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Interested committees:

Title: Draft BS ISO/IEC 11801-1 Amendment 1 - Information technology - Generic cabling for customer premises - Part 1: General requirements

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



JTC1-SC25/3023/CD

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IEC ISO/IEC JTC 1/SC 25 : INTERCONNECTION OF INFORMATION TECHNOLOGY EQUIPMENT	
SECRETARIAT: Germany	SECRETARY: Mr Marco Peter
OF INTEREST TO THE FOLLOWING COMMITTEES: SC 46C, SC 48B	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	

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TITLE:

Amendment 1 - Information technology - Generic cabling for customer premises - Part 1: General requirements

NOTE FROM TC/SC OFFICERS:

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Proposed draft Amendment 1 to ISO/IEC 11801-1:2017

FOREWORD

- 1) ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.
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Amendment 1 of International Standard ISO/IEC 11801-1 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

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

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

INTRODUCTION

This amendment specifies single pair component Categories T1-A, T1-B, and T1-C, as well as cabling channels and link Classes T1-A, T1-B, and T1-C to support single pair applications. Balanced single pair channels and links specified in this amendment are not a replacement for the generic 4-pair channels in ISO/IEC 11801-1. They are an additional media type intended for use in intelligent building and industrial automation devices (e.g in network sensors, actuators, and controllers). Because of the different types and locations of these devices, single pair cabling will have distinct structures and distribution architectures that are detailed in other parts of the ISO/IEC 11801 series.

Amendment 1 also provides modifications and corrections to ISO/IEC 11801-1:2017.

Replace existing Figure 1 by the following:

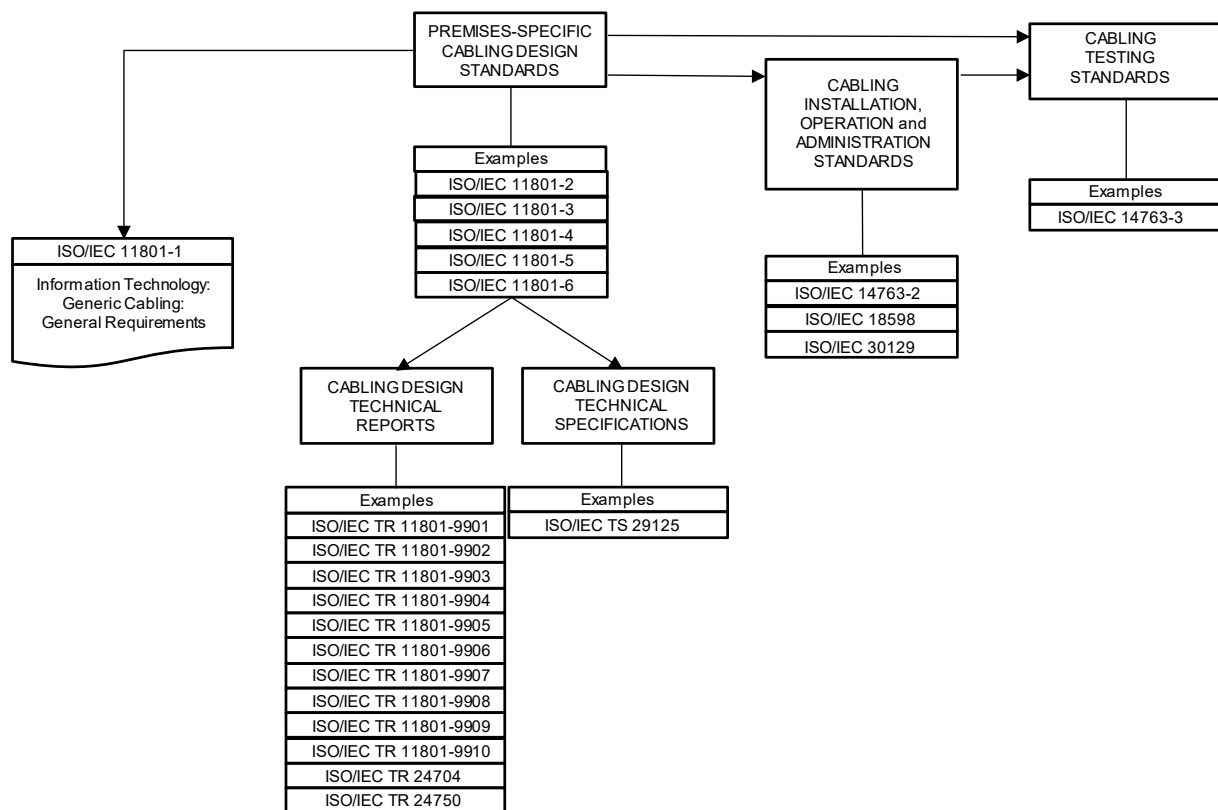


Figure 1 – Relationships between the generic cabling documents produced by ISO/IEC JTC 1/SC25

Proposed draft Amendment 1 to ISO/IEC 11801-1:2017

1 Scope

Replace existing bullet b) by the following:

b) channel transmission, environmental and power delivery performance requirements;

2 Normative references

Insert normative references in alphabetical/numeric order:

IEC 61156-11, *Multicore and symmetrical pair/quad cables for digital communications – Part 11: Symmetrical single pair cables with transmission characteristics up to 600 MHz – Horizontal floor wiring – Sectional specification*

IEC 61156-12, *Multicore and symmetrical pair/quad cables for digital communications – Part 12: Symmetrical single pair cables with transmission characteristics up to 600 MHz – work area wiring – Sectional specification (in preparation)*

IEC 61156-13, *Multicore and symmetrical pair/quad cables for digital communications – Part 13: Symmetrical single pair cables with transmission characteristics up to 20 MHz – horizontal floor wiring – Sectional specification (in preparation)*

IEC 61156-14, *Multicore and symmetrical pair/quad cables for digital communications – Part 14: Symmetrical single pair cables with transmission characteristics up to 20 MHz – work area wiring – Sectional specification (in preparation)*

IEC 61196-1-105, *Coaxial communication cables - Part 1-105: Electrical test methods - Test for withstand voltage of cable dielectric*

IEC 63171-1, *Connectors for electronic equipment – Part 1: Detail specification for two-way, shielded or unshielded, free and fixed connectors - Mechanical mating information, pin assignment and additional requirements for Type 1 copper LC style*

IEC 63171-6, *Connectors for electrical and electronic equipment – Part 6: Detail specification for 2-way and 4-way (data/power), shielded, free and fixed connectors for power and data transmission with frequencies up to 600 MHz*

3 Terms, definitions, abbreviations and symbols

3.1 Terms and definitions

3.2 Abbreviations

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

SP single-pair

SPE single-pair Ethernet

5.3.1 Cabling subsystem 1

Replace the last paragraph, with the following paragraph:

Although terminal equipment cords and equipment cords are used to connect terminal and transmission equipment respectively to the cabling subsystem, they are not considered part of the cabling subsystem because they can be application specific.

Channel performance requirements

6.3.3.4.1 General

Delete the existing 2nd paragraph.

6.3.3.6 Direct current loop resistance

Replace the existing Table 17, with the following new Table 17.

Table 17 – DC loop resistance for a channel

Class	Maximum DC loop resistance at 60 °C ^e Ω	Informative DC loop resistance at 20 °C ^e Ω
A	560	472
B	170	143,3
C	40	33,7
D, E, E_A, F, F_A	25 ^a	21,1 ^c
BCT-B-L	4,0	3,4
BCT-B-M	6,9	5,8
I, II	6,4 ^b	5,4 ^d

^a The maximum DC loop resistance at 60 °C of each pair of a cable (excluding connections) within a 2-connector link used in a channel shall be 0,22 Ω/m. This shall be achieved by an appropriate design.

^b The maximum DC loop resistance at 60 °C of each pair of a cable (excluding connections) within a 2-connector link used in a channel shall be 0,16 Ω/m. This shall be achieved by an appropriate design.

^c The maximum DC loop resistance at 20 °C of each pair of a cable (excluding connections) within a 2-connector link used in a channel shall be 0,19 Ω/m. This shall be achieved by an appropriate design.

^d The maximum DC loop resistance at 20 °C of each pair of a cable (excluding connections) within a 2-connector link used in a channel shall be 0,14 Ω/m. This shall be achieved by an appropriate design.

^e The requirements at 20 °C and 60 °C are equivalent according to the generic formula for temperature correction of resistance. To correct DC loop resistance to a different temperature, the conversion is as follows:

$$R = R_{ref} \left[1 + \alpha (T - T_{ref}) \right]$$

Where,

R = Conductor resistance at temperature T

R_{ref} = Conductor resistance at reference temperature T_{ref} , usually 20 °C

α = Temperature coefficient of resistance for the conductor material (Copper = 0,00393 at 20 °C)

T = Conductor temperature in degrees Celcius

T_{ref} = Reference temperature that α is specified at for the conductor material

6.3.3.12.2 Unbalance attenuation, near-end

Replace the existing Table 22, with the following revised Table 22:

Table 22 – Informative TCL values for unscreened channels at key frequencies

Frequency MHz	Minimum TCL dB								
	Class								
	A	B	C	D			E, E _A		
	E ₁ , E ₂ , E ₃	E ₁ , E ₂ , E ₃	E ₁ , E ₂ , E ₃	E ₁	E ₂	E ₃	E ₁	E ₂	E ₃
0,1	30,0	40,0	–	–	–	–	–	–	–
1	–	20,0	30,0	40,0	40,0	40,0	40,0	40,0	40,0
16	–	–	24,0	34,9	40,0	40,0	34,9	40,0	40,0
30	–	–	–	30,8	40,0	40,0	30,8	40,0	40,0
100	–	–	–	20,3	30,3	40,0	20,3	30,3	40,0
250	–	–	–	–	–	–	12,3	22,3	32,3

6.3.3.13.6 Alien crosstalk and coupling attenuation for screened channels

Replace the existing Table 38, with the following revised Table 38.

Table 38 – Alien crosstalk and coupling attenuation for screened channels

Class	Frequency MHz	Minimum coupling attenuation to meet PS ANEXT limits dB	Minimum coupling attenuation to meet PS AACR-F limits dB
E _A	$30 \leq f < 100$	50	50
	$100 \leq f \leq 500$	$90 - 20\lg(f)$	$90 - 20\lg(f)$
F	$30 \leq f < 100$	50	50
	$100 \leq f \leq 600$	$90 - 20\lg(f)$	$90 - 20\lg(f)$
F _A	$30 \leq f < 100$	65	65
	$100 \leq f \leq 1000$	$105 - 20\lg(f)$	$105 - 20\lg(f)$
I	$30 \leq f < 100$	65	65
	$100 \leq f \leq 2000$	$105 - 20\lg(f)$	$105 - 20\lg(f)$
II	$30 \leq f < 100$	65	65
	$100 \leq f \leq 2000$	$105 - 20\lg(f)$	$105 - 20\lg(f)$

Insert new subclause:

6.6 Single pair cabling transmission performance

6.6.1 General

This document specifies the following Classes for single-pair balanced cabling:

- a) Class T1-A is specified from 0,1 MHz to 20 MHz,
- b) Class T1-B is specified from 0,1 MHz to 600 MHz,
- c) Class T1-C is specified from 0,1 MHz to 1 250 MHz.

The insertion loss and other length related parameter performance of Class T1-A cabling is further subdivided into four sub-Classes, T1-A-100, T1-A-250, T1-A-400, and T1-A-1000. These sub-Classes have identical performance requirements for all other transmission parameters.

A Class T1-A channel is specified so that it will provide the minimum transmission performance to support Class T1-A applications. Channels of a given Class will support all applications of a lower Class with the same length. For example, a 100 m Class T1-B channel is backward compatible to a 100 m Class T1-A channel. Annex E lists known single-pair balanced cabling applications by Class.

The requirements in 6.6 are given by limits computed to one decimal place, using the equation for a defined frequency range. The limits for the propagation delay and delay skew are computed to three decimal places. The additional tables are for information only and have limits derived from the relevant equation at key frequencies. Many specifications in 6.6 have a plateau in the specified requirement. These plateaus do not accurately depict the system performance. They have been added for measurement purposes.

6.6.2 Component choice

The parameters specified in 6.6 apply to channels with screened or unscreened cable elements, with or without an overall screen, unless explicitly stated otherwise.

The nominal differential mode impedance of channels is 100 Ω . This is achieved by suitable design and appropriate choice of cabling components (irrespective of their nominal impedance).

6.6.3 Channel parameters

6.6.3.1 Return loss

The return loss requirements are applicable to all single pair cabling Classes.

The return loss (*RL*) of a single pair channel shall meet the requirements in Table 46.

The return loss requirements shall be met at both ends of the cabling. Return loss (*RL*) values at frequencies where the insertion loss (*IL*) is below 3,0 dB are for information only.

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Table 46 – Return loss for a single pair channel

Class	Frequency MHz	Minimum return loss dB
T1-A	$0,1 \leq f < 0,5$	$9 + 8(f)$
	$0,5 \leq f \leq 20$	13,0
T1-B	$0,1 \leq f < 1$	$9 + 10(f)$
	$1 \leq f < 10$	19,0
	$10 \leq f < 40$	$24 - 5 \lg(f)$
	$40 \leq f < 130$	16,0
	$130 \leq f < 400$	$37 - 10 \lg(f)$
	$400 \leq f \leq 600$	11,0
T1-C	$0,1 \leq f < 1$	$9 + 10(f)$
	$1 \leq f < 10$	19,0
	$10 \leq f < 40$	$24 - 5 \lg(f)$
	$40 \leq f < 130$	16,0
	$130 \leq f < 400$	$37 - 10 \lg(f)$
	$400 \leq f < 600$	11,0
	$600 \leq f \leq 1\,250$	$38,8 - 10 \lg(f)$

345

Table 47 – Informative return loss values for a single pair channel at key frequencies

Minimum return loss dB			
Frequency MHz	Class		
	T1-A	T1-B	T1-C
0,1	9,8	10,0	10,0
1	13,0	19,0	19,0
20	13,0	17,5	17,5
100	–	16,0	16,0
250	–	13,0	13,0
500	–	11,0	11,0
600	–	11,0	11,0
1 000	–	–	8,8
1 250	–	–	7,8

346

347 **6.6.3.2 Insertion loss/attenuation**

348 The insertion loss requirements are applicable to all single pair cabling Classes.

349 The insertion loss (*IL*) of a single pair channel shall meet the requirements in Table 48.

350

Table 48 – Insertion loss for a single pair channel

Class	Frequency MHz	Maximum insertion loss ^a dB
T1-A-1000 ^b	$0,1 \leq f \leq 20$	$10 \cdot \left(1,23 \cdot \sqrt{f} + 0,01 \cdot f + \frac{0,2}{\sqrt{f}} \right) + 10 \cdot 0,02 \cdot \sqrt{f}$
T1-A-400 ^c	$0,1 \leq f \leq 20$	$4,05 \cdot \left(1,82 \cdot \sqrt{f} + 0,0091 \cdot f + \frac{0,25}{\sqrt{f}} \right) + 5 \cdot 0,02 \cdot \sqrt{f}$
T1-A-250 ^c	$0,1 \leq f \leq 20$	$2,55 \cdot \left(1,82 \cdot \sqrt{f} + 0,0091 \cdot f + \frac{0,25}{\sqrt{f}} \right) + 4 \cdot 0,02 \cdot \sqrt{f}$
T1-A-100 ^c	$0,1 \leq f \leq 20$	$1,05 \cdot \left(1,82 \cdot \sqrt{f} + 0,0091 \cdot f + \frac{0,25}{\sqrt{f}} \right) + 4 \cdot 0,02 \cdot \sqrt{f}$
T1-B ^c	$0,1 \leq f \leq 600$	$1,05 \cdot \left(1,8 \sqrt{f} + 0,005 f + \frac{0,25}{\sqrt{f}} \right) + 4 \cdot 0,02 \sqrt{f}$
T1-C ^c	$0,1 \leq f \leq 1\,250$	$1,05 \cdot \left(1,8 \sqrt{f} + 0,005 f + \frac{0,25}{\sqrt{f}} \right) + 4 \cdot 0,02 \sqrt{f}$
^a Insertion loss (IL) at frequencies that correspond to calculated values of less than 3,0 dB shall revert to a maximum requirement of 3,0 dB. ^b Cord cable used in the channel is expected to have no de-rating based on construction. ^c 10 m of 50% de-rated (based on construction) cord cable is assumed in the equation.		

351

Table 49 – Informative insertion loss values for a single pair channel at key frequencies

Frequency MHz	Maximum insertion loss dB					
	Class					
	T1-A-1000	T1-A-400	T1-A-250	T1-A-100	T1-B	T1-C
0,1	10,3	5,6	3,5	3,0	3,0	3,0
1	14,6	8,5	5,4	3,0	3,0	3,0
20	58,3	34,4	21,7	9,2	9,0	9,0
100	–	–	–	–	20,3	20,3
250	–	–	–	–	32,5	32,5
500	–	–	–	–	46,7	46,7
600	–	–	–	–	51,4	51,4
1 000	–	–	–	–	–	67,6
1 250	–	–	–	–	–	76,2

6.6.3.3 Direct current (DC) loop resistance

The DC loop resistance requirements are applicable to all single pair cabling Classes.

The DC loop resistance of a single pair channel shall meet the requirements in Table 50.

356

Table 50 – Direct current (DC) loop resistance for a single pair channel at 20 °C

Class	Maximum DC loop resistance at 20 °C ^c Ω
T1-A-1000 ^a	46,5
T1-A-400 ^b	58,3
T1-A-250 ^b	36,5
T1-A-100 ^b	14,7
T1-B ^b	14,7
T1-C ^b	14,7
^a The maximum DC loop resistance at 20 °C of the cable pair (excluding connections) within a link, used in a channel shall be 0,046 Ω/m. This shall be achieved by an appropriate design. ^b The maximum DC loop resistance at 20 °C of the cable pair (excluding connections) within a link, used in a channel shall be 0,145 Ω/m. This shall be achieved by an appropriate design. ^c The requirements at 20 °C and 60 °C are equivalent according to the generic formula for temperature correction of resistance. To correct DC loop resistance to a different temperature, the conversion is as follows: $R = R_{ref} \left[1 + \alpha (T - T_{ref}) \right]$ Where, R = Conductor resistance at temperature T R _{ref} = Conductor resistance at reference temperature T _{ref} , usually 20 °C α = Temperature coefficient of resistance for the conductor material (Copper = 0,00393 @ 20 °C) T = Conductor temperature in degrees Celcius T _{ref} = Reference temperature that α is specified at for the conductor material	

357 6.6.3.4 Direct current (DC) resistance unbalance

358 The DC resistance unbalance requirements are applicable to all single pair cabling Classes.

359 The DC resistance unbalance between the two conductors of a single pair channel shall not
360 exceed 3 % or 100 mΩ , whichever is greater.

361 6.6.3.5 DC current carrying capacity

362 The minimum DC current carrying capacity requirements are applicable to all single pair cabling
363 Classes.

364 Each conductor within a single channel shall have a minimum DC current carrying capacity
365 under continuous operation of 2,0 A at 60 °C.

366 The DC current carrying capacity is not a guide for application support since other factors
367 including the channel length, number of conductors and cables carrying remote powering
368 current and their installation environment may place further restrictions on the current per
369 conductor.

370 For information on DC current carrying capacity with respect to installation conditions and
371 applications using remote power supplied over these Classes of single pair balanced cabling,
372 see ISO/IEC TS 29125.

Note: When remote powering applications of up to 2,0 A per conductor are used, the maximum channel length is limited. If remote powering is limited to 0,75 A per conductor, certain remote powering applications can be used at the full channel length. Table G.2 provides guidance regarding the maximum channel length in relation to the remote powering.

6.6.3.6 Dielectric withstand

The minimum dielectric withstand requirements are applicable to all single pair cabling Classes.

Dielectric withstand of single pair channels shall be a minimum of 1 000 V DC conductor-to-conductor and shall be a minimum of 1 000 V DC conductor-to-screen or conductor to earth, if a screen is not present, in accordance with IEC 61196-1-105. This requirement shall be met by design.

6.6.3.7 Propagation delay

The maximum propagation delay requirements are applicable to all single pair cabling Classes.

The propagation delay of a single pair channel shall meet the requirements in Table 51.

Table 51 – Propagation delay for a single pair channel

Class	Frequency MHz	Maximum propagation delay μs
T1-A	$0,1 \leq f \leq 20$	8,834
T1-B	$0,1 \leq f \leq 600$	$0,534 + 0,036/\sqrt{f} + 4 \times 0,0025$
T1-C	$0,1 \leq f \leq 1\,250$	$0,534 + 0,036/\sqrt{f} + 4 \times 0,0025$

Table 52 – Informative propagation delay values for a single pair channel at key frequencies

Frequency MHz	Maximum propagation delay μs		
	Class		
	T1-A	T1-B	T1-C
0,1	8,834	0,658	0,658
1	8,834	0,580	0,580
20	8,834	0,552	0,552
100	–	0,548	0,548
250	–	0,546	0,546
500	–	0,546	0,546
600	–	0,545	0,545
1 000	–	–	0,545
1 250	–	–	0,545

6.6.3.8 Unbalance attenuation and coupling attenuation

6.6.3.8.1 General

Unbalance attenuation (*TCL* and *ELTCTL*) is specified for unscreened systems. Coupling attenuation is specified for screened systems.

6.6.3.8.2 Unbalance attenuation, near-end

The unbalance attenuation near-end is measured as transverse conversion loss (*TCL*).

Minimum *TCL* requirements are applicable to unscreened systems. The *TCL* of a single pair channel that is intended to be subjected to an environmental classification E_x shall meet the requirements in Table 53.

The *TCL* requirements shall be met at both ends of the cabling and shall be achieved by design and installation in accordance with manufacturer's instructions.

Table 53 – TCL for a single pair channel for unscreened systems

Class	Frequency MHz	Environmental classification		
		E_1	E_2^b	E_3^b
		Minimum <i>TCL</i> ^a dB		
T1-A	$0,1 \leq f \leq 20$	$50 - 20\lg\left(\frac{f}{10}\right)$	$50 - 20\lg\left(\frac{f}{10}\right)$	$60 - 20\lg\left(\frac{f}{10}\right)$
T1-B	$0,1 \leq f \leq 600$	$50 - 20\lg\left(\frac{f}{10}\right)$	$60 - 20\lg\left(\frac{f}{10}\right)_{\text{ffs}}$	$70 - 20\lg\left(\frac{f}{10}\right)_{\text{ffs}}$
T1-C	$0,1 \leq f \leq 1\,250$	$50 - 20\lg\left(\frac{f}{10}\right)$	$60 - 20\lg\left(\frac{f}{10}\right)_{\text{ffs}}$	$70 - 20\lg\left(\frac{f}{10}\right)_{\text{ffs}}$

^a Calculated values of greater than 50 dB shall revert to a minimum requirement of 50 dB.

^b Reference implementation does not ensure channel compliance for E_2 or E_3 .

Table 54 – Informative TCL values for a single pair unscreened channel at key frequencies

Minimum <i>TCL</i> dB									
Frequency MHz	Class								
	T1-A			T1-B			T1-C		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
0,1	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
1	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
20	44,0	44,0	50,0	44,0	50,0	50,0	44,0	50,0	50,0
100	—	—	—	30,0	40,0	50,0	30,0	40,0	50,0
250	—	—	—	22,0	32,0	42,0	22,0	32,0	42,0
500	—	—	—	16,0	26,0	36,0	16,0	26,0	36,0
600	—	—	—	14,4	24,4	34,4	14,4	24,4	34,4
1 000	—	—	—	—	—	—	10,0	20,0	30,0
1 250	—	—	—	—	—	—	8,1	18,1	28,1

6.6.3.8.3 Unbalance attenuation, far-end

The unbalance attenuation far-end is measured as equal level transverse conversion transfer loss (*ELTCTL*).

Minimum *ELTCTL* requirements are applicable to unscreened systems. The *ELTCTL* of a single pair channel that is intended to be subjected to an environmental classification E_x shall meet the requirements in Table 55.

The *ELTCTL* requirements shall be met at both ends of the cabling and shall be achieved by design and installation in accordance with manufacturer's instructions.

Editor's Note: Table 55 and 56 need further work and consideration. Editor implemented different levels for the 4 sub Classes of T1-A. They are based on the TCTL of T1-B. The equations do not fit the calculations perfectly, but are a compromise between having more cumbersome equations.

Table 55 – ELTCTL for a single pair channel for unscreened systems

Class	Frequency MHz	Environmental classification		
		E_1	E_2	E_3
		Minimum ELTCTL ^{a, b} dB		
T1-A-1000	$0,1 \leq f \leq 20$	$16,5 - 36\lg(f)$ ffs	$26,5 - 36\lg(f)$ ffs	$36,5 - 36\lg(f)$ ffs
T1-A-400	$0,1 \leq f \leq 20$	$23 - 30\lg(f)$ ffs	$33 - 30\lg(f)$ ffs	$43 - 30\lg(f)$ ffs
T1-A-250	$0,1 \leq f \leq 20$	$26 - 25\lg(f)$ ffs	$36 - 25\lg(f)$ ffs	$46 - 25\lg(f)$ ffs
T1-A-100	$0,1 \leq f \leq 20$	$30 - 20\lg(f)$ ffs	$40 - 20\lg(f)$ ffs	$50 - 20\lg(f)$ ffs
T1-B	$0,1 \leq f \leq 600$	$30 - 20\lg(f)$ ffs	$40 - 20\lg(f)$ ffs	$50 - 20\lg(f)$ ffs
T1-C	$0,1 \leq f \leq 1\,250$	$30 - 20\lg(f)$ ffs	$40 - 20\lg(f)$ ffs	$50 - 20\lg(f)$ ffs
^a Calculated values of greater than 50 dB shall revert to a minimum requirement of 50 dB.				
^b Calculated values of less than 3 dB shall revert to a requirement of 3 dB.				

Table 56 – Informative ELTCTL values for a single pair unscreened channel at key frequencies

Minimum ELTCTL dB												
Frequency MHz	Class											
	T1-A-1000			T1-A-400			T1-A-250			T1-A-100, T1-B, T1-C ^a		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
0,1	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0	50,0
1	16,5	26,5	36,5	23,0	33,0	43,0	26,0	36,0	46,0	30,0	40,0	50,0
20	3,0	3,0	3,0	3,0	3,0	4,0	3,0	3,5	13,5	4,0	14,0	24,0
100	—	—	—	—	—	—	—	—	—	3,0	3,0	10,0
250	—	—	—	—	—	—	—	—	—	3,0	3,0	3,0
500	—	—	—	—	—	—	—	—	—	3,0	3,0	3,0
600	—	—	—	—	—	—	—	—	—	3,0	3,0	3,0
1 000	—	—	—	—	—	—	—	—	—	3,0	3,0	3,0
1 250	—	—	—	—	—	—	—	—	—	3,0	3,0	3,0
^a The informative values are only applicable to the highest frequency of the referenced Class.												

6.6.3.8.4 Coupling attenuation

Minimum coupling attenuation requirements are applicable to screened systems.

The coupling attenuation of a single pair channel that is intended to be subjected to an environmental classification E_x shall meet the requirements in Table 57.

The coupling attenuation requirements shall be met at both ends of the cabling and shall be achieved by design and installation in accordance with manufacturer's instructions.

Table 57 – Coupling attenuation for a single pair channel for screened systems

Class	Frequency MHz	Environmental classification		
		E_1	E_2	E_3
		Minimum coupling attenuation dB		
T1-A-1000	$0,1 \leq f \leq 20$	60 ffs	70 ffs	80 ffs
T1-A-400	$0,1 \leq f \leq 20$	60 ffs	70 ffs	80 ffs
T1-A-250	$0,1 \leq f \leq 20$	60 ffs	70 ffs	80 ffs
T1-A-100	$0,1 \leq f \leq 20$	54	64	74
T1-B	$0,1 \leq f < 20$	54	64	74
	$20 \leq f \leq 600$	80-20lg(f)	90-20lg(f)	100-20lg(f)
T1-C	$0,1 \leq f < 20$	54	64	74
	$20 \leq f \leq 1\,250$	80-20lg(f)	90-20lg(f)	100-20lg(f)

Table 58 – Informative coupling attenuation values for a single pair screened channel at key frequencies

Minimum coupling attenuation dB												
Frequency MHz	Class											
	T1-A-1000, T1-A-400, T1-A-250			T1-A-100			T1-B			T1-C		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
0,1	60,0ffs	70,0ffs	80,0ffs	54,0	64,0	74,0	54,0	64,0	74,0	54,0	64,0	74,0
1	60,0ffs	70,0ffs	80,0ffs	54,0	64,0	74,0	54,0	64,0	74,0	54,0	64,0	74,0
20	60,0ffs	70,0ffs	80,0ffs	54,0	64,0	74,0	54,0	64,0	74,0	54,0	64,0	74,0
100	—	—	—	—	—	—	40,0	50,0	60,0	40,0	50,0	60,0
250	—	—	—	—	—	—	32,0	42,0	52,0	32,0	42,0	52,0
500	—	—	—	—	—	—	26,0	36,0	46,0	26,0	36,0	46,0
600	—	—	—	—	—	—	24,4	34,4	44,4	24,4	34,4	44,4
1 000	—	—	—	—	—	—	—	—	—	20,0	30,0	40,0
1 250	—	—	—	—	—	—	—	—	—	18,1	28,1	38,1