ISO/IEC JTC 1/SC 25/WG 3 N 754

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ISO/IEC JTC 1/SC 25/WG 3

Customer Premises Cabling

Secretariat: Germany (DIN)

DOC TYPE:	**Liaison document**
TITLE:	**Letter to the chairman of IEEE 802.3 on a WD for ISO/IEC TR 24750: Guidelines for the support of 10GBASE-T over Copper Balanced Pairs of Class E and Class F as per ISO/IEC 11801(ED.2.0): 2002 and IEEE 802.3an**
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PROJECT:	**25.03.02.02-03**
STATUS:	**SC 25/WG 3 N 746 has been distributed for internal review by the WG 2005-03-16, the comments, collated in SC 25/WG 3 N 752, just came in and the resolution process will start in few days. It will include comments from IEEE 802.3 in case such are provided.**
ACTION ID:	**FYI**
DUE DATE:	**n/a**
REQUESTED:	**For information**
ACTION	**The attached drafts are forwarded to IEEE 802.3 as preliminary information, for consideration and if wished for comment.**
MEDIUM:	**Def**
No of Pages:	**40 (including cover)**

DISTRIBUTION:

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To: IEEE 802.3 Bob Grow

copy to Brad Booth, Alan Flatman

From: IEC/JTC1/SC25/WG 3 Secretariat

Date: 2005-05-17

Letter to the chairman of IEEE 802.3 on a WD for ISO/IEC TR 24750: Guidelines for the support of 10GBASE-T over Copper Balanced Pairs of Class E and Class F as per ISO/IEC 11801(ED.2.0): 2002 and IEEE 802.3an

Dear Bob,

since you have your meeting before we have time to consider the comments on our draft on support of 10GBASE-T with cabling already installed I herewith send you the text of the working draft as well as the draft collation of comments.

Feel free to provide your comments to both these documents.

Should you have comments I will forward them to the editor of the document and to SC 25/WG 3.

Please let me know, whether I shall expect comments from IEEE 802.3 as soon as possible. In case I receive such message, I will withhold distribution of the collation of comments in order to add your comments to the collation.

Kind regards

Walter

Attachment: SC 25/WG 3 N 746 and draft for N 752

ISO/IEC JTC 1/SC 25/WG 3 N 746

Date: 2005-03-16

Replaces ISO/IEC JTC 1/SC 25/WG 3 N n/a

Customer Premises Cabling

Secretariat: Germany (DIN)

DOC TYPE:	**Working draft**
TITLE:	**WD for ISO/IEC TR 24750: Guidelines for the support of 10GBASE-T over Copper Balanced Pairs of Class E and Class F as per ISO/IEC 11801(ED.2.0): 2002 and IEEE 802.3an**
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ACTION ID:	**ACT**
DUE DATE:	**2005-02 n/a**
REQUESTED: ACTION	**This draft is distributed in SC 25/WG 3 with the kind request to provide comments using the attached template by 2005-05-17.**
MEDIUM:	**P, Def, Open**
NOTE:	**Electronically this document consists of two files: WG 3 N 746.pdf and N764v.doc.**
No of Pages:	**24 (including cover)**

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1 **Working draft for ISO/IEC TR 24750**
2

Guidelines for the support of 10GBASE-T over Copper Balanced Pairs of Class E and Class F as per ISO/IEC 11801(ED.2.0): 2002 and IEEE 802.3an

Assessment of installed balanced cabling channels for the support of 10GBASE-T

Assessment of installed class E and class F cabling performance beyond their maximum specified frequencies.

Editors note: This is the official title, I like the original better because it is not only frequency.

Editors note: IEEE Draft 1.3 is not available for the public so up to 1.2 included.

3

4 **Document prepared by: Dieter Schicketanz**

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Guidelines for the support of 10GBASE-T over Copper Balanced Pairs of Class E and Class F as per ISO/IEC 11801(ED.2.0): 2002 and IEEE 802.3an

FOREWORD

1) ISO (International Organization for Standardization) and IEC (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.

2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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

The main task of IEC and ISO technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where, for any other reason, there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when the technical committee has collected data of a different kind from that which is normally published as an International Standard, for example ‘state of the art’.

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/IEC 24750, which is a technical report of type 3, was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This publication was drafted in accordance with ISO/IEC directives, Part 2.

This document is a draft under development by ISO IEC SC25WG 3.

The channel parameters specified in this draft are based upon IEEE 802.3an Draft 1.2

Introduction

IEEE 802.3 is developing a standard to support 10 Gigabit Ethernet over twisted pair.

This standard will be called IEEE 802.3an

An extract of the objectives of IEEE802.3an relating to cabling is:

- support operation over 4- connector, four- pair balanced copper cabling;
- select copper media from ISO/IEC 11801;
- support a single 10 Gbit/s PHY which supports links of:
- at least 100 m on four-pair Class F balanced copper cabling;
- at least 55m to 100m on four- pair Class E balanced copper cabling;
- meet CISPR/ FCC Class A EMC limits;
- support a BER of 10^{-12}.

Since 10GBASE-T will include new transmission technologies, new parameters are needed to qualify channels for 10GBASE-T. The following topics are of relevance to the generic cabling.

- frequency range up to 500 MHz;
- power sum alien crosstalk.

Guidelines for the support of 10GBASE-T over Copper Balanced Pairs of Class E and Class F as per ISO/IEC 11801(ED.2.0): 2002 and IEEE 802.3an

1 Scope

This technical report provides guidelines on the support of 10GBASE-T over balanced cabling of Class E and Class F as per ISO/IEC 11801(ED.2.0): 2002 and IEEE 802.3an

This TR does not re-specify Class E and F cabling of ISO/IEC 11801(ED.2.0): 2002.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 11801(ED.2.0): 2002 , *Information technology – Generic cabling systems*

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this technical report the following definitions apply in addition to those of ISO/IEC 11801(ED.2.0): 2002

NOTE The abbreviation "lg" in the equations signifies "$\log_{10}$".

3.1.1
alien
external to the cabling or part thereof in use

3.2 Abbreviations

For the purposes of this technical report the following abbreviations apply in addition to those of ISO/IEC 11801(ED.2.0): 2002.

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

4 Background Information

4.1 Comparison of 1000BASE-T with ISO/IEC 11801: 2000

During the development of Gigabit Ethernet (1000BASE-T) it was determined that a Class D channel as specified in ISO/IEC 11801 (1995) was sufficient in frequency but was lacking necessary definitions for power sum parameters. In addition, the limits for certain other parameters fell a little short of the demands of the 1000BASE-T application. The minimum performance for class D channels was upgraded accordingly with ISO/IEC 11801 (2000).

For suppliers it was rather easy to confirm without the need for further verification that channels they originally had delivered as class D: 1995 would also meet class D:2000. Thus it was fairly easy to establish that Gigabit Ethernet would be supported over both installed and new cabling.

It is, to some extent, similar with 10GBASE-T although this application requires frequencies up to 500 MHz. Whether a specific channel will do so, has to be determined case-by-case, either by design when the behaviour of the material between 250 MHz and 500 MHz is known or by measurement. There are also cases where the channel will support 10GBASE-T only after its performance has been improved. This is primarily due to new external noise specifications that are heavily dependent on installations and not all are fixed at the moment. Also the increased frequency range, compared with the Class E specification of ISO/IEC 11801, contains additional performance assumptions not always included in installed cabling. Here the supplier and installer plays a major role.

4.2 10GBASE-T Timetable

IEEE 802.3an expects to become a standard by July 2006

5 New parameters needed for generic cabling for the support of 10GBASE-T

Alien crosstalk and power sum crosstalk are well defined in ISO/IEC 11801(ED.2.0): 2002 and relate to noise coming from the other pairs in the same channel.

As cables are laid in trays, ducts and/or are bundled together, the noise from one cable can couple into other cables. This can happen between telecommunications cables of the same Category, but also between cables with different Categories or even between signal or power line cables and telecommunications cables.

This type of noise is well known in telephony and 10BASE-T and has not been an issue in the systems in use to date. However, the increased frequency range and sensitivity of the 10GBASE-T transmission cannot neglect this external noise any more.

Only the power sum of the noise is of importance and will be specified because it is irrelevant from which external pairs or cables the noise is coming from and the noise cannot be compensated for (as per 802.3an Draft1.2) within the application-specific equipment.

In a channel as specified in ISO/IEC 11801, and measured in accordance with IEC 61935-1, the near end (where the measurement transmitter is) and the far end (were the measurement receiver is) are known and the terms NEXT and FEXT are easy to define.

For alien crosstalk the term ANEXT or AFEXT can be ambiguous and the new definition of power sum alien crosstalk noise (near end and far end) is “the power sum of pair-to-pair alien crosstalk, from all pairs of other channels external to that channel pair” (ISO/IEC JTC 1/SC 25/WG 3 2/2004).

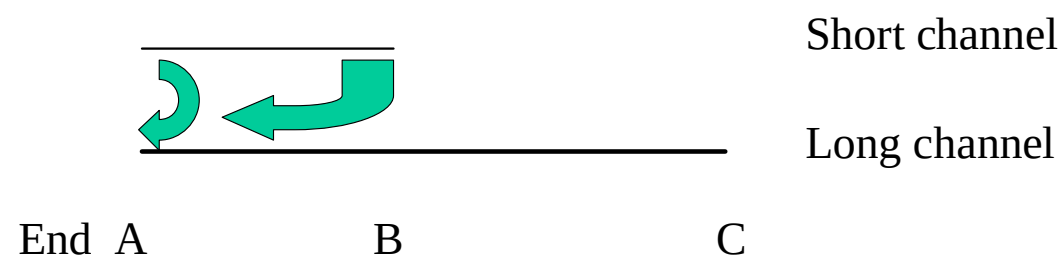

Figure 1 – Example of short channel and long Channel disturbing each other

It appears that the worst case situation is when a short channel runs in parallel at either end of a long channel. The short channel with high signals will disturb the long channel receiver where receiving signals have been attenuated due to the insertion loss of the long channel. See Figure 1.

NOTE There are proposals for PSANEXT limits at the moment, Limits for the PSAFEXT are under study(see 6).

6 Channel requirements

6.1 General

In this clause the minimum channel requirements of 10GBASE-T are our specified.

In addition their relationship with the requirements of ISO/IEC ISO/IEC 11801(ED.2.0): 2002 are discussed.

The channel performance limit formulae of this cause represent an extension to the existing Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T together with additional requirements for:

- PSANEXT;
- PSAFEXT.

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

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

NOTE The term „attenuation“ is used in 6.5, and 6.6 since it is common usage within the cabling industry. However, the correct term is insertion loss which includes the effect of impedance variations both with and between the cabling components in the channel.

6.2 Return loss

The variation of the input impedance of a channel is characterised by the return loss. The return loss for each pair of a channel should meet the limits computed, to one decimal place, using the formulae of Table 1. The limits shown in Table 2 are derived from the formulae at key frequencies only.

When required, the return loss should be measured according to IEC 61935-1. Terminations of 100 Ω should be connected to the cabling elements under test at the remote end of the channel. The return loss requirements should be met at both ends of the cabling.

Table 1 - Formulae for return loss limits for a channel

Frequency MHz	**Minimum return loss** dB
$1 \le f < 10$	19,0
$10 \le f < 40$	24-5log(f)
$40 \le f < 400$	32-10log(f)
$400 \le f \le 500$	6,0

Table 2 - Return loss limits for a channel at key frequencies

Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
Minimum return loss (dB)	19,0	18,0	12,0	8,0	6,0

Values of return loss at frequencies for which the measured channel insertion loss is below 3,0 dB are for information only.

The formulae of Table 1 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The formulae of Table 1 conform to the Class F requirements of ISO/IEC 11801(ED.2.0): 2002 .

6.3 Insertion loss and alien crosstalk

6.3.1 General

The insertion loss of each pair of a channel shall not exceed the limits computed, to one decimal place, using the formulae of Table 3. The limits shown in Table 4 are derived from the formulae at key frequencies only.

When required, the insertion loss of the channel shall be measured according to xx??.

Table 3 - Formulae for insertion loss limits for a channel

Frequency MHz	**Maximum insertion loss dB**
$1 \le f \le 500$	$1{,}05 \times \left(1{,}82 \times \sqrt{f} + 0{,}0169 \times f + 0{,}25 \Big/ \sqrt{f}\right) + 4 \times 0{,}02 \times \sqrt{f}$, 4,0 min

Table 4 - Insertion loss limits for a channel at key frequencies

Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
Maximum insertion loss (dB)	4,0	8,3	21,7	35,9	53,4

The formula of Table 3 represents an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The formula of Table 3 conforms to the Class F requirements of ISO/IEC 11801(ED.2.0): 2002.

Lower insertion losses are obtained on shorter channels or by using lower loss cables.

The allowable PSANEXT is inter-related to the insertion loss of the channel and is based upon the measured insertion loss at 250 MHz as detailed below.

The PSANEXT for each pair of a channel shall meet the limits computed, to one decimal place, using the formulae of Table 5. The limits shown in Table 6 are derived from the formulae at key frequencies only.

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

PSANEXT of pair k, αPSANEXT(k), is computed from pair-to-pair ANEXT αANEXT(i,k) of the adjacent pairs i, i = 1…n, as follows:

$$\alpha_{PSANEXT}(k) = -10 \times \lg \sum_{i=1,\, i \neq k}^{n} 10^{-0{,}1 \times \alpha_{ANEXT}(i,k)} \qquad (1)$$

where αANEXT (i,k) is the pair-to-pair ANEXT of pair k to adjacent pair i in dB

NOTE adjacent pairs are all the relevant pairs of other channels surrounding the channel pair

Table 5 - Formulae for PSANEXT limits for a channel

Frequency MHz	**Minimum PSANEXT** dB
$1 \le f \le 100$	$((28{,}6 + \text{IL}(250))/1{,}04) - 10\lg(f/100)$
$100 < f \le 500$	$((28{,}6 + \text{IL}(250))/1{,}04) - 15\lg(f/100)$
Where IL(250) is channel insertion loss at 250 MHz Where IL(250) is less than 20,3 a value of 20,3 shall be used	

Table 6 - PSANEXT limits for a channel at key frequencies

	Minimum PSANEXT dB				
Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
IL(250) ≤ 20,3 dB	67,0	55,0	47,0	41,1	36,5
IL(250) = 33,8 dB	80,0	68,0	60,0	54,0	49,5
IL(250) = 35,9 dB	82,0	70,0	62,0	56,1	51,5

Values of PSANEXT at frequencies for which the measured channel insertion loss is below 4,0dB are for information only.

6.3.2 Examples of reference implementation at key IL(250)

IL(250) < 20,3 dB: This is achieved with

- Cat 6 components 42,8 m + 10m cords
- Cat7 components 45,8 m + 10m cords

IL(250) 33,8 dB: This is achieved with

- Cat 6 components 83,5 m + 10m cords
- Cat7 components 90 m + 10m cords *

IL(250) 35,9 dB: This is achieved with

- Cat 6 components 90 m + 10m cords *
- Cat7 components 90 m + 10m cords *

* length limited to 90 m, could be longer than 90 m with channel implementation if 6.9 and 6.10 (delay) are met

6.4 Near-end crosstalk loss (NEXT)

6.4.1 Pair- to pair NEXT

The pair-to-pair NEXT □NEXT between each pair combination of a channel should meet the limits computed, to one decimal place, using the formulae of Table 7. The limits shown in Table 8 are derived from the formulae at key frequencies only.

When required, the NEXT should be measured according to IEC 61935-1. The NEXT requirements should be met at both ends of the cabling.

Table 7 - Formulae for NEXT limits for a channel

Frequency MHz	**Minimum NEXT** dB
$1 \le f \le 330$	$-20 \times \lg\left(10^{\frac{74{,}3 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{94 - 20 \times \lg f}{-20}}\right)$, 65,0 max
$330 < f \le 500$	31-50 x lg(f/330)

Table 8 - NEXT limits for a channel at key frequencies

Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
Minimum NEXT (dB)	65,0	53,2	39,9	33,1	22,0

Values of NEXT at frequencies for which the measured channel insertion loss is below 4,0 dB are for information only.

The formulae of Table 7 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The formulae of Table 7 conform to the Class F requirements of ISO/IEC 11801(ED.2.0): 2002.

6.4.2 Power Sum NEXT (PSNEXT)

The PSNEXT for each pair of a channel should meet the limits computed, to one decimal place, using the formulae of Table 9. The limits shown in Table 10 are derived from the formulae at key frequencies only.

The PSNEXT requirements should be met at both ends of the cabling.

PSNEXT of pair k, $\alpha_{PSNEXT}(k)$, is computed from pair-to-pair NEXT $\alpha_{NEXT}(i,k)$ of the adjacent pairs i, i = 1…n, as follows:

$$\alpha_{PSNEXT}(k) = -10 \times \lg \sum_{i=1,\, i \neq k}^{n} 10^{-0,1 \times \alpha_{NEXT}(i,k)} \qquad (1)$$

where $\alpha_{NEXT}(i,k)$ is the pair-to-pair NEXT of pair *k* to adjacent pair *i* in dB

Table 9 - Formulae for PSNEXT limits for a channel

Frequency MHz	**Minimum PSNEXT** dB
$1 \le f \le 330$	$-20 \times \lg\left(10^{\frac{72{,}3 - 15 \times \lg f}{-20}} + 2 \times 10^{\frac{90 - 20 \times \lg f}{-20}}\right)$, 62,0 max
$330 < f \le 500$	28-42xlg(f/330)

Table 10 - PSNEXT limits for a channel at key frequencies

Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
Minimum PSNEXT (dB)	62,0	50,6	37,1	30,2	20,4

297

298 Values of PSNEXT at frequencies for which the measured channel insertion loss is below 4,0 dB are
299 for information only

300 The formulae of Table 9 represent an extension to the Class E requirements of
301 ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The formulae of Table 9 conform to
302 the Class F requirements of ISO/IEC 11801(ED.2.0): 2002.

303 ## 6.5 Attenuation to crosstalk loss ratio (ACR)

304 ### 6.5.1 Pair-to-pair ACR

305 ACR of pairs *i* and *k*, $\alpha_{ACR}(i,k)$, is computed from pair-to-pair NEXT $\alpha_{NEXT}(i,k)$ and attenuation α_i of
306 pair *i* as follows:

307 $$\alpha_{ACR}(i,k) = \alpha_{NEXT}(i,k) - \alpha_i \quad (2)$$

308 where $\alpha_{NEXT}(i,k)$ is the pair-to-pair NEXT of pair *k* to adjacent pair *i*, in dB. The NEXT should be
309 measured according to IEC 61935-1 in dB.

310 α_i is the attenuation of pair *i*, when measured according to IEC 61935-1, in dB.

311 The ACR for each pair combination of a channel should meet the limits computed according to
312 equation (2), to one decimal place, using the relevant formulae of Table 3 and Table 7. The limits
313 shown in Table 11 are derived with equation (2) at key frequencies only.

314 The ACR requirements should be met at both ends of the cabling.

315 **Table 11 - ACR limits for a channel at key frequencies**

Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
Minimum ACR (dB)	61,0	44,9	18,2	-2,8	-31,4

316

317 The limits of Table 11 represent an extension to the Class E requirements of
318 ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The limits of Table 11 conform to the
319 Class F requirements of ISO/IEC 11801(ED.2.0): 2002 .

320 ### 6.5.2 Power sum ACR (PSACR)

321 PSACR of pair *k*, $\alpha_{PSACR}(k)$, is computed from PSNEXT $\alpha_{PSNEXT}(k)$ and attenuation $\alpha(k)$ of pair *k* as follows:
322 $$\alpha_{PSACR}(k) = \alpha_{PSNEXT}(k) - \alpha(k) \quad (3)$$

323 where $\alpha_{PSNEXT}(k)$ is the PSNEXT of pair *k* in dB

324 $\alpha(k)$ is the attenuation of pair *k* in dB when measured according to IEC 61935-1.

325 The PSACR for each pair of a channel should meet the limits computed according to equation (3), to
326 one decimal place, using the relevant formulae of Table 3 and Table 9. The limits shown in Table 10
327 are derived with equation (3) at key frequencies only.

328 The PSACR requirements should be met at both ends of the cabling.

329 **Table 12 - PSACR limits for a channel at key frequencies**

Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
Minimum PSACR (dB)	58,0	42,3	15,4	-5,8	-33,0

The limits of Table 12 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The limits of Table 12 conform to the Class F requirements of ISO/IEC 11801(ED.2.0): 2002 .

6.6 ELFEXT

6.6.1 Pair-to-pair ELFEXT

ELFEXT of pairs *i* and *k*, $\alpha_{ELFEXT}(i,k)$, is computed from pair-to-pair FEXT $\alpha_{FEXT}(i,k)$ and attenuation αk) of pair *k* as follows:

$$\alpha_{ELFEXT}(i,k) = \alpha_{FEXT}(i,k) - \alpha(k) \quad (4)$$

where *i* is the number of the disturbed pair.

k is the number of the disturbing pair.

$\alpha_{FEXT}(i,k)$ is the pair-to-pair FEXT of pair *k* to adjacent pair *i* in dB. The FEXT should be measured according to IEC 61935-1 in dB.

$\alpha(k)$ is the attenuation of pair *k* in dB when measured according to IEC 61935-1.

The ELFEXT for each pair combination of a channel should meet the limits computed, to one decimal place, using the formulae of Table 13. The limits shown in Table 14 are derived from the formulae at key frequencies only.

Table 13 - Formulae for ELFEXT limits for a channel

Frequency MHz	**Minimum ELFEXT** dB
$1 \le f \le 500$	$-20 \times \lg\left(10^{\frac{67{,}8 - 20 \times \lg f}{-20}} + 4 \times 10^{\frac{83{,}1 - 20 \times \lg f}{-20}}\right)$
NOTE ELFEXT values at frequencies that correspond to measured FEXT values of greater than 70,0 dB are for information only.	

Table 14 - ELFEXT limits for a channel at key frequencies

Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
Minimum ELFEXT (dB)	63,3	39,2	23,3	15,3	9,3

The formulae of Table 14 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The formulae of Table 14 conform to the Class F requirements of ISO/IEC 11801(ED.2.0): 2002 .

6.6.2 Power sum ELFEXT (PSELFEXT)

The PSELFEXT for each pair of a channel should meet the limits computed, to one decimal place, using the formulae of Table 15. The limits shown in Table 16 are derived from the formulae at key frequencies only.

PSELFEXT of disturbed pair *k*, $\alpha_{PSELFEXT}(k)$, is computed from pair-to-pair $\alpha_{ELFEXT}(i,k)$ of the adjacent pairs *i*, *i* = 1...*n* as follows:

$$\alpha_{PSELFEXT}(k) = -10\lg\sum_{i=1,\, i\neq k}^{n} 10^{-0,1\alpha_{ELFEXT}(i,k)} \quad (5)$$

where αELFEXT (i,k) is the pair-to-pair ELFEXT of pair k to adjacent pair i

Table 15 - Formulae for PSELFEXT limits for a channel

Frequency MHz	**Minimum ELFEXT** dB
$1 \le f \le 500$	$-20\times\lg\left(10^{\frac{64,8-20\times\lg f}{-20}}+4\times10^{\frac{80,1-20\times\lg f}{-20}}\right)$
NOTE ELFEXT values at frequencies that correspond to measured FEXT values of greater than 70,0 dB are for information only.	

Table 16 - PSELFEXT limits for a channel at key frequencies

Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
Minimum PSELFEXT (dB)	60,3	36,2	20,3	12,3	6,3

The formulae of Table 15 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The formulae of Table 15 conform to the Class F requirements of ISO/IEC 11801(ED.2.0):2002 .

6.7 Power Sum alien NEXT (PSANEXT)

See 6.3.

6.8 Power sum alien FEXT (PSAFEXT)

ffs.

6.9 Propagation Delay

The propagation delay for each pair of a channel, measured – when required - according to IEC 61935-1, should be less than the limits computed using the formulae, to three decimal places, of Table 17. The limits shown in Table 18 are derived from the formulae at key frequencies only.

Table 17 - Formulae for propagation delay limits for a channel

Frequency MHz	**Maximum propagation delay** µs
$1 \le f \le 500$	$0,534 + 0,036/\sqrt{f} + 4\times0,002\,5$

Table 18 - Propagation delay limits for a channel at key frequencies

Frequency (MHz)	**1,0**	**16,0**	**100,0**	**250,0**	**500,0**
Maximum propagation delay (µs)	0,580	0,553	0,548	0,546	0,546

The formula of Table 17 represents an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The formula of Table 17 conforms to the Class F requirements of ISO/IEC 11801(ED.2.0): 2002 .

6.10 Delay Skew

The delay skew between all pairs of a channel, measured - when required - according to IEC 61935-1, should be less than the limits computed using the equation, to three decimal places, of Table 19.

Table 19 - Delay skew limits for a channel

Frequency MHz	**Maximum delay skew** μs
1< f <500	0,050 [a]
[a] Calculation is based upon 0,045 + 4 × 0,001 25	

The formula of Table 19 represents an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. The formula of Table 19 conforms to the Class F requirements of ISO/IEC 11801(ED.2.0):2002.

7 Components

Supplier's advice is needed for the additional requirement, interoperability, the handling and installation of the components.

8 Guidance for mitigation

8.1 Certification measurements and documentation

The certification measurement and the documentation of the channel in question should be in accordance with a quality plan as per IEC 61935-1.

Special care should be taken for the documentation of the 10GBASE-T installations.

8.2 Mitigation techniques if internal parameters from clause 6 are not met

Depending on the components used and the layout of the cable and components, some parameters will not be met. Supplier advice should be asked to improve this parameters.

Major failure sources:

- cables;
- connectors;
- cords;

Possibilities:

- use better categorised components;
- change the crossconnects to interconnects;
- replace the consolidation points with better specified components.

8.3 Mitigation techniques if external parameters from clause 6 are not met

8.3.1 General

Depending on the components used and the layout of the cable and components, some parameters will not be met. The most critical one are the power sum alien crosstalk (at the moment no standardised measurement procedure available). For channels which where re-qualified the manufacturer should be asked on mitigation technique or the following points should be taken. For new installation the manufacturer should be asked on installation techniques, planning and/or mitigation processes to fulfil the requirements of 10GBASE-T.

A careful planning of the electrical systems could be very helpful.

The following chapters are non finished possibilities to avoid or to improve power sum alien crosstalk.

8.3.2 Coupling Sources

To avoid noise coupling, distance between cables, or interrupting the coupling path between the cables, is a well known procedure. In a first step, the major coupling source has to be evaluated:

- patchcords
- distributors, outlets
- cable runs
- cable from same Category
- cable with an other Category
- other type of cables
- The fixed part (PL) and the changeable part of the cabling have be looked differently.

A differentiation of screened and unscreened systems is needed since they behave differently for external noise.

8.3.3 Screened cabling

Major coupling sources:

- connectors in the channel that are not individually screened (e.g. screened in groups);
- non-compliant screened cables and cords.

Possibilities:

- good braided cables and cords;
- improve the equipment cords;
- all connectors are individually screened, or separated in distance;
- for connectors screened in groups see 8.3.4

8.3.4 Unscreened cabling

Major coupling sources:

- patchcords
- distributors, outlets
- cable runs

Possibilities:

- use better categorised components;
- cords, keeping these unbundled and randomly organised.;
- improve the equipment cords; use of longer (may be screened) patchcords and mechanically randomising them. This may decrease the signal at the receiving end but because there is no coupling any more the noise will be attenuated, specially the high frequency AFEXT noise of short runs. Of course precautions are to be taken not to increase the insertion loss of the channel over the limit proposed in 6. As a rule of thumb anything less then 55m can handle the highest noise ;
- use an interconnect configuration to attach equipment rather than a cross connect;
- un-bundle and randomise the cabling within the telecommunications room;
- unbundling of the cabling (randomising, separation);
- choose non-adjacent channels for the 10GBASE-T application i.e. skip at patch panel;
- reduction of channel length;
- physical separation of all connectors in a channel (especially at the patch panel end, because at the TO 2 will probably be in one housing);
- if the connectors are grouped see 8.3.4
- separating in the horizontal long from short runs. This will probably be the best solution to decrease the short length high frequency AFEXT noise, (see 5.1)
- installing the cables not always with the same production direction;
- if metallic trays were used, cables should be physically separated to avoid AFEXT over this tray.

8.3.5 Grouped connectors

- When the connectors are grouped together under a common shield or no mechanical separation possible, (like in TOs) :
- Use different protocols like one 10GBASE-T and one telephone at Tos.
- Use the same procedure at the patchpanel separating physically 10GBASE-T transmissions

8.3.6 Example of a step by step mitigation procedure

In case there is not sufficient knowledge how to proceed in installed class E cabling try the following step by step procedure (mainly for unshielded cabling and ANEXT only).

Editors note: As cat6e is not mentioned in this TR all references are replaced by cat 7 as discussed in Ixtapa Other wording may be appropriate, please advice (The editor does not think that replacing a patchcord with a one with lower losses will be helpful, something else is probably meant).

This for remembering were it came from: The tried and tested procedural approach used in TSB95 is a good starting point for ANEXT mitigation in TSB155. (If ANEXT measurements are not standardised how can we ask to measure it?? Do we need to explain the 6 dB?? In Ixtapa we said more experience was necessary) now

1) Select 6 channels in the telecommunications room. Measure the ANEXT between each of these channels and all other channels in the same rack panel, and in the rack panels above and below it.
2) Calculate the power sum ANEXT for each of the 6 channels, based on the data from this channel to all other channels, as obtained from the step above.
3) Measure the insertion loss of all channels.
4) If any of the 6 channels does not meet the ANEXT requirement, mitigation is needed.
5) If the ANEXT negative margin is greater than 6 dB at any frequency between 1 to 500MHz, mitigation is not feasible. Limit the use of 10G in this telecommunications room to those channels of sufficiently short length, and low insertion loss, that the negative margin is less than 6 dB, and replace the other channels with better cabling.
6) Replace the patch cords, equipment cords, and work area cords with Category 7 cords, keeping these unbundled and randomly organised.
7) Use an interconnect configuration to attach equipment to the horizontal cabling rather than a cross connect.
8) Un-bundle and randomise the horizontal cabling in the telecommunications room up to the point it exits the telecommunications room. This will reduce coupling in the first 5 to 15 meters, which is the major source of ANEXT.
9) Choose non-adjacent class E channels for the 10GBASE-T application, i.e, skip patch panel positions. The “skipped” positions may be used for other applications. The use of 1000BASE-T in this other applications is under study by IEEE
10) Replace the interconnect or cross-connect with a Category 7 interconnect or cross-connect. The older cross-connect may be re-used for other applications.
11) Replace the consolidation point and telecommunications outlet connectors with Category 7 connectors.
12) Repeat steps 1-5 above to assure that mitigation has been successful, selecting different 6 channels on which to measure ANEXT.
13) Once the channels have been qualified for ANEXT, each channel needs to be further qualified for internal transmission parameters up to 500 Hz. If any channel fails these internal guidelines, the mitigation steps above need to be followed.

9 View into the future

In order to provide normative cabling specifications in support of 10GBASE-T, ISO/IEC 11801(ED.2.0): 2002 will require amendment and a new work item proposal has been accepted to start this work. For this, further definition of the channel specifications is required from IEEE and ISO/IEC will have to provide complete channel specifications together with component and link specifications. Completion may be expected in 2007 depending on the component standards.

521 **Bibliography**

522 ffs
523

Differences between this TR and TSB 155 from Document 3N731 as per Minutes of Ixtapa

- **No priorities no special order**
  - **Fist line :Technical report**
  - **Second line: Document 3N731**
- General 1:
  - Only extensions from ISO/IEC 11801
  - The text has two parts: extended cat 6 and new cat6e
- General 2:
  - Only Channels (class E, class F mentioned as conformant were appropriate)
  - Channels ,Pl and some components (like patchcords)
- Patchcords
  - 50% assumed as ISO/IEC 11801
  - 20% mentioned
- Insertion loss:
  - Insertion loss (I_l) one formula up to 500 MHz 4dB minimum
  - 2 formulas: one 1 to 250 MHz another250 up to 500 MHz jump at 250, no minimum value
- scaling 55-100m
  - Formulas for 55-100 m relating PSANEXT and insertion loss (I_l)
  - Technical identical, approach like 802.3 an Draft 1.2
- Exemption rules for Rl ant NEXT
  - Given as ISO/IEC 11801
  - No exemption rules mentioned
- Far end alien noise
  - AFEXT ffs
  - A**EL**FEXT ffs
- Shielding
  - Shielded and unshielded cabling as in ISO/IEC 11801
  - Unshielded

- Certification measurements:
  - not included, IEC referenced , certification margins not mentioned
  - and equipment included in full detail, margin for uncertainties mentioned but not included
- Mitigation techniques:
  - explained in detail
  - ffs
- Propagation Delay:
  - Formula
  - One value at 10 MHz
- Delay sqew:
  - 50ns 1 to 500 MHz
  - 50ns for cat6 cabling
- ELFEXT and PSELFEXT
  - One formula 1-500 MHz
  - 2 Formulas 1-250 MHz references TIA/EIA-568-B.2-1(not explicitly written) 250 –500 MHz formula different but probably the same values
- 55m channel insertion loss
  - scaled down 55%
  - same formula but as insertion loss is slightly different, different scaling results up to 250 MHz

Draft ISO/IEC JTC 1/SC 25/WG 3 N 752

Date: 2005-05-18

Replaces ISO/IEC JTC 1/SC 25/WG 3 N n/a

DOC TYPE:	**Collation of comments on Working draft**
TITLE:	**Collation of comments on WG 3 N 746 WD for ISO/IEC TR 24750: Guidelines for the support of 10GBASE-T over Copper Balanced Pairs of Class E and Class F as per ISO/IEC 11801(ED.2.0): 2002 and IEEE 802.3an**
SOURCE:	**Secretary of ISO/IEC JTC 1/SC 25/WG 3**
PROJECT:	**25.03.02.02-03**
STATUS:	**The WD has been distributed with WG 3 N 746. The comments received our collated in this document**
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DUE DATE:	**n/a**
REQUESTED:	**For information**
ACTION	**To the project editor with the kind request to draft resolutions to these comments.**
MEDIUM:	**Def**
No of Pages:	**15 (including cover)**

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Collation of comments on WG 3 N 746 WD for ISO/IEC TR 24750: Guidelines for the support of 10GBASE-T over Copper Balanced Pairs of Class E and Class F as per ISO/IEC 11801(ED.2.0): 2002 and IEEE 802.3an

E: editorial, G: general, T: technical

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
00	000	All	T	UK01	This standard has “guidelines” and not “requirements”.	Replace “shall” accordingly in all places e.g. line 229.	Reject TRs may contain shalls
00	000		G	Au9	General Comment -Document Good	More work on Mitigation techniques text	noted
00	000		G	Baranger	I do not agree with the extension of existing classes. Customer will not invest in a class that might be obsolete soon.	1 - Class E is proposed to be extended up to 500 MHz, to comply with US requirements of 10 GB/s on an UTP solution. We do not oppose on this proposal, which will help US market. 2 – Class F was offered to be extended from 600 MHz to 1000 MHz, or 1200 MHz. We note that, even this solution is useless for the proposed 10 Gbit/s model, the rational would have been to keep untouched this class F and to offer in the vote to the group to keep class F at 600 MHz. The preference of the group, which had a limited choice, was finally to 1000 MHz. After this vote, we had a bright demonstration (made by Henricus Koeman) that we do not know how to measure with an acceptable margin of error the parameters of the channel above 500 MHz. And above 900 MHz we are just in total uncertainty! So the idea to extend it has no technical base, and is just an intellectual game of Experts far from the final user. **Conclusion 1: THERE IS NO RATIONAL TO EXTEND THE EXISTING CLASS F.** **Marketing considerations:** Structured cabling is already very confusing and difficult to appreciate by a final Customer. Instead of confusing the market with various alternate classes, we suggest to the WG3 to create a new class G, from 600 to 1200 MHz, while we may forecast a future class H up to 2400 MHz, which is a	This comment may be misplaced as it rather fits to the intended amendment to ISO/IEC 11801

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
						good technical limit corresponding to satellite transmission needs. This class G will help the growth of class F; i.e. in public biddings, the choice will be oriented to the middle range solution which will be class F instead of class E now. **Conclusion 2: NEW CLASS G WILL HELP THE DEVELOPPEMENT OF CLASS F.**	
00	000	ALL	T	IL1	IEEE 802.3an has already published DRAFT 2.0	References to 802.3an and affected formulae throughout the document should be updated (i.e. PSANEXT, PSAELFEXT)	accept
00	000		G	DS2	The TR is outdated respect to IEEE	Update TR from IEEE D1.3 to D 2.0 as given by IEEE Liaison	accept
00	000		G	DS3	For Anoise it is not clearly mentioned that neither Field nor Lab measurements are standardised	Stress this issue more clearly in all pertinent chapters. e.g. clause 5	
00	000		G	ES1	The Spanish National Committee accepts this WD for ISO/IEC TR 24750 has no comments.		noted
01	000	Cover	E	US01	Please use document format and comment form that allows indicates LINE NUMBER	Edit accordingly	accepted
01	001	Title	E	US02	Erroneous	Fix later Remove “10GBASE-T” Replace IEEE 802.3an With “IEEE 802.3 PHY Type 10GBASE-T“ See US comment re intro	Accommodate with relevant reference to ISO/IEC 8802-3
01	001	2	T	DS1	The title of Project does not explain exactly what is done	Take CENELEC title as proposed by editor	Accommodate with accepting vPty4
01	001	Title	T	vPty4	The title of Project does not explain exactly what is done	Guidelines for the qualification and mitigation of installed cabling in order to support10 GBASE-T	accept
01	002	Title	G	SYS-1	IEEE 802.3an is the committee and 10GBASE-T is the application. This is a global change	Replace 802.3an with “proposed IEEE 10GBASE-T”	Accommodate with relevant reference to ISO/IEC 8802-3
05	110	Forward	E	US03	Line 110, Use latest draft identification	Currently this is 2.0	accept

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
06	111 ff	Introduction	T	FI01	The objective in line 120 is in contradiction with the general development of EMC standards. Class A is sufficient only for industrial environments. It also should be noticed that the CISPR limits of emission are not applicable for passive cabling.	Delete line 120.	Accept in principle and forward to IEEE as the signal shape and –level significantly influences radiation. Accommodate with a note that the objective is to meet Class a without shields, while shields will improve to class B
06	111 ff	Introd	T	vPty1	The introduction should describe clearly what can be expected from the document	Replace present introduction with Annex 1	accept
06	111 ff	Intro	T	IL2	SEE IL1 as per objectives of 802.3an	Update objectives without Class/length references	accept
06	112	Intro	E	UK02	112-113 Tidy up introductory text.	Replace first two lines with "IEEE 802.3an is being developed to support the operation of 10 Gigabit Ethernet over balanced cabling. This application will be known as 10GBASE-T."	
06	113	Intro	G	SYS-2	Need to use the correct name for the standard	From: This standard will be called IEEE 802.3an To: This standard will be called IEEE 10GBASE-T	Accommodate with ISO/IEC 8802-3: 10GBASE-T
06	114	Intro	E	UK03	114-125 It would be more instructive to *summarise* the relevant objectives, rather than extract them from early drafts. Specific lengths for Class E and Class F cabling have also been removed from the objectives in 802.3an D2.0.	Replace lines 114 to 125 with: "A summary of 10GBASE-T objectives relating to cabling is: Support copper media from ISO/IEC 11801 (Ed.2.0): 2002 with additional requirements for power sum alien crosstalk and all parameters defined up to 500 MHz. Support operation over 4 connector, 4-pair balanced cabling. Define a single 10 Gigabit PHY to support channels of 55m to 100m in length. To meet IEC CISPR 22 and FCC Part 15 Class A EMC requirements. To support a BER no greater than 10^{-12}."	Accommodate with accepting vPty1
07	128 ff	1		Bretaudeau	I would like to draw your attention on the fact that the scope of this document is not in line with its content. Actually, the title and the scope of this document deals with class E and F while the text only gives requirements on class E to support 10G.	I suggest to put in line the title and the scope of this document with its content.	Accommodate with accepting vPty4

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
07	143	3.1.1	G / E	UK04	The term “alien” is incorrect usage. According to the Compact Oxford English Dictionary it means: *belonging to a foreign country; unfamiliar and distasteful; (of a plant or animal species) introduced from another country and later naturalized; relating to beings from other worlds*. It is derived from the Latin “alienus” meaning foreign and does NOT mean external. Additionally, “alien” does not translate the correct meaning in many other languages. There has been a proposal to use the term “exogenous”. Whilst this is correct usage, it is not beneficial to non-English speakers to use more unusual words when there are simpler words available.	Replace “alien” by “external”, defining it as “coming or acting from outside the channel or part thereof”. Maintain abbreviations such as AFEXT and ANEXT, using the term ”alien”, for historical continuity. Add note to these abbreviations explaining this historical context and the use of “external” in the rest of the document. Replace “alien” by external in the rest of the document (cf. current title of clause 8.3).	Accept in principle
07	148	3.2	T	SYS-2	Need to define the parameters used in the document	Add acronym for PSAELFEXT : Power Sum Equal Level Far End Crosstalk	accept
07	156	4.1	E	UK05	156-167 Delete or rewrite sentence clearly in TR language		
07 f	156 ff	4	E	IL3	Lines156-167 – Not consistent with style used in Technical Reports	Rewrite	
08	161	4.1	E	SYS-3	Use “channel” consistently	Replace “material” with “channel”	
08	166	4.1	E	SYS-4	This sentence is superfluous. It does not provide any guidelines for any parameters.	Delete: “Here the supplier and installer play a major role”	
08	170 ff	5	T	vPty2		Add in the beginning: As other applications 10GBASE-T is sensitive to noise. The degree of sensitivity depends on the kind of noise. While 10GBASE-T uses the means of modern technology to compensate for the noise it imposes on itself by crosstalk from one pair to the other, it is more sensitive to noise coming from other sources. Alien crosstalk is the characteristics that is used to express the sensitivity of a cable to external influences.	Accept in principle, consider the word alien, see UK04
08	171	5	E	UK06	“Alien” is a typo.	Delete the word “Alien”.	accept

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
08	171	5	T	SYS-5	Crosstalk is noise within the same channel while alien crosstalk is noise coming from outside the victim channel.	Change: Alien crosstalk and power sum crosstalk are well defined in ISO/IEC 11801(ED.2.0): 2002 and relate to noise coming from the other pairs in the same channel. To: Crosstalk and power sum crosstalk are well defined in ISO/IEC 11801(ED.2.0): 2002 and relate to noise coming from the other pairs in the same channel.	Accept, see UK06
08	171	5	T	vPty3	Up to now alien crosstalk is not specified	Change: alien crosstalk and power sum, to: crosstalk and power sum	Accept, see UK06
08	177	5	T	UK07	Also well known for all existing versions of twisted pair Ethernet	Combine with previous para and replace "10BASE-T" with "existing versions of Ethernet over balanced cabling".	
08	182	5	E	UK08	Reference to 802.3an D1.2 is not necessary; the statement does not require qualification.	Delete reference.	
08	184	5	E	UK09	Spelling of "were"	Change to "where"	
08	184	5	E	IL4	Line 184: Misspelling	Change "were" to "where"	
08	188	5	E	UK10	Why is there a reference to ISO/IEC SC25 WG3?	Delete reference or elaborate as an editor's note.	
08	189	5	E	LCG-4	In the Figure 1, need to define the size of the text		
08	194	5	E	UK11	The NOTE is not necessary. PSAELFEXT limits are proposed by 802.3an D2.0 (see AVF15).	Delete NOTE.	
08	194	5	E	IL5	Line 194: SEE IL1	Delete note as DRAFT 2.0 contains the formulae	
09	195	6	T	UK12	195 – 392 Whilst it is the Channel that supports the application, the Channel may not always be in place (even on cabling that has already been installed). It may only be possible to test a Permanent Link. As in the current ISO/IEC 11801:2002, we should the option to "conform" against Permanent Link "requirements". This will also maintain harmonisation with the current TIA TSB-155 draft document.	Include Permanent Link" requirements" for all parameters. Use the information contained in 3N731 (or a later contribution if available) as a starting point.	
09	195	6	T	UK13	195 – 392 The documents transmission "requirements" need to align with the latest proposals in IEEE's 802.3an; in particular, their requirements for PSANEXT & PSAELFEXT - maximum and averaged across all 4 pairs.	Update according to latest IEEE 802.3an draft and also ensure all abbreviations and definitions are included.	
09	195 ff	6	T	IL6	Lines 195-392: SEE IL1	Update transmission requirements as per DRAFT 2.0	

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
09	195 ff	6	T	IL7	Lines 195-392: Only channels are noted	Permanent link requirements are also necessary and should be included using most up to date contributions available	
09	197	6	E	vPty5	The minimum requirements of 10GBASE-T are still under consideration in IEEE	Add a note, that these values are still under development in dialogue with IEEE 802.3	accept
09	197	6.1	E	UK14	Delete *our*	… are specified	
09	197	6.1	E	IL8	Line 197	Delete “our”	
09	197	6.1	G	SYS-6	Typo. Also “channel requirements” should be changed to “channel guidelines”. This is a global change (e.g. Title of clause 6, line 195)	Change: In this clause the minimum channel requirements are our specified. To: In this clause the minimum channel guidelines are specified.	
09	200	6.1	E	UK15	Spelling of “cause”	Change to “clause”	
09	202	6.1	T	SYS-7	Cannot have new additional requirements for installed cabling that was not designed for these new parameters. Can have guidelines that some of the installed cabling may meet to support 10GBASE-T	Change: additional requirements for: To: Additional guidelines for:	
09	204	6.1	T	UK16	PSAELFEXT which is more important than PSAFEXT	Replace PSAFEXT with PSAELFEXT	
09	205	6.1	T	SYS-8	Cannot have new additional requirements for installed cabling that was not designed for these new parameters. Can have guidelines that some of the installed cabling may meet to support 10GBASE-T	Change: specified To: included	
10	000	6.3.1	G	IL9	This is a TR - replace all occurrences of “shall”	“should”	
10	195 ff	6	G	DS4	AFEXT is now to be added, as there is also a Noise to IL requirement as for ANEXT	Rearrange clause 6 to have Anoise presented properly.	
10	225	6.2	T	UK17	225-226 The formulae of table 1 do not conform to Class F requirements but they are met by them.	Change “conform to” to “is compatible with”.	
10	227	6.3	G	LCG-1	Insertion loss and alien crosstalk. Add the abbreviation	Replace “Insertion loss and alien crosstalk (IL)	accept
10	229	6.3.1	T	SYS-9	Cannot have new additional requirements for installed cabling that was not designed for these extended frequencies. Can have guidelines that some of the installed cabling may meet to support 10GBASE-T	Change: shall not exceed To: should not exceed	
10	232	6.3.1	E	UK18	Add in the testing doc reference	Replace xx?? with IEC 61935-1	

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
10	237	6.3.1	T	IL10	Line 237: Just as in Return loss, the "3dB rule" is relevant for insertion loss	Insert: Values of insertion loss at frequencies for which the measured channel insertion loss is below 3,0 dB are for information only.	
10	238	6.3.1	T	UK19	238-239 The formula of table 3 does not conform to Class F requirements but it is met by them.	Change "conform to" to "is compatible with".	
11	253	6.3.1	E	LCG-5	Centre the information in the table 6		
11	257	6.3.2	T	SYS-10	Table 5 is the PSANEXT guideline and Table 6 is information at key frequencies. To further elaborate on the information in Table 6 with examples of reference implementations is unnecessary and does not cover many other possible examples. If such examples are shown, we will have to show them for other parameters as well. We should not make PSANEXT into a "special" parameter and treat it differently from other parameters such as IL, RL, NEXT, ELFEXT, etc.	Delete section 6.3.2	
11	260	6.3.2	G	LCG-6	Need to define the use of Cat 6 or Cat6		
11	271	6.4.1	E	UK21	Delete "□ Next"	Delete "□ Next"	
11	271		E	Au1	" [] NEXT" is redundant text	Typo -delete	
12	282	6.4.1	T	SYS-11	Need to make it clear that the extension of Class E from 250 MHz to 500 MHz is a guideline not a requirement	Change: The formulae of Table 7 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. To: The formulae of Table 7 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 to guidelines from 250 MHz to 500 MHz in order to support 10GBASE-T.	
12	283	6.4.1	T	UK22	283-284 The formulae of table 7 do not conform to Class F requirements but they are met by them.	Change "conform to" to "is compatible with".	
13	300	6.4.2	T	SYS-12	Need to make it clear that the extension of Class E from 250 MHz to 500 MHz is a guideline not a requirement	Change: The formulae of Table 9 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. To: The formulae of Table 9 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 to guidelines from 250 MHz to 500 MHz in order to support 10GBASE-T.	

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
13	301	6.4.2	T	UK23	301-302 The formulae of table 9 do not conform to Class F requirements but they are met by them.	Change “conform to” to “is compatible with”.	
13	314	6.5.1	T	SYS-13	Change requirements to guidelines to make it clear that all the new parameters and extended frequency performance are guidelines and not additional requirements for installed Class E cabling	Change: The ACR requirements should be met at both ends of the cabling To: The ACR guidelines should be met at both ends of the cabling	
13	317	6..5.1	T	SYS-14	Need to make it clear that the extension of Class E from 250 MHz to 500 MHz is a guideline not a requirement	Change: The formulae of Table 11 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. To: The formulae of Table 11 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 to guidelines from 250 MHz to 500 MHz in order to support 10GBASE-T.	
13	318	6.5.1	T	UK24	318-319 The limits of table 11 do not conform to Class F requirements but they are met by them.	Change “conform to” to “is compatible with”.	
13	328	6.5.2	T	SYS-15	Change requirements to guidelines to make it clear that all the new parameters and extended frequency performance are guidelines and not additional requirements for installed Class E cabling	Change: The PSACR requirements should be met at both ends of the cabling To: The PSACR guidelines should be met at both ends of the cabling	
14	331	6..5.2	T	SYS-16	Need to make it clear that the extension of Class E from 250 MHz to 500 MHz is a guideline not a requirement	Change: The formulae of Table 12 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. To: The formulae of Table 12 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 to guidelines from 250 MHz to 500 MHz in order to support 10GBASE-T.	
14	332	6.5.2	T	UK25	332-333 The limits of table 12 do not conform to Class F requirements but they are met by them.	Change “conform to” to “is compatible with”.	
14	334	6.6	G	LCG-2	ELFEXT. Add the definition	Replace “Equal level far end crosstalk (ELFEXT)”	

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
14	351	6..6.1	T	SYS-17	Need to make it clear that the extension of Class E from 250 MHz to 500 MHz is a guideline not a requirement	Change: The formulae of Table 14 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. To: The formulae of Table 14 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 to guidelines from 250 MHz to 500 MHz in order to support 10GBASE-T.	
14	352	6.6.1	T	UK26	352-353 The formula of table 13 does not conform to Class F requirements but it is met by them.	Change “conform to” to “is compatible with”.	
15	367	6..6.2	T	SYS-18	Need to make it clear that the extension of Class E from 250 MHz to 500 MHz is a guideline not a requirement	Change: The formulae of Table 15 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. To: The formulae of Table 15 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 to guidelines from 250 MHz to 500 MHz in order to support 10GBASE-T.	
15	368	6.6.2	T	UK27	368-369 The formula of table 14 does not conform to Class F requirements but it is met by them.	Change “conform to” to “is compatible with”.	
15	370	6.7	G	LCG-3	Power Sum alien NEXT (PSANEXT). Need to define the use of capital letter.	Replace “Power sum alien NEXT (PSANEXT)”	
15	371	6.8	E	UK28	Reference should be more specific.	Replace “6.3” with “See 6.3.2”.	
15	372	6.8	T	UK29	PSAELFEXT which is more important than PSAFEXT	Replace Power sum alien FEXT (PSAFEXT) with Power sum alien equal level FEXT (PSAELFEXT)	
15	373	6.8	T	UK30	Need to add IEEE 802.3an PSAELFEXT requirement	PSAELFEXT = (50.9+IL(250)/2.29 – 10* log (IL(250)/35.9 – 20*log(f/100)	
15	373	6.8	E	UK31	Needs appropriate reference.	Replace “ffs” with “See 6.3.3”.	
16	000	8.2	T	IL11	The TR is intended to provide guidance supporting an application which therefore should be media (cable construction) independent	Do not differentiate between screened and unscreened cables. Lines specifying differences should be deleted or unified	
16	382	6..9	T	SYS-19	Need to make it clear that the extension of Class E from 250 MHz to 500 MHz is a guideline not a requirement	Change: The formulae of Table 17 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. To: The formulae of Table 17 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 to guidelines from 250 MHz to 500 MHz in order to support 10GBASE-T.	

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
16	383	6.9	T	UK32	383-384 The formula of table 19 does not conform to Class F requirements but it is met by them.	Change “conform to” to “is compatible with”.	
16	390	6.10	T	SYS-20	Need to make it clear that the extension of Class E from 250 MHz to 500 MHz is a guideline not a requirement	Change: The formulae of Table 19 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 in order to support 10GBASE-T. To: The formulae of Table 19 represent an extension to the Class E requirements of ISO/IEC 11801(ED.2.0): 2002 to guidelines from 250 MHz to 500 MHz in order to support 10GBASE-T.	
16	394 ff	7	T	vPty6	The present advise is not sufficient especially in case the different components came from different sources without a system integrator taking responsibility for the channel design	Add new text: 7.1 General In cases where the channel design and the characteristics of the components used are known for the whole frequency range up to 500 MHz it may be more efficient to check whether the channel could meet by its design meet the minimum performance specified in clause **Fehler! Verweisquelle konnte nicht gefunden werden.** before any measurements are undertaken. For the ease of such design checks this clause provides the minimum characteristics for components needed for channels with a length of 55 m and 100 m. 7.2 Minimum performance for cabling components Add tables for minimum performance of cables and connectors for the above channel lengths	consider
16	394	7	E	UK33	394-395 This sentence makes no sense	Reword to clarify	
16	396	New8	T	vPty7	Differentiate measurement and mitigation	Add new clause: 8 Guidance for measurement this clause specifies efficient ways to determine whether a channel installed would support 10GBASE-Tas it is or whether it is likely to do so after mitigation. Add appropriate measurement references and minimum values that should be available before mitigation is started.	

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
16	398	8.1	E	UK34	398 – 401 Delete, as unnecessary.	Replace by "The test procedures for balanced cabling installations are specified in IEC 61935-1." as per existing ISO/IEC 11801:2002.	
16	401	8.1	E	UK35	Special care – in what respect	Reword to show intent of clause	
16	402	8.2 – 8.3	T	UK36	402 – 514 It is detrimental to the standard to highlight "unscreened" and "screened". There is no need to differentiate. Application support is independent of this sub-division of media type. The coupling sources are the same, and do not need to repeat clause 8.3.2. The "improvements" need to generalised for all balanced cabling. It is not necessary to repeat in the mitigation procedure example that which has already been detailed in the current clauses 8.3.3 to 8.3.5.	Delete lines 434 and 435. Delete lines 437 to 439, and 446 to 449. Combine lines 440 to 444 and 450 to 474. Consider combining clauses 8.3.3 to 8.3.6 into a single, coherent and logical set of mitigation techniques. It is not necessary to "order" the process; it is more useful, and sufficient, to "order" the mitigation steps in terms of benefit in improving cabling performance.	
16	402	8.2	E	UK37	402-404 Title unclear.	Change "internal" to "in-channel" and list relevant parameters in introductory text.	
16	403	8.2	E	UK38	403-404 This sentence makes no sense	Reword to clarify	
16	403 ff	8.2	T	vPty8		Add an Introduction "This clause specifies the magnitude of the improvement that can be achieved with help of mitigation in order to determine those channels that may be upgraded to support 10GBASE-T, as well as the mitigation techniques to achieve these improvements. " and Appropriate specific information.	
16	403	8.2	E	UK39		Delete 403- 408	
16	403	8.2	E	SYS-21	Improve wording	From: Depending on the components used and the layout of the cable and components, some parameters will not be met. Supplier advice should be asked to improve this parameters. To: Depending on the components used and the layout of the cable and components, the performance guidelines for some parameters may not be met. Suppliers should be consulted to improve the performance of these parameters.	
16	410	8.2	E	UK40	"better categorised components" is unclear.	Change "better categorised components" to "components with higher Category".	
17	413	8.3	E	UK41	Title unclear.		
17 f	413 ff	8.3	T	IL12	SEE IL11		

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
17	416	8.3.1	E	UK42		Change “one are the” to “one is”	
17	416	8.3.1	T	UK43	416-417 Why specify a parameter for which there is no agreed measurement method	Make editors note	
17	416		E	Au2	Poor English Expression	Change to read “ The most critical ones”	
17	417	8.3.1	E	UK44		Change “where” to “were”	
17	417	8.3.1	E	UK45	416-423	Reword to clarify	
17	418		E	Au3	Poor English Expression	Change to read “should be asked for”	
17	422		E	Au4	Poor English Expression	Add the words “unfinished’	
17	424	8.3.2	E	UK46	422-435	Reword to clarify	
17	441	8.3.3	T	UK47	Good braided cords? Implies that non-braided cords are not good?	Improve screening performance?	
17	444	8.3.3	E	UK48	Wrong clause reference	Replace 8.3.4 with 8.3.5	
18	451	8.3.4	E	UK49	“better categorised components” is unclear.	Change “better categorised components” to “components with higher Category”.	
18	453	8.3.4	T	SYS-22	Mixing of unscreened and screened cabling components is not a good idea since this will cause the end to end continuity of the screen to be compromised and result in degraded channel balance performance, which is not good for applications like 10GBASE-T	Delete: (may be screened)	
18	465	8.3.4	E	UK50	Wrong clause reference	Replace 8.3.4 with 8.3.5	
18	468	8.3.4	G	UK51	Query the meaning of this sentence		
18	473	8.3.5	E	UK52	Wrong letter case	Replace Tos with TOs	
18	474	8.3.5	E	UK53	Space between patch and panel	… patch panel ..	
18	476	8.3.6	T	UK54	476-514 As step 1 is difficult (or perhaps impossible) to achieve in the field the rest of this advise seems at best hopeful if not seriously flawed	Make all this text an editors note	
19	241	6.3	E	UK20	Need to introduce a separate subclause for PSANEXT.	Change title of 6.3.1 to insertion loss Create new 6.3.2 PSANEXT and be ready for new subclause 6.3.3 PSAELFEXT	
19	396 ff	8	G	DS5	In mitigation there is mentioned that for ANEXT the most coupling happens at the firsts 10m and by unbundling this cables the problem is reduced drastically	Explain clearly that the issue is different. The most coupling happens at the first 10 m, unbundling just moves the coupling further on. The main effect is the high frequency attenuation (twice) of the signal till the coupling starts.	
19	396 ff	8.	G	DS6	The TR is now from mid march, there may be new findings on mitigation	Input any new findings on Mitigation	

Page	Line	Clause	E/G/T	ID	Comment	Proposed change	Observation of the Secretary
19	475 ff	8.3.6	T	DS7	This clause is old now	This clause needs to be updated for AFEXT and better references to higher quality cables	
19	478		E	Au5	Inconsistent use of terminology	Change to read “Category 6e” and “Category 7”	
19	496	8.3.6	T	UK55	*Category 7* should be replaced by better alien crosstalk performing	… with better alien crosstalk performing cords	
19	496	8.1	T	SYS-23	Implementation error by changing the original contribution submitted by the US	From: Category 7 cords To: Augmented category 6 cords	
19	503		E	Au6	Inconsistent use of terminology	Change to read “Class E”	
19	506	8.3.6	T	UK56	*Category 7* should be replaced by better alien crosstalk performing	… with better alien crosstalk performing interconnect or cross-connect	
19	506	8.1	T	SYS-24	Implementation error by changing the original contribution submitted by the US	From: Category 7 interconnect or cross-connect To: Augmented category 6 interconnect or cross-connect	
19	508	8.3.6	T	UK57	*Category 7* should be replaced by better alien crosstalk performing	… with better alien crosstalk performing connectors	
19	508	8.1	T	SYS-25	Implementation error by changing the original contribution submitted by the US	From: Category 7 connectors To: Augmented category 6 connectors	
19	515	9	G	UK58	515-520 This clause is outside of the scope of this TR.	Delete and if necessary explain status of IS11801 in Introduction.	
19	515 ff	9	G	IL13	Lines 515-520: Not in the scope of this TR	Delete	
21	526		E	LCG-7	Fist line:	First line	
21	530		E	Au7	Inconsistent use of terminology	Change to read “Category 6”	
21	532		E	Au8	Inconsistent use of terminology	Change to read “Class” i.e. use a capital C	
22	524 ff		T	DS8	This comparison was here because of Ixtapa	Delete comparison , it is outdated now	
22	561		E	LCG-8	Delay sqew	Delay skew	

Annex 1 - Introduction

Even before ISO/IEC 11801, generic cabling for customer premises, was first published in 1995 it was used to provide customer premises with a generic communications infrastructure. In order to meet its objective to specify an infrastructure that was anticipated to have a usable life in excess of 10 years at the time it was installed the standard has undergone revisions since it’s first edition. During this process existing channel specifications have been upgraded and new channels have been developed that exploited the advances in component technology and anticipated the requirements of future applications.

10 Gigabit Ethernet over balanced cabling (10GBASE-T) is one of these applications that is supported by class F channels, first published in 2002, although the standard does not explicitly specify all the characteristics this application is sensitive to. Also channels that where installed before

publication of ISO/IEC 11801:2002 and channels marked class E may be usable for this application for a number of reasons: the channels are shorter than 100 m, the material used exceeded the minimum requirements for the channel as specified by ISO/IEC 11801 at that time.

This technical report provides guidance whether an installed channel that is not marked as class F according to ISO/IEC 11801:2002 would support 10GBASE-T and how the channel the performance of which comes near to the minimum requirements for 10GBASE-T can be improved to the point where the application is supported.

This technical report takes into account the design goals for 10GBASE-T like:

- frequency range up to 500 MHz;
- meet CISPR Class A EMC limits;
- support a BER of 10^{-12}.
- cope with the maximum power sum alien crosstalk of ??.
- support operation over 4- connector, four- pair balanced copper cabling

It is expected that the following cabling channels will support 10GBASE-T using a single 10 Gbit/s PHY:

channels of at least 100 m category 7:2002 balanced copper cabling

channels of at least 55 m, under specific conditions up to 100 m, implemented with balanced copper cables marked as category 6:2002.

Since 10GBASE-T will include new transmission technologies, new parameters are needed to qualify channels for 10GBASE-T. The following topics are of relevance to the generic cabling.

- frequency range up to 500 MHz;
- power sum alien crosstalk.