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TECHNICAL REPORT

Information technology – Generic cabling for customer premises – Part 9911: Guidelines for the use of balanced single pair applications within a balanced 4-pair cabling system

ISO/IEC TR 11801-9911:2024-11(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ISO/IEC TR 11801-9911 has been prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology. It is a Technical Report.

The list of all currently available parts of the ISO/IEC 11801 series, under the general title *Information technology - Generic cabling for customer premises*, can be found on the IEC and ISO websites.

The text of this Technical Report is based on the following documents:

DTR	Report on voting
JTC1-SC25/3253/DTR	JTC1-SC25/3282/RVDTR

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, JTC 1 Supplement, available at http://www.iec.ch/members_experts/refdocs and http://www.iso.org/directives.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The ISO/IEC 11801 series is currently being revised to cover “balanced single pair cabling systems”, which will expand the range of use for structured cabling systems. With the capability of delivering data and power, these systems are ideally suited for incorporating Internet of Things (IoT) devices into premises cabling systems. Single pair applications are increasingly important for all operators of automation networks in buildings and industrial areas. Implementing these new single pair cabling structures provides for application of device-level diagnostics and security and provides for improved system scalability. Single pair cabling is not meant to replace traditional 4-pair cabling, but to support emerging applications, such as interconnecting IoT and M2M (machine-to-machine) devices.

This document gives guidance and instructions for the use of balanced single pair cabling as specified in ISO/IEC 11801-1:2017/AMD1:- [1][1] and 4-pair components specified in ISO/IEC 11801-1:2017 [2] together in the same balanced cabling system assuring application support in accordance with ISO/IEC 11801-6 [3].

[1] Under preparation. Stage at the time of publication: ISO/IEC CD 11801-1:2017/AMD1:2023.

Information technology – Generic cabling for customer premises – Part 9911: Guidelines for the use of balanced single pair applications within a balanced 4-pair cabling system

1 Scope

This part of ISO/IEC 11801, which is a Technical Report,

a) describes the rules of implementation of balanced single pair cabling as specified by ISO/IEC 11801-6 [3] within a balanced 4-pair cabling system with a current carrying capacity of 0,75 A per conductor as specified in ISO/IEC 11801-1:2017 [2];

b) describes the use of ISO/IEC 11801-1:2017 [2] components and cabling to implement and configure in accordance with ISO/IEC 11801-3:2017/AMD1:2021 [4], ISO/IEC 11801-4 [5] and ISO/IEC 11801-6 [3];

c) describes links and components for generic single pair channels in accordance with ISO/IEC 11801-1:2017/AMD1:- [1]. Particular areas of interest are

   1) remote powering in accordance with IEEE Std 802.3dd [6],
   2) loop resistance and maximum current,
   3) insertion loss,
   4) return loss,
   5) noise considerations,
   6) frequency range requirements (low and high),
   7) length calculation of the SCP link 4-pair-cable, and
   8) number of channels;

d) describes the use of application-specific single pair channels in addition to ISO/IEC 11801-1:2017/AMD1:- [1], 6.6.4;

e) describes guidance on single pair remote powering applications when using 4-pair cabling with current carrying capacity specified by ISO/IEC 11801-1:2017 [2];

f) describes guidelines for planning, administration and installation.

NOTE This document compares requirements of existing 4-pair cabling classes and single-pair classes. The described approach can be adjusted to any number of pairs.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 11801-1, *Information technology - Generic cabling for customer premises - Part 1: General requiements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 11801-1 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

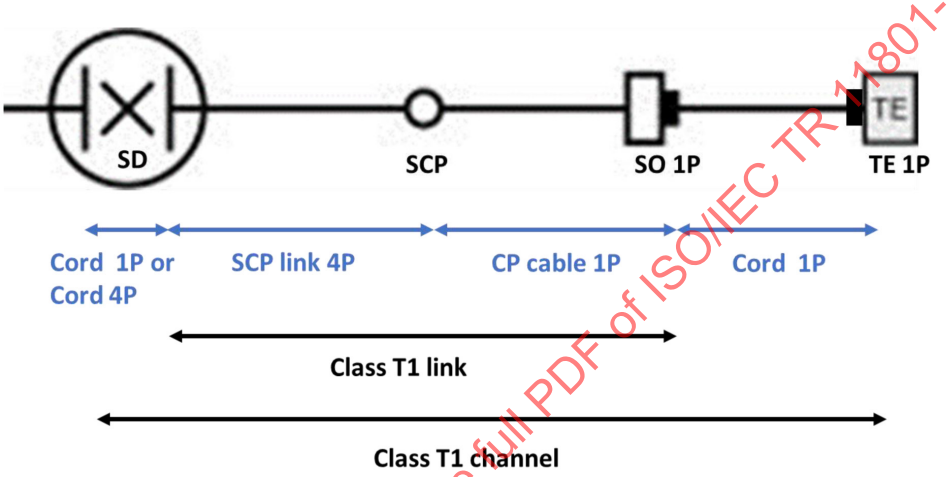
- IEC Electropedia: available at https://www.electropedia.org/

- ISO Online browsing platform: available at https://www.iso.org/obp

4 Simultaneous operation of multiple single pair applications within an engineered system that includes 4-pair cabling components in accordance with ISO/IEC 11801-1:2017 [2]

4.1 General

This document assumes an extension of a 2-connector SCP link 4-pair type B cabling as specified in ISO/IEC 11801-6 [3] with single pair components to create up to four channels that conform to single pair generic channels (see Figure 1).



SD	service distributor
SCP	service concentration point
1P	single pair
4P	4-pair
SO 1P	service outlet, see ISO/IEC 11801-1:2017/AMD1:- [1], 10.14 and 10.15, TE outlet
TE 1P	terminal equipment single pair
Cord 1P (SD + SO)	single pair patchcord at both ends
Cord 4P (SD)	4-pair patchcord at SD end
SCP link 4P	4-pair service concentration point link
CP cable 1P	concentration point cable single pair

Figure 1 – Structure and definition of an extended type B generic channel

4.2 Creation of single pair cabling channels

Based on 4.1 cabling channels can be achieved by:

a) creating up to four single pair channels based on 4-pair cabling that conforms to T1-A, T1-B or T1-C;

b) creating up to four single pair links based on SCP link 4-pair cabling that conforms to T1-A, T1-B or T1-C and adding single pair conformant cords;

c) reference implementation using single pair conformant single pair and 4-pair components (see Clauses 9 and 10 of ISO/IEC 11801-1:2017/AMD1:- [1]).

4.3 Evaluation of the parameters that must be fulfilled by the shared SCP 4-pair link

4.3.1 General

Parameters that must be fulfilled by the shared cabling portion (SCP link 4-pair) to create a single pair channel are specified by a single pair 2-connector link in ISO/IEC 11801-1:2017/AMD1:- [1]. The result of the evaluation for $M_1I_1C_1E_1$ is given in the respective tables. For other environments the result is re-evaluated with the requirements given in ISO/IEC 11801-1:2017/AMD1:- [1] .

In Table 1, Table 3, Table 4, Table 5, Table 6, Table 8 and Table 9, “D”, “Q”, “M”, “NA” and “N” are used with the following meaning:

a) D: met by design
b) Q: met when passing a qualification test
c) M: met when mitigation action is taken
d) NA: not applicable
e) N: not possible

Guidance is given in Clause 5.

4.3.2 T1-A-100

The evaluation of the 4-pair SCP link to create a T1-A-100 link is shown in Table 1.

Table 1 – Evaluation of a 4-pair SCP link for T1-A-100

4-pair SCP link parameter	Fulfilled by Class					Guidance subclause
	D	E	E_A	F	F_A	
Frequency range:						5.2
low	Q	Q	Q	Q	Q	5.2.1
high	D	D	D	D	D	5.2.2
Return loss	Q	Q	Q	Q	Q	5.3
Insertion loss	M	D	D	D	D	5.4
Direct current (DC) loop resistance	M	M	D	D	D	5.5
Direct current (DC) resistance unbalance	Q	Q	D	D	D	5.6
Current carrying capacity	D	D	D	D	D	5.7
Dielectric withstand	D	D	D	D	D	5.8
Propagation delay	D	D	D	D	D	5.9
TCL (unscreened only)	Q	Q	Q	NA	NA	5.10
ELTCTL (unscreened only)	Q	Q	Q	NA	NA	5.10
Coupling attenuation (screened only)	D	D	D	D	D	5.11
PS ANEXT	Q	Q	D	D	D	5.12
PS AACR-F	Q	Q	D	D	D	5.12
Additional criteria to be considered						
Different disturbers						5.13
Cables						5.14
Connectors						5.15
Installation						5.16
Bonding						5.17

4-pair SCP link parameter	Fulfilled by Class					Guidance subclause
	D	E	E_A	F	F_A	
Administration						5.18
Supported applications: Data in accordance with ISO/IEC/IEEE 8802-3:2021/Amd 5:2021 [7] and Power in accordance with IEEE Std 802.3dd [6]						5.19
Segregation of maximum 0,75 A cabling components from higher power applications						5.20
NOTE 1 4-pair cabling Classes D, E, E_A, F, F_A, I and II do not support applications above 0,75 A per conductor. All remote powering ratings of single pair cabling installations are for further study. NOTE 2 The 4-pair classes are not assured below 1 MHz by the requirements of their class and therefore can need qualification.						

4.3.3 T1-A-400 and T1-A-1000

T1-A-1000 was designed for long reach and low insertion loss. Since the cables used for T1-A-1000 have less insertion loss per unit length than the other classes, the allowed extension length is reduced in accordance with Table 2, to account for the higher level of insertion loss compared to a channel consisting of T1-A-1000 cables only.

Table 2 – Allowed extension lengths for T1-A-1000 extensions based on 4-pair SCP classes

Class	Reference length (m)	Powering Class 11, 14 of T1-A-1000 (m)	Powering Class 10, 13 of T1-A-1000 (m)
D	100	0	468
E	100	0	468
E_A	100	0	468
F	100	0	468
F_A	100	0	468

NOTE 1 Standardized connectors are not designed to connect with components based on T1-A-1000 channels (AWG18 cables).

Table 3 provides informative values to demonstrate the relationship between the cabling class and maximum channel length supported by the powering classes.

Table 3 – Allowed extension lengths for T1-A-400 extension based on 4-pair SCP classes

Class	Reference length (m)	Powering Class 11, 14 of T1-A-400 (m)	Powering Class 10, 13 of T1-A-400 (m)
D	100	0	300
E	100	0	300
E_A	100	0	300
F	100	0	300
F_A	100	0	300

For information on cable bundling under different conditions, see ISO/IEC TS 29125 [8].

Table 4 – Evaluation of an 4-pair SCP link for T1-A-400 and T1-A-1000

4-pair SCP link parameter	Fulfilled by Class					Guidance subclause
	D	E	E_A	F	F_A	
Frequency range:						5.2
low	Q	Q	Q	Q	Q	5.2.1
high	D	D	D	D	D	5.2.2
Return loss	Q	Q	Q	Q	Q	5.3
Insertion loss	M	D	D	D	D	5.4
Direct current (DC) loop resistance	M	M	D	D	D	5.5
Direct current (DC) resistance unbalance	Q	Q	D	D	D	5.6
Current carrying capacity	D	D	D	D	D	5.7
Dielectric withstand	D	D	D	D	D	5.8
Propagation delay	D	D	D	D	D	5.9
TCL (unscreened only)	Q	Q	Q	NA	NA	5.10
ELTCTL (unscreened only)	Q	Q	Q	NA	NA	5.10
Coupling attenuation (screened only)	D	D	D	D	D	5.11
PS ANEXT	Q	Q	D	D	D	5.12
PS AACR-F	Q	Q	D	D	D	5.12
Additional criteria to be considered						
Different disturbers						5.13
Cables						5.14
Connectors						5.15
Installation						5.16
Bonding						5.17
Administration						5.18
Supported applications: Data in accordance with ISO/IEC/IEEE 8802-3:2021/Amd 5:2021 [7] and Power in accordance with IEEE Std 802.3dd [6]						5.19
Segregation of maximum 0,75 A cabling components from higher power applications						5.20

NOTE 2 4-pair cabling Classes D, E, E_A, F, F_A, I and II do not support applications above 0,75 A. All remote powering ratings of single pair cabling installations are for further study.

NOTE 3 The 4-pair classes are not assured below 1 MHz by the requirements of their class and therefore can need qualification.

4.3.4 T1-B

The evaluation of the 4-pair SCP link to create a T1-B is shown in Table 5.

Table 5 – Evaluation of a 4-pair SCP link for T1-B

4-pair SCP link parameter	Fulfilled by Class			Guidance subclause
	E_A	F	F_A	
Frequency range:				5.2
low	Q	Q	Q	5.2.1
high	Q	D	D	5.2.2
Return loss	Q	Q	Q	5.3
Insertion loss	Q	D	D	5.4

4-pair SCP link parameter	Fulfilled by Class			Guidance subclause
	E_A	F	F_A	
Direct current (DC) loop resistance	D	D	D	5.5
Direct current (DC) resistance unbalance	D	D	D	5.6
Current carrying capacity	D	D	D	5.7
Dielectric withstand	D	D	D	5.8
Propagation delay	D	D	D	5.9
TCL (unscreened only)	Q	NA	NA	5.10
ELTCTL (unscreened only)	Q	NA	NA	5.10
Coupling attenuation (screened only)	D	D	D	5.11
PS ANEXT	Q	D	D	5.12
PS AACR-F	Q	D	D	5.12
Additional criteria to be considered				
Different disturbers				5.13
Cables				5.14
Connectors				5.15
Installation				5.16
Bonding				5.17
Administration				5.18
Supported applications: Data in accordance with ISO/IEC/IEEE 8802-3:2021/Amd 5:2021 [7] and Power in accordance with IEEE Std 802.3dd [6]				5.19
Segregation of maximum 0,75 A cabling components from higher power applications				5.20

NOTE 1 4-pair cabling Classes D, E, E_A, F, F_A, I and II do not support applications above 0,75 A per conductor. All remote powering ratings of single pair cabling installations are for further study.

NOTE 2 The 4-pair classes are not assured below 1 MHz by the requirements of their class and therefore can need qualification.

4.3.5 T1-C

The evaluation of the 4-pair SCP link to create a T1-C is shown in Table 6.

Table 6 – Evaluation of a 4-pair SCP link for T1-C

4-pair SCP link parameter	Fulfilled by Class			Guidance subclause
	E_A	F	F_A	
Frequency range:				5.2
low	Q	Q	Q	5.2.1
high	N	N	Q	5.2.2
Return loss	N	N	Q	5.3
Insertion loss	N	N	D	5.4
Direct current (DC) loop resistance	D	D	D	5.5
Direct current (DC) resistance unbalance	D	D	D	5.6
Current carrying capacity	D	D	D	5.7
Dielectric withstand	D	D	D	5.8
Propagation delay	D	D	D	5.9
TCL (unscreened only)	Q	-	-	5.10
ELTCTL (unscreened only)	Q	-	-	5.10

4-pair SCP link parameter	Fulfilled by Class			Guidance subclause
	E_A	F	F_A	
Coupling attenuation (screened only)	D	D	D	5.11
PS ANEXT	Q	Q	D	5.12
PS AACR-F	Q	Q	D	5.12
Additional criteria to be considered				
Different disturbers				5.13
Cables				5.14
Connectors				5.15
Installation				5.16
Bonding				5.17
Administration				5.18
Supported applications: Data in accordance with ISO/IEC/IEEE 8802-3:2021/Amd 5:2021 [7] and Power in accordance with IEEE Std 802.3dd [6]				5.19
Segregation of maximum 0,75 A cabling components from higher power applications				5.20

NOTE 1 4-pair cabling Classes D, E, E_A, F, F_A, I and II do not support applications above 0,75 A per conductor. All remote powering ratings of single pair cabling installations are for further study.

NOTE 2 The 4-pair classes are not assured below 1 MHz by the requirements of their class and therefore can need qualification.

5 Guidance

5.1 General

Clause 5 provides background information on the criteria or parameters and explanations about the evaluation results for transmission, component, installation, administration and application support. Additional guidance is given to meet the requirements as specified in ISO/IEC 11801-1:2017/AMD1:- [1].

Clause 5 provides procedures if an ISO/IEC 11801-1:2017 [2] installation fails any of the parameters of Clause 4. The corrective actions (mitigation) outlined were derived to accommodate a two-connector topology. In most initially non-compliant cases, fewer than all corrective actions will be required. ISO/IEC 14763-2:2019 [9], 10.2.4, requires to re-test for compliance after each option is implemented. The option or options most appropriate for the situation are selected:

- Option 1: The outlet connector in the telecommunication room or floor distributor is replaced with a better outlet connector of the 4-pair SCP link in Figure 1.
- Option 2: The service concentration point connector of the 4-pair SCP link in Figure 1 is replaced with a better service concentration point connector.
- Option 3: The work area, patch, or equipment cords are replaced with better cords.
- Option 4: The cable used for the 4-pair SCP link is replaced with a better cable with better crosstalk performance between the pairs and optionally lower resistance and lower attenuation per unit length.

For new installations, ISO/IEC 11801-6 [3] recommends Class E_A or higher.

5.2 Frequency range

5.2.1 Lower frequency

Lower frequency is defined where requirements of single pair channels are below the frequency range of 4-pair cabling systems.

Specifications for lower frequencies specified for T1-A, T1-B or T1-C of a 4-pair link are not necessarily assured by the 4-pair link by the requirements of its class. The requirements for the single pair channels created by cable sharing with 4-pair cabling are specified by ISO/IEC 11801-1:2017/AMD1:- [1].

5.2.2 Upper or higher frequency

Upper or higher frequency is defined where requirements of single pair channels are above the frequency range of 4-pair cabling systems.

If the 4-pair SCP link upper frequency is less than the single pair specification (600 MHz for Class T1-B and 1 250 MHz for Class T1-C), a qualification of the link is needed to show if the requirements of ISO/IEC 11801-1:2017/AMD1:- [1] are met.

5.3 Return loss

Return loss below 1 MHz:

- Specifications for lower frequencies specified for T1-A, T1-B or T1-C of a 4-pair link are not necessarily assured by the 4-pair link by the requirements of its class.
- The requirements for the single pair channels created by cable sharing with 4-pair cabling are specified by ISO/IEC 11801-1:2017/AMD1:- [1].

Return loss above 1 MHz:

- The return loss of the T1-B and T1-C channels above 64 MHz are specified higher than Class E_A, Class F and Class F_A. The link classes E_A to F_A do not formally meet these values, but measured links generally do.
- The 4-pair links were defined for up to three connectors in ISO/IEC 11801-1:2017 [2]. The 4-pair SCP link in this document is based only on two connectors.
- ISO/IEC 14763-2:2019 [9], 6.3, states that qualification is required for compliance.

The return loss comparison is shown in Figure 2.

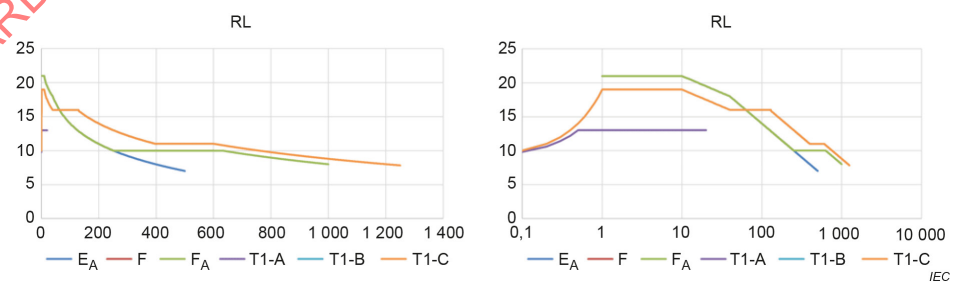
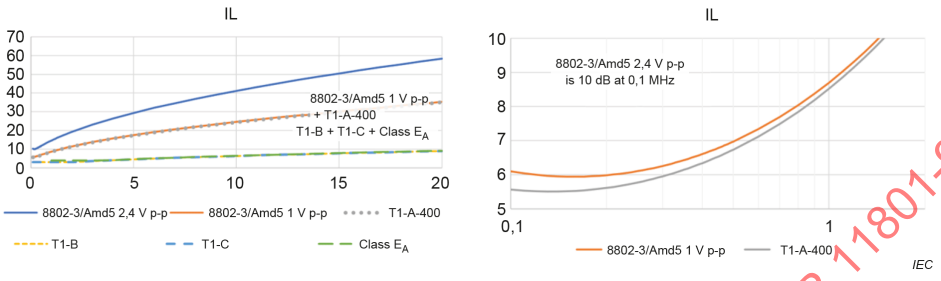


Figure 2 – Return loss (RL) comparison between single pair and 4-pair cabling classes

NOTE In frequency ranges where the requirements for 4-pair classes are above the requirements of single pair classes, testing is voluntary. In frequency ranges where the single pair requirements are above the 4-pair requirements or no 4-pair requirements are available, testing is important.

5.4 Insertion loss

The classes of ISO/IEC 11801-1:2017 [2] do not specify insertion loss from 0,1 MHz to 1 MHz and the specification has a plateau of 4 dB. While it is expected that the T1-A, T1-B or T1-C insertion loss requirement will be met, ISO/IEC 14763-2:2019 [9], 6.3 states that it must be qualified, see Figure 3.



8802-3/Amd5 ISO/IEC/IEEE 8802-3:2021/Amd 5:2021 [7]

Figure 3 – Insertion loss (IL) comparison between ISO/IEC/IEEE 8802-3:2021/Amd 5:2021 [7] and cabling classes

5.5 Direct current (DC) loop resistance

In ISO/IEC 11801-1:2017 [2] direct current (DC) loop resistance is not differentiated by 4-pair classes. The nominal values are taken for the cable direct current (DC) loop resistance at 20 °C from IEC TR 61156-1-6 [10] as shown in Table 7.

Table 7 – Nominal cable DC loop resistance

Category and Class	Resistance per 100 m
Category 5e for Class D channel	9,0 Ω
Category 6 for Class E channel	8,5 Ω
Category 6_A for Class E_A channel	7,5 Ω
Category 7 for Class F channel	7,5 Ω
Category 7_A for Class F_A channel	6,8 Ω

For new installations, ISO/IEC 11801-6 [3] recommends Class E_A or higher.

5.6 Direct current (DC) resistance unbalance

The DC current resistance unbalance is not specified by ISO/IEC/IEEE 8802-3:2021/Amd 5:2021 [7] for single pair systems. Compliant 4-pair cabling meets the following DC resistance unbalance values.

– Channel: 3 % or 200 mΩ (50 mΩ per connector).
– Link: 3 % or 150 mΩ for up to three connectors (50 mΩ per connector).

5.7 Current carrying capacity

A channel made from a combination of single pair and 4-pair cabling components as specified by ISO/IEC 11801-1:2017 [2] has a maximum current carrying capacity of 0,75 A per conductor. Current carrying capacity larger than 0,75 A per conductor is out of scope of this document and will not be supported by the current carrying capacity of cabling specified by ISO/IEC 11801-1:2017 [2].

5.8 Dielectric withstand

Dielectric withstand requirements are met by design.

5.9 Propagation delay

Propagation delay requirements can be assured when maximum lengths are respected.

5.10 Unbalance attenuation (TCL and ELTCTL)

The requirement for unbalance attenuation is only applicable for unscreened cabling. The single pair requirements are about 10 dB more stringent than 4-pair cabling; therefore, qualification is needed.

5.11 Coupling attenuation

The requirements for coupling attenuation are only applicable for screened cabling, in accordance with the requirements of ISO/IEC 11801-1 [11].

5.12 Alien crosstalk (PS ANEXT and PS AACR-F)

In the case of multiple channels shared under one sheath, Alien crosstalk of single pair corresponds to PS NEXT and PS ACR-F of 4-pair cabling.

The disturbance of neighboured screened 4-pair cabling can be neglected if 7.2.12.6 of ISO/IEC 11801-1:2017 [2] is met.

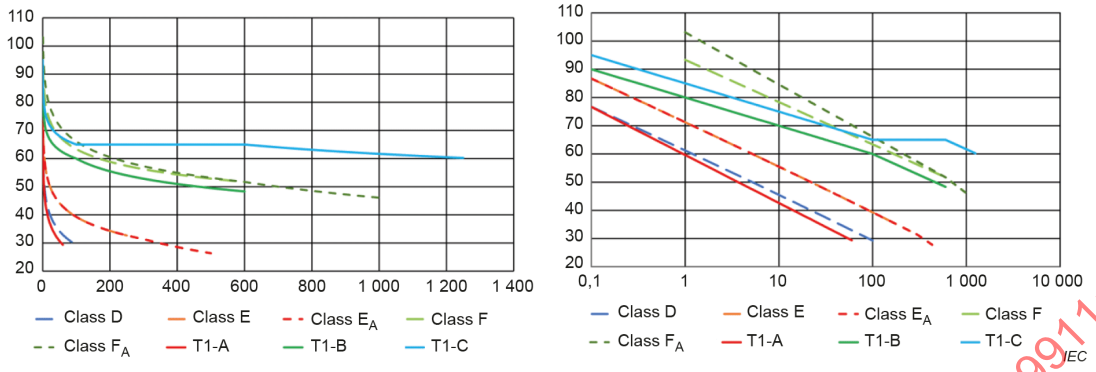
The definition of external alien crosstalk for 4-pair is 6-around-1 (see ISO/IEC 11801-1 [11]) compared to internal alien crosstalk of 3-around-1 (see ISO/IEC 11801-1:2017/AMD1:- [1]) for single pair. Therefore, a correction factor of two (3 dB) applies resulting from six disturbers versus three.

Further correction factors apply depending on the number of single pair channels in a 4-pair SCP link:

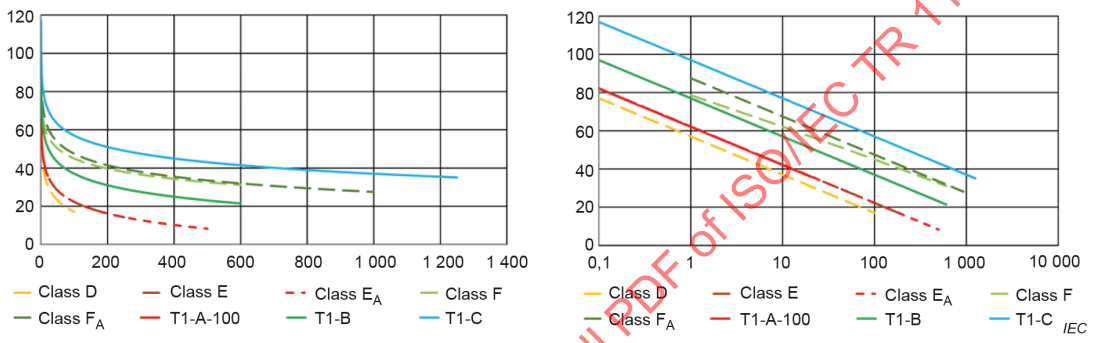
a) three single pair channels (one disturbed and two disturbers): correction factor is 4,8 dB;

b) two single pair channels (one disturbed and one disturber): correction factor is 7,8 dB;

c) one single pair channel (no disturber): met by design.



4 a) Comparison of link requirements for PS NEXT of Class D, E, EA, F and FA with PS ANEXT for single pair links T1-A, T1-B and T1-C in linear and logarithmic scale



4 b) Comparison of link requirements for PS ACR-F of Class D, E, EA, F and FA with PS AACR-F for single pair links T1-A, T1-B and T1-C in linear and logarithmic scale

Figure 4 – Comparison between 4-pair and single pair link requirements in linear and logarithmic scale

Table 8 is derived from Figure 4.

Table 8 – Support of single pair cabling classes by 4-pair cabling classes based on alien crosstalk

	T1-A	T1-B	T1-C
Class E_A link	D	N	N
Class F link	D	D	N
Class F_A link	D	D	Q

If the disturbers are different see 5.13.

5.13 Different disturbers

Mixing of different types of disturber in the same bundle is not considered in this document as the current state of the art has not reached consensus in this regard.

5.14 Cables

For cables, see the IEC 61156 series [12].