFEXT (dB)
1.00	77.0 (TBD)
4.00	65.0 (TBD)
8.00	58.9 (TBD)
10.00	57.0 (TBD)
16.00	52.9 (TBD)
20.00	51.0 (TBD)
25.00	49.0 (TBD)
31.25	47.1 (TBD)
62.50	41.1 (TBD)
100.00	37.0 (TBD)
200.00	31.0 (TBD)
250.00	29.0 (TBD)
300.00	27.5 (TBD)
400.00	25.0 (TBD)
500.00	23.0 (TBD)

ANNEX A Cable ANEXT and AFEXT reference test procedure (normative)

A.1 Purpose

This annex describes a procedure for measuring alien near end crosstalk loss (ANEXT loss) between pairs of adjacent cables in a 7 cable assembly. The frequency range is 1-500 MHz.

A.2 Equipment

Network Analyzer
Baluns
100 Ohm pair terminations
Tie wraps or other cable binding devices
Seven 100 meter lengths of 4 pair UTP cable

A.3 Procedure

Prepare the cables to be tested in the form of an assembly consisting of seven cables utilizing tie wraps longitudinally spaced about 200 mm (8 in.) apart. The seven cables shall be maintained in a six-around-one parallel configuration throughout the length to be tested as shown in figure A.1 (to be quickly drawn up by Shadi “Picasso” AbuGhazaleh). The 6 cables shall not be deformed by the tie wraps. The assembly shall be laid out on the floor of the test facility in one large loop or serpentine configuration so that crossovers do not occur. The pairs at each end of the assembly shall be prepared for termination with common and differential resistors. The far-end of the pairs under test and both ends of the remaining pairs shall be terminated (Editor: with what?).

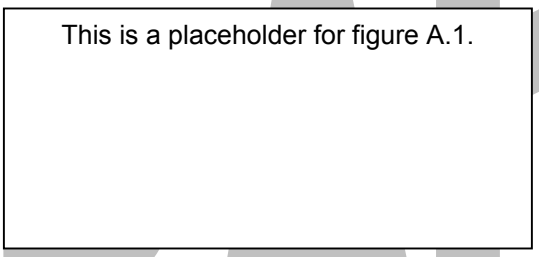

Figure A.1: Six-around-one cable test configuration

Measure the NEXT loss and FEXT between all pairs of the middle victim cable and each pair of all adjacent cables.

For modeling channel performance, cable PSANEXT loss and PSAFEXT values shall be determined from the assumptions in annex C.

Editor’s note: Move “of the same design” somewhere in the body of the Standard where the PSANEXT loss and PSAFEXT test method is called out.

A.4 Results

Calculate PSANEXT loss and PSAFEXT from the measured data.

Editor's Note: Add figures shown in contribution #189/#190 to this text.

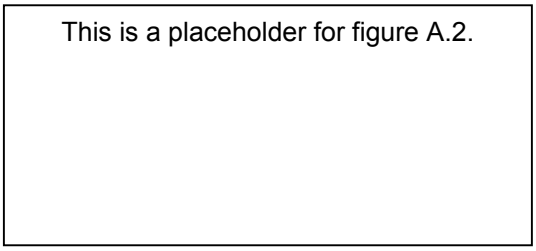

Figure A.2: Placeholder for figure from contribution #189

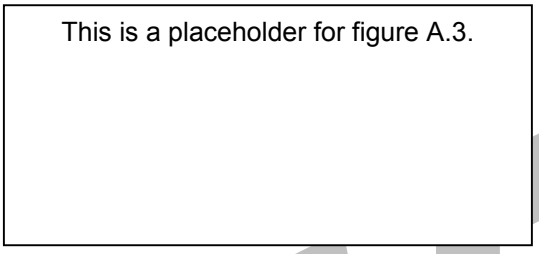

Figure A.3: Placeholder for figure from contribution #190

ANNEX B Connecting hardware ANEXT loss and AFEXT reference test procedure (normative)

B.1 Purpose

Editor's Note: This text is expected to be provided by the connecting hardware ANEXT loss task group by The February meeting.

ANNEX C Channel ANEXT loss and AFEXT test configurations (normative) (TBD)

C.1 Reference measurement instructions

1. Pull seven to ten (depending on conduit fill) up to 90 meter (295 ft) 4-pair cables into a conduit with a length of > 30 meters (98 ft). The conduit shall be sized to ensure a conduit fill of 40 % ± 3.5 %. The conduit fill is calculated as the ratio of $N*(D_{cable})^2 /(D_{conduit})^2$ expressed as a percentage. See table C.1 for standard EMT conduit sizes and the number of cables within the fill range specified above.

Figure C.1 – EMT conduit sizes and cable fill range

N Cables	DIA (in)	3/4 0.824 % Fill	1 1.047 % Fill	1 1/4 1.38 % Fill
9	**0.17**	38.3%		
8	**0.18**	38.2%		
7	**0.19**	37.2%		
7	**0.2**	41.2%		
10	**0.21**		40.2%	
9	**0.22**		39.7%	
8	**0.23**		38.6%	
7	**0.24**		36.8%	
7	**0.25**		39.9%	
7	**0.26**		43.2%	
10	**0.27**			38.3%
9	**0.28**			37.1%
9	**0.29**			39.7%
8	**0.3**			37.8%
8	**0.31**			40.4%

2. Pull-out a maximum of 1 meter (3.3 ft) of cable for attachment to the measurement equipment.
   - •Measure NEXT loss and FEXT loss between all of the 4-pair cable pair combinations excluding within cable pair combinations.
   - •Calculate PSNEXT loss and ELFEXT

3. Pull-out 5 meters (16.4 ft) of the 90 meter 4-pair cables from the conduit and tie-wrap every meter (3.3 ft)
   - •Measure NEXT loss and FEXT loss between all of the 4-pair cable pair combinations excluding within cable pair combinations.
   - •Calculate PSNEXT loss and ELFEXT

4. Terminate cable pairs to adjacent category compatible connecting hardware patch panel positions. Use a 1 meter (3.2 ft) test cord.
   - •Measure NEXT loss and FEXT loss between all of the 4-pair cabling pair combinations excluding within cable pair combinations.
   - •Calculate PSNEXT loss and ELFEXT

C.2 Additional ANEXT loss measurement procedures being discussed

- 2 cables in a conduit
- 2 cables bound together
- 6 around 1 cables bound together
- drum accumulator with a spiral groove for 2 cables
- two cables side by side with fixed spacing
- connecting hardware ANEXT loss measurement procedures
- channel ANEXT loss and AELFEXT measurement procedures