ETSI EG 202 192 V1.1.2 (2004-11)

ETSI Guide

Speech Processing, Transmission and Quality Aspects (STQ); Comparison of PBX transmission requirements in ANSI/TIA-464-C and ETSI ES 201 168 V1.2.1



Reference

2

DEG/STQ-00039

Keywords

digital, transmission

ETSI

650 Route des Lucioles F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C Association à but non lucratif enregistrée à la Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from: <u>http://www.etsi.org</u>

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services: <u>http://portal.etsi.org/chaircor/ETSI_support.asp</u>

Copyright Notification

No part may be reproduced except as authorized by written permission. The copyright and the foregoing restriction extend to reproduction in all media.

> © European Telecommunications Standards Institute 2004. All rights reserved.

DECTTM, **PLUGTESTS**TM and **UMTS**TM are Trade Marks of ETSI registered for the benefit of its Members. **TIPHON**TM and the **TIPHON logo** are Trade Marks currently being registered by ETSI for the benefit of its Members. **3GPP**TM is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.

Contents

Intelle	ectual Property Rights	4
Forew	vord	4
Introd	luction	4
1	Scope	5
2	References	5
3	Abbreviations	6
4	Reference model	6
5	Requirements	7
5.1	Loss and loss - related parameters	8
5.1.1	Port to port insertion loss	
5111	Insertion loss ranges and variations	Q
5117	Digital nad disabling	
512		
5.1.2	requency response	12
5.1.2.1	Comparison of both definitions of frequency response	
5.1.2.2	2 Analogue to digital/digital to analogue	
5.1.3	Levels	14
5.1.3.1	Comparison of both definitions of interfaces levels	14
5.1.3.2	2 Interface levels	14
5.1.3.3	B Level tracking: tracking error	
5.1.3.4	Level tracking: overload compression	
5.1.3.5	5 Signal levels	
5.1.4	Hybrid balance	
515	Input impedance	18
516	Fcho loss	
517	Stability loss	
5.1.7	Voice impeirment perspectars	
5.21	Noise	
5.2.1	Noist	
5.2.1.1	weighted holse	
5.2.1.2	2 5-KHZ Hat noise	
5.2.1.3	Single frequency noise	
5.2.1.4	Spurious out of band signals	
5.2.2	Balance	
5.2.2.1	Longitudinal balance	
5.2.2.2	2 Transverse balance	
5.2.3	Crosstalk	23
5.2.4	Distortion	23
5.2.4.1	Quantization distortion	23
5.2.4.2	2 Single frequency distortion	
5.2.5	Delay	
5.3	Loudness levels	
54	Other impairment narameters	25
541	Intermodulation distortion	25
542	Group delay distortion	
5.4.2	Impulse noise	20 74
54.5	Impuise noise Littor	20 24
J.4.4	Jilli	
5.4.5		
5.4.6	Phase hit	
5.4.7	Dropout	27
Anne	x A (informative): Bibliography	28
Histor	ry	

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards", which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

4

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This ETSI Guide (EG) has been produced by ETSI Technical Committee Speech Processing, Transmission and Quality Aspects (STQ).

The present document is a Telecommunications Systems Bulletin (TSB), jointly produced by:

- Telecommunications Industry Association (TIA) Subcommittee TR-41.1, Multiline Telecommunications Systems (MLTS); and
- European Telecommunications Standards Institute (ETSI) Technical Committee (TC) Speech processing, Transmission and Quality aspects (STQ).

The document is being published as a TIA TSB-147 and as an EG. The document is not an industry standard and compliance to its contents is voluntary. The document compares corresponding Private Branch eXchange (PBX) transmission requirements in TIA and ETSI standards to be considered when developing equipments or standards intended for global application.

ETSI has granted TIA permission to use copyrighted material from ES 201 168 [8], in the TIA TSB-147. Likewise, TIA has granted ETSI permission to use copyrighted material from ANSI/TIA-464-C [7], in the present document.

Introduction

Over the last decade, continuing telecommunications improvements have brought the continents closer together - digital signalling allows calls to be established in less than a second and digital transmission has improved voice quality. Such changes have made it convenient to call anywhere in the world without a thought being given to past difficulties in completing such calls with acceptable transmission quality.

These improvements have made it possible for multi-national companies to efficiently conduct business in a real-time environment and to be able to efficiently design and produce world-wide products. This gives impetus to international telecommunications equipment suppliers and users of such equipment to consider the differences in transmission requirements of PBX systems that are manufactured for different world marketplaces.

The present document provides a comparison of North America and European PBX standards with the goal of creating maximum commonality for serving the global PBX marketplace, while recognizing the existence of differences in regional telecommunications environments, regulatory practices, geographic constraints, and customer expectations. Technical differences between the TIA and PBX standards are identified and rationalized.

1 Scope

The present document compares, in an orderly manner, like transmission requirements in ANSI/TIA-464-C [7] and those in ES 201 168 [8].

Since only the PBX transmission requirements in ANSI/TIA-464-C [7] and ES 201 168 [8] are compared, it is necessary to examine relevant portions of the scope of each of these standards to gain an overall idea of the scope of the comparison. ES 201 168 [8] provides transmission requirements while ANSI/TIA-464-C [7] provides transmission requirements as well as other PBX parameters, e.g. signalling and supervision. All appearance of ANSI/TIA-464-C [7] in the present document includes ANSI/TIA-464-C-1 [7].

The following table is an overview comparison of the two documents:

	ANSI/TIA-464-C	ES 201 168
SCOPE	Digital PBX	Digital PBX with test point
TRAFFIC	3,1 kHz voice	3,1 kHz voice
CODING (at interface to network)	μ-law	A-law
Measurement	Port-to-port (full-channel)	Port-to-test point (half-channel)
INCLUDES (interfaces):		
Analogue	Yes	Yes
Digital	Yes	Yes
Cordless	No	Yes
Loud-speaking (hands-free)	No	No
Proprietary sets	Yes	Yes
Non-transmission requirements	Yes	No
Test methods for compliance	No	Yes

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

ITU-T Recommendation G.122 (1993): "Influence of national systems on stability and talker echo [1] in international connections". ITU-T Recommendation G.711 (1988): "Pulse code modulation (PCM) of voice frequencies". [2] ITU-T Recommendation G.712 (2001): "Transmission performance characteristics of pulse code [3] modulation channels". [4] ITU-T Recommendation O.41 (1994): "Psophometer for use on telephone-type circuits". [5] ITU-T Recommendation Q.551 (2002): "Transmission characteristics of digital exchanges". [6] ETSI TR 101 802 (V1.1.1): "Speech processing, Transmission and Quality Aspects (STQ); The Concept of Relative Levels". [7] ANSI-TIA-464-C-2002: "Telecommunications - Multiline Terminal Systems - Requirements for PBX Switching Equipment".

[8]	ETSI ES 201 168 (V1.2.1): "Speech processing, Transmission and Quality Aspects (STQ); Transmission characteristics of digital Private Branch eXchanges (PBXs) for interconnection to private networks, to the public switched network or to IP gateways".
[9]	ANSI/TIA-968-A-2002 and ANSI/TIA-968-A-1-2003: "Telecommunications - Telephone Terminal Equipment - Technical Requirements for Connection of Terminal Equipment to the Telephone Network".
[10]	ANSI T1.508-2004: "Network Performance - Loss Plan for Evolving Digital Networks".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAL(A)	Analogue Access Line - Analogue connection to analogue or digital Central Office
AAL(D)	Analogue Access Line - Digital connection to an analogue Central Office
ATT	Analogue Tie Trunk - Private network connection to a remote PBX
DAL	Direct Access Line - Digital connection to a digital Central Office or another PBX
DGS	DiGital Station (telephone)
DID	Data IDentifier
DMW	Digital MilliWatt
ERL	Echo Return Loss
FCC	Federal Communications Commission
FEXT	Far End Cross Talk
GoS	Grade-of-Service
K2	Analogue 2-wire trunk interface to analogue PSTN access line
KD	Digital trunk interface to digital PSTN access line
L2	Analogue 2-wire extension interface
LCL	Longitudinal Conversion Loss
LD	Digital line interface to ISDN compatible TE
M2	Analogue 2-wire tie-line interface
M4	Analogue 4-wire tie-line interface
MD	Digital tie-line interface
MS	Specific (non-analogue) tie-line interface
NL	Nominal Loss
OLR	Overall Loudness Rating
ONS	Line interface to on-premises station
OPS	Line interface to Off-Premises Station
qdu	quantizing distortion unit
RED	Relative Envelope Delay
RLR	Receive Loudness Rating
SLR	Send Loudness Rating
TBRL	Terminal Balance Return Loss
TE	Terminal Equipment
ZLP	Zero Level Point

4 Reference model

Each of the documents in this comparison specifies the interfaces to which the PBX can connect and make connections between. An understanding of these interfaces is integral to the proper interpretation and application of the transmission requirements being compared.

Figure 1 presents a simplified model of the PBX interfaces in terms of the ETSI interface designations. The correspondence to TIA interface designations is shown in the figure. Note that there is no ETSI designation for an Off-Premises Station interface; thus the TIA designation is used for that interface.





5 Requirements

On the following pages, the corresponding requirements in each document are referenced and then compared side-by-side. This is followed by an analysis of the comparison where applicable. Additional sheets provide tables, figures, and background explanation for specific requirements.

7

5.1.1 Port to port insertion loss

	ANSI/TIA-464-C		ES 201 168			
6.2.3	Insertion loss criteria for PBX	3.1.5	Transmission loss			
6.2.5	PBX loss ranges	5.2.1	Nominal transmission loss (analogue interfaces)			
Table 12	PBX loss plan	6.2	Nominal transmission loss (digital interfaces)			
		7.2	Nominal transmission loss (system specific			
			MS interfaces)			
		9.2	Transmission loss between interfaces			
		Clause A.4	I.2: Measurements			
The insertion	on loss is specified as port-to-port loss between PBX	Nominal transmission loss NL is defined as the difference between				
interfaces a	and loss ranges.	relative input level L _i of one port and the relative output level L _o of				
Requireme	nts are formatted in a loss plan matrix; each matrix cell	the other p	ort in a connection, including the loss SL of a digital			
defines the	nominal insertion loss in dB for both directions of	$NL = L_i - L$	$_{0}$ + SL where L _i and L ₀ are in dBr referenced to 0 dBr.			
transmissio	n. Table 1 gives the PBX loss plan for connections.	The values for L _i and L _o must be stated by the supplier.				
Conditions:						
Measured a	at 1 004 Hz (nominal) with both source and measuring	Conditions	:			
instruments	s at 600 Ω impedance.	Measured at 1 020 Hz (nominal) with a test level of -10 dBm0				
	·	(clause A.4.2).				

8

Analysis: In ETSI, neither the port-to-port loss nor the allocation of loss is specified. However, the port-to-test point loss must be stated by the supplier on the basis of input/output levels. These losses are in many cases subject to national requirements, which differ from country to country on the signal levels at the point of connection to the PSTN while maintaining a harmonized requirement at the point of connection to the ISDN.

In TIA, the port-to-port-losses for PBXs were developed based on the loss plans for public and private networks. The PBX loss plan is intended to provide satisfactory Grade-of-Service (GoS) performance and compatibility with the public and private network loss plans. The following assumptions were the prime considerations:

- 1) The transmission loss and level plan of the PSTN, which is primarily an all-digital network with some fixed loss as described in ANSI T1.508-2004 [10], forms a basis for the private network loss plan.
- 2) Digital end offices insert 6 dB of loss, as described in ANSI T1.508-2004 [10], in the receive direction of analogue access lines to ensure network stability and echo control.
- 3) Transmission facilities to be used have losses compatible with the PBX port-to-port losses.
- 4) PBX port-to-port losses associated with analogue interfaces apply to any trunks with analogue terminations at the PBX.
- 5) PBX port-to-port losses associated with digital interfaces apply to any trunks with digital terminations at the PBX.
- 6) Non-proprietary PBX stations have the following loudness ratings:

Station	SLR	RLR
OPS (see note 1)	8	-3
ONS (see note 2)	4	-7
DGS (see note 3)	8	2

- NOTE 1: The OPS (Off-Premises Station) ratings are representative of 2 500-type sets operating on 26 gauge/2,75 km loops with normal 48 V battery feed and 600 Ω termination, as measured at a VG OPS port. See annex E of ANSI/TIA-470.110-C for further details.
- NOTE 2: The ONS (On-premises Station) ratings are representative of 2500-type sets operating on very short loops with the typical current-limited battery feed and 600 Ω termination of VG ONS port. See annex E of ANSI/TIA-470.110-C for further details.

NOTE 3: The DGS (digital station) ratings are chosen to improve interoperability with the ITU-T standard SLR/RLR levels for digital sets of 8 and 2. See ANSI/TIA-810-A for further details.

			Α	В	С	D	E	F	G
			ONS	OPS	DGS	DAL	AAL(A)	AAL(D)	ATT
		Loss	\uparrow						
1	ONS	\rightarrow	12	9	3	3	3	6	9
2	OPS	\rightarrow	9	6	0	0	0	0	3
3	DGS	\rightarrow	9	6	0	0	0	3	3
4	DAL	\rightarrow	9	6	0	0	0	3	3
5	AAL(A)	\rightarrow	0	0	-6	-6	0	0	0
6	AAL(D)	\rightarrow	3	0	-3	-3	0	0	0
7	ATT	\rightarrow	6	0	0	0	0	0	0
NOTE 1: The units for all loss values are dB.									
NOTE 2: Losses have been selected as multiples of 3 dB, in the assumption that this may make implementation easier.									

Table 1: ANSI/TIA-464-C PBX loss plan

5.1.1.1 Insertion loss ranges and variations

	ANSI/TIA-464-C	ES 201 168			
6.2.5 Table 15	PBX loss ranges TIA-968-A allowable net loss between ports	5.2.1	Nominal transmission loss (all analogue interfaces)		
Table 16	ANSI/TIA-464-C-2002 [7] recommended net loss between ports	6.2 7.2	Nominal transmission loss (all digital interfaces) Nominal transmission loss (system specific MS		
Table 17	Difference between TIA-968-A [9] and ANSI/TIA-464-C-2002 [7] port loss		interfaces)		
The port-to nominal va	p-port losses in table 1are the recommended alues.	Loss variations is the difference between actual measured and the nominal input/output transmission loss as stated by the supplier. This difference can be interpreted as the			
Although t with these fall within table 1.	here are no mandatory loss ranges associated values, it is desirable that the average 1 kHz loss ±0,5 dB of the nominal loss values given in	permitted tolerance due to design tolerances, cabling and adjustment increments. The values shall lie in the range: -0,35 dB to +0,35 dB for analogue interfaces; -0,15 dB to +0,15 dB for digital interfaces.			
Tables 2 to loss values defined po	o 4 provide a cross reference from the table 1 s to the equivalent limits for the TIA-968-A [9] orts.	Conditions: The values are referred to input or output half-connection losses only and not to port-to-port connections.			
Table 3 sh ANSI/TIA- between th	ows the losses recommended in 464-C-2002 [7], and table 4 shows the difference ne allowable and recommended losses.				

Analysis: The TIA desired nominal values are shown in table 1, however a PBX may have a declared nominal value within the TIA range quoted above. The tolerance in clause 5.1.1.1 is applied to the declared nominal value. However, depending on allocation between input and output ports, meeting TIA connection requirements do not guarantee meeting ETSI half-channel requirements.

It should be noted that a number of analogue connections have a zero tolerance between the table 1 values and the ANSI/TIA-968-A [9] requirements.

Care should be taken to ensure that no analogue connection violates the ANSI/TIA-968-A [9] section 4.5.2.5 for allowable net amplification between ports. In general this is achieved by offsetting the nominal loss by amount equal to the maximum expected component tolerance and measurement error.

The recommended losses are based on a desirable port-to-port OLR of 10 dB. The change in the RLR of digital ports from 0 dB to 2 dB requires a corresponding decrease in loss for some of the analogue stations to digital trunk connections, in order to maintain an optimum OLR.

ANSI/TIA-464-C-2002 [7] is intended to be in conformance with the ANSI/TIA-968-A [9] (formerly the terminal equipment certification requirements in part 68 of the FCC (Federal Communications Commission) Rules and Regulations). If the requirements in ANSI/TIA-968-A [9] are more stringent than those contained in ANSI/TIA-464-C-2002 [7], the provisions of ANSI/TIA-968-A [9] apply. Some of the desirable ONS and OPS losses would violate the ANSI/TIA-968-A [9] requirements for through-gain transmission. In these cases the losses have been set to levels compliant with the ANSI/TIA-968-A [9] requirements, even though this results in a less than optimum OLR of 13 dB. Until the requirements in ANSI/TIA-968-A [9] are changed, users should ensure they comply with the current ANSI/TIA-968-A [9] requirements for through-gain transmission.

|--|

То		Tie trunk type ports			Integrated	OPS	Analogue Public		Subrate	
From (E)		Lossless 2/4-wire	Subrate 1,544 Mb/s satellite 4W	Subrate 1,544 Mb/s tandem 4W	services trunk	ports (2-wire)	swite networ (2-w	ched k ports ⁄ire)	1,544 Mb/s Digital PBX-CO Trunk Port (4-wire)	
			ATT	DAL	DAL	DAL	OPS	AAL(A)	AAL(D)	DAL
		1	1	2	3	4	7	8	9	10
1	ATT	Lossless Tie Trunk Port (2/4-wire)	0 dB	-2 dB	-2 dB	-2 dB	-2 dB			
2	DAL	Subrate 1,544 Mb/s Satellite 4W Tie	-1 dB		-3 dB	-3 dB	-3 dB			
3	DAL	Subrate 1,544 Mb/s Tandem 4W Tie	2 dB	0 dB	0 dB	0 dB	0 dB			
4	DAL	Integrated Services Trunk	2 dB	0 dB	0 dB	0 dB	0 dB			
5	DGS	Approved Digital TE	2 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB
6	ONS	ONS Port with Approved TE	2 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB
7	OPS	OPS (2-Wire)	-2 dB	-4 dB	-4 dB	-4 dB	-4 dB	-4 dB	-4 dB	-4 dB
8	AAL(A)	Analogue Public Switched Network port (2-wire)					-3 dB	-3 dB	-3 dB	
9	AAL(D)	Analogue Public Switched Network port (2-wire)					-3 dB	-3 dB	-3 dB	
10	DAL	Subrate 1,544 Mb/s Digital PBX-CO Trunk Port (4-wire)					0 dB			
NO	FE: P	ositive values denote l	oss. Negativ	e (-) values de	enote gain.					

То		Tie trunk type ports			Integrated	OPS	Analogu	e Public	Subrate	
From (E)		Lossless 2/4-wire	Subrate 1,544 Mb/s satellite 4W	Subrate 1,544 Mb/s tandem 4W	services trunk	ports (2-wire)	switched network ports (2-wire)		1,544 Mb/s Digital PBX-CO Trunk Port (4-wire)	
			ATT	DAL	DAL	DAL	OPS	AAL(A)	AAL(D)	DAL
			1	2	3	4	7	8	9	10
1	ATT	Lossless Tie Trunk Port (2/4-wire)	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB	0 dB
2	DAL	Subrate 1,544 Mb/s Satellite 4W Tie	3 dB	0 dB	0 dB	0 dB	6 dB	0 dB	3 dB	0 dB
3	DAL	Subrate 1,544 Mb/s Tandem 4W Tie	3 dB	0 dB	0 dB	0 dB	6 dB	0 dB	3 dB	0 dB
4	DAL	Integrated Services Trunk	3 dB	0 dB	0 dB	0 dB	6 dB	0 dB	3 dB	0 dB
5	DGS	Approved Digital TE	3 dB	0 dB	0 dB	0 dB	6 dB	0 dB	3 dB	0 dB
6	ONS	ONS Port with Approved TE	9 dB	3 dB	3 dB	3 dB	9 dB	3 dB	6 dB	3 dB
7	OPS	OPS (2-wire)	3 dB	0 dB	0 dB	0 dB	6 dB	0 dB	0 dB	0 dB
8	AAL(A)	Analogue Public Switched Network Port (2-wire)	0 dB	-6 dB	-6 dB	-6 dB	0 dB	0 dB	0 dB	-6 dB
9	AAL(D)	Analogue Public Switched Network Port (2-wire)	0 dB	-3 dB	-3 dB	-3 dB	0 dB	0 dB	0 dB	-3 dB
10		Subrate 1,544 Mb/s Digital PBX-CO Trunk Port (4-wire)	3 dB		0 dB	0 dB	6 dB	0 dB	3 dB	0 dB

Table 3: ANSI/TIA-464-C-2002 Recommended Net Loss Between ports

11

Table 4: Difference between ANSI/TIA-968-A-1, section 4.5.2.5 and ANSI/TIA-464-C-2002 Port Loss

То			Tie trunk type ports			Integrated	OPS	Analogu	e public	Subrate 1,544
From (E)			Lossless	Subrate	Subrate	services	ports	switched network		Mb/s digital
			2/4-wire	1,544 Mb/s	1,544 Mb/s	trunk	(2-wire)	ports (2	2-wire)	PBX-CO
				satellite	tandem					Trunk Port
				4W	4W					(4-wire)
			ATT	DAL	DAL	DAL	OPS	AAL(A)	AAL(D)	DAL
			1	2	3	4	7	8	9	10
1	ATT	Lossless Tie	0 dB	2 dB	2 dB	2 dB	2 dB			
		Trunk Port								
		(2/4-wire)								
2	DAL	Subrate 1,544	4 dB		3 dB	3 dB	9 dB			
		Mb/s Satellite 4W								
		Tie								
3	DAL	Subrate 1,544	1 dB	0 dB	0 dB	0 dB	6 dB			
		Mb/s Tandem 4W								
		Tie								
4	DAL	Integrated	1 dB	0 dB	0 dB	0 dB	6 dB			
		Services Trunk								
5	DGS	Approved Digital	1 dB	0 dB	0 dB	0 dB	6 dB	0 dB	3 dB	0 dB
		TE								
6	ONS	ONS Port with	7 dB	3 dB	3 dB	3 dB	9 dB	3 dB	6 dB	3 dB
		Approved TE								
7	OPS	OPS (2-Wire)	5 dB	4 dB	4 dB	4 dB	10 dB	4 dB	4 dB	4 dB
8	AAL(A)	Analogue Public					3 dB	3 dB	3 dB	
		Switched								
		Network Port								
		(2-wire)								
9	AAL(D)	Analogue Public					3 dB	3 dB	3 dB	
		Switched								
		Network Port								
	1	(2-wire)	1				1			

То		Tie trunk type ports		Integrated 0	OPS	Analogu	e public	Subrate 1,544		
From (E)		Lossless 2/4-wire	Subrate 1,544 Mb/s satellite 4W	Subrate 1,544 Mb/s tandem 4W	services trunk	ports (2-wire)	switched ports (network 2-wire)	Mb/s digital PBX-CO Trunk Port (4-wire)	
10	DAL	Subrate 1,544 Mb/s Digital PBX-CO Trunk Port (4-wire)					6 dB			
NO	TE 1:	Positive values denote loss relative to ANSI/TIA-968-A [9] Negative (-) values denote gain relative to ANSI/TIA-968-A [9].								
NOTE 2:		The ANSI/TIA-968-A-1 [9] limits in table 2 are only provided as a convenience to users of this standard. Users should consult the latest ANSI/TIA-968-A-1 [9] to ensure that they are in compliance.								
NOTE 3:		The ONS ports with approved TE are for 2-wire on-premises station ports to separately approved terminal equipment.								
NOTE 4:		Subrate 1,544 Mb/s	Digital PBX-	CO trunk port	ts are for 4-wi	re 1,544 Mb/s I	High Capa	city Circuit c	ligital ports.	
NO	TE 5:	The numbers in the f port nomenclature.	irst column	of each table	are used in th	e first row of e	ach table a	as reference	s to the ANS	SI/TIA-968-A [9]

5.1.1.2 Digital pad disabling

ANSI/TIA-464-C	ES 201 168		
Requirements not given	3.1.8.1 Bit integrity		
	4 Compliance principles		
	Digital processing devices must be disabled to provide bit		
	integrity when needed. If digital pads are part of the loss		
	adjustment of input- and output half channels, they must be		
	rendered inoperative during all transmission measurements,		
	with the exception of the parameters Nominal Transmission		
	Loss and Loss Tolerances		

Analysis: There is no issue in about ANSI/TIA-464-C-2002 [7] the influence of digital pads on transmission parameters such as level tracking, quantizing distortion, output level, overload compression etc. With respect to the above mentioned parameters, the ETSI Standard is mainly based on ITU-T Recommendation G.712 [3], which provides parameters limits, assuming no digital loss or gain pads. To avoid the calculation and creation of new, extended limits for the standard, all digital signal processing devices including digital pads should be switched inoperative. This procedure was agreed upon since, usually, the influence on transmission quality of those devices is known and can be tolerated in practice.

5.1.2 Frequency response

5.1.2.1 Comparison of both definitions of frequency response

In both standards, the frequency response is defined as the difference between the actual loss at any frequency and the actual loss at the reference frequency 1 004 Hz (TIA) or 1 020 Hz (ETSI). With respect to the given frequency masks, positive values indicate more loss and vice versa. The loss at the reference frequency is assumed to be 0 dB.

By definition, loss is the logarithmic ratio between two values of power. For ANSI/TIA-464-C [7] requirements, measurements of frequency response are performed with all analogue ports terminated with 600 Ω (section 6.2 of ANSI/TIA-464-C [7]). Since this termination is independent of frequency, the measured voltage response across the port interface is identical with the power response. In contrast, for ETSI requirements, the ports are terminated with their nominal impedance, which is capacitive complex, i.e. frequency dependent. Therefore, ETSI defines the frequency response loss distortion with frequency, (clause 3.1.6 of ES 201 168 [8]) as the logarithmic ratio between the actual measured voltage at the reference frequency (1 020 Hz) and the voltage at any other frequency. This definition is in accordance with ITU-T Recommendation Q.551, section 1.2.5 [5].

ANSI/TIA-464-C				ES 201 168				
6.3.1	3.1 Frequency response (attenuation distortion)			3.1.6 Definition of loss distortion				
Figure 40	Figure 40 (a) Analogue to digital		5.2.3	5.2.3 Variation of gain with frequency (analogue half				
-	(b) Digital to analogue			connections)				
	., .		Figures 7	Figures 7, 8 Loss distortion with frequency (input and output				
			_	connec	tions)			
Template: Fi	gure 2		K2, L2, N	/l2, K4 and	M4 interfac	ces:		
Response ta	ble (breakpoints):		Template	e: Figure 2				
Frequency (Hz) Minimum (dB)	Maximum (dB)	Frequen	cy (Hz)	Minimu	ım (dB)	Maximum (dB)	
			_		Input	Output	(see note 3)	
60	+20 (see note 1)	+3 (see note 2)		< 200	0	-0,3	-	
200	0	+0,5	200	300	-0,3	-0,3	-	
300	-0,25	+0,5	300	400	-0,3	-0,3	+1	
3 000	-0,25	+0,75	400	600	-0,3	-0,3	+0,75	
3 200	-0,25	+1,5	600	2 000	-0,3	-0,3	+0,35	
3 400	0		2 000	2 400	-0,3	-0,3	+0,45	
			2 400	3 000	-0,3	-0,3	+0,7	
			3 000	3 400	-0,3	-0,3	+1,7	
			3 400	3 600	-0,3	-0,3	-	
			> 3 600		0	0	-	
Conditions:			Condition	าร:				
Relative to lo	oss measured at 1 004 Hz (not	minal); "+" values	Reference	ed to 1 02) Hz. Prefe	rred input lev	vel: -10 dBm0	
indicate mor	e loss, "-" values indicate less	loss than measured at						
1 004 Hz. For each connection category, 95 % of connections								
shall meet the above requirements.								
NOTE 1: I	N/A for digital to analogue con	version.						
NOTE 2:	+2 dB for digital to analogue c	onversion.						
NOTE 3: Same for input and output.								

13

5.1.2.2 Analogue to digital/digital to analogue

Analysis: TIA requirements are tighter than ETSI with the exception of maximum loss relative to 1 004 Hz in the frequency range 600 Hz to 2 400 Hz. Though not shown in the template, TIA requirements extend beyond 4 000 Hz with minimum loss, relative to 1 004 Hz, of 28 (D-A) or 32 (A-D) dB at 4 600 Hz and beyond. In ETSI, requirements for the frequency response are only related to the speech band from 200 Hz to 3 600 Hz. Signals above 3,6 kHz, which may cause interference (harm) to the public network are considered as "access requirements", and contained in ENs or TBRs. For additional information see also "Comparison of both definitions of frequency response" in clause 5.1.2 of the present document.



Figure 2: Analogue to digital frequency response

5.1.3 Levels

5.1.3.1 Comparison of both definitions of interfaces levels

The understanding and use of interface levels differs between TIA and ETSI standards. In ANSI/TIA-464-C [7] a zero-level point (ZLP) is defined; generally it represents the digital (PCM) switching point in a PBX. A 0 dBm0 signal at this point will decode to 0 dBm, or 1 mW in 600 Ω , and furthermore corresponds to the Digital MilliWatt (DMW) as defined in ANSI/TIA-464-C [7] section B.3.3 and based on ITU-T Recommendation G.711 [2] section 5. Overload occurs at a level which, for μ -law coding, is greater than +3,17 dBm at a 0 dB interface. Transmission Level Translation (section 6.1.4.3): in many cases, the interface level will be different from the Zero-Level Point (ZLP) due to the losses introduced to meet the loss plan. In these cases (unless otherwise stated) the appropriate interface loss should be included when determining compliance with the requirements.

In ETSI, interface levels are expressed with the term "relative level". The values are given as relative input level L_i and relative output level L_o at each analogue or digital interface. The purpose of this parameter must be seen in several ways. Primarily the relative level is directly related to the Nominal Loss (NL) of an input or output connection, which is defined as a unidirectional path between the interface and the test point. These relations are:

 $\mathbf{NL}_i = \mathbf{L}_i \qquad \qquad \mathbf{NL}_o = -\mathbf{L}_o$

Relative levels are used also in network planning in different applications. The relative output level at an interface may give an indication about the absolute signal power at this point, since signal levels are often expressed as a value in dBm0 (e.g. -15 dBm0 for test signals) which is understood as the absolute signal power at a 0 dBr point. The relative input level is used to control an overloading during encoding by signal sources in practical use. The relative levels are defined at a frequency of 1 020 Hz and corresponding to the Digital MilliWatt (DMW) and an analogue signal power of 1 mW as in TIA and based on ITU-T Recommendation G.711 [2].

The definition of a relative level in ETSI is referred to a termination with a frequency-dependant complex impedance. The nominal value of those impedances at the reference frequency 1 020 Hz may differ from 600 Ω , therefore the reference voltage is not necessarily 0,775 V. The definition can be given as follows:

• The output level at an interface is designated 0 dBr, if an internal digital signal, corresponding to the Digital MilliWatt (DMW), is resulting in an analogue signal of 1 020 Hz with an apparent power of 1 mW at the terminating complex impedance. Overload occurs at a level which, for A-law coding, is +3,14 dB above 1 mW (ITU-T Recommendation G.711 [2]). The definition of relative input levels is similar.

More detailed information about the concept and use of relative levels is given in TR 101 802 [6].

5.1.3.2 Interface levels

ANSI/TIA-464-C	ES 201 168
6.1.4.3 Transmission level translation Annex B3 Reference levels	 3.1.4 Relative levels (definition for test point and analogue interfaces) 6.2 Transmission loss (relative levels of digital interfaces)
The gain or loss from the port interface to the zero-level point has to be taken into account when making measurements. In the case of input ports, the input level should be increased or decreased by the amount equivalent to the loss or gain from the interface to the zero-level point. In the case of output ports, the output measurement should have an amount added or subtracted equivalent to the loss or gain from the zero-level point to the interface. This amount is not the same as specified in table 1, as table 1 is for port-to-port connections, and the port-to-ZLP-to-port losses and gains are defined by the PBX manufacturer. For nominal acoustic reference values, see section 5.3 of the present document.	The adjustment of relative input and output levels is left to the manufacturer's discretion. See also clause 5.1.1 of the ES 201 168.
Conditions:	Conditions:
Measured at 1 004 Hz (nominal) with both source and measuring instruments at 600 Ω impedance.	Measured at 1 020 Hz (nominal) with a test level of -10 dBm0 (clause A.4.2)

Analysis: See clause 5.1.3.1 of the present document.

5.1.3.3 Level tracking: tracking error

	ANSI/TIA-464-C			ES 201 168
6.3.4 Tracking	error		5.2.2	Variation of gain with input level (analogue half
Figure 41 Tracking	error			connections)
			Figure 6	Variation of gain with input level
 For all port-to-port connections, the tracking error should not exceed the limits shown in figure 3. Analogue to digital connections and digital to analogue connections: 				gure 3 below
Input signal	Tracking	error (dB)	Condition	IS:
(dBm) Max. Avg.		With a sir	ne-wave test signal at 1 020 Hz over the range of	
0 to -37 ±0,25 ±0,125		±0,125	input leve	els shown in figure 3, the gain variation, relative to
-37 to -50 ±0,5 ±0,25		the gain a	at -10 dBm0 shall lie within the limits shown in	
			figure 3.	

Analysis: ETSI requirements cover a wide range of input levels than TIA; however, where the ranges overlap, TIA is tighter except for the input range of -37 dBm0 to -40 dBm0.

Remark: TIA does not define tracking error with respect to a reference input level. If the limits must be interpreted as absolute total loss deviations, in contrast to the deviation referred to the loss at a specific input level (0 dBm or -10 dBm), then ETSI and TIA requirements are not comparable.



Figure 3: Level tracking: tracking error

5.1.3.4 Level tracking: overload compression

ANSI/TIA-464-C	ES 201 168
6.3.3 Overload compression	No comparable requirement.
Figure 41 Overload compression	
Overload compression requirements are shown in figure 4.	
Deviation is relative to 1 kHz.	

Analysis: None.



Figure 4: Level tracking: overload compression

5.1.3.5 Signal levels

ANSI/TIA-464-C-2002	ES 201 168
6.8 Signal levels	No comparable requirement.
The PBX shall comply with ANSI/TIA-968-A [9] section 4.5, for the following signal power limitations:	
 In-band signal power limits: a) Internal signal sources not intended for network control signalling; b) Internal signal sources intended primarily for network control signalling; c) Through transmission; d) Idle state circuit stability for tie trunks; e) Metallic signal power at frequencies in the range 3 995 Hz to 4 005 Hz; f) Longitudinal voltage in the 100 Hz to 4 000 Hz frequency range. 	
 2) Out-of-band signal voltage limits: a) Metallic voltage; b) Longitudinal voltage. 	
 The above listed signal power limitations shall apply to: 1) Analogue trunk interfaces (ground start, loop start, DID). 2) OPS interfaces. 3) Analogue tie trunk interfaces. 4) Digital trunk interfaces (ground start, loop start, DID, ISDN basic rate and primary rate) with encoded analogue contents. 5) Digital OPS interfaces with encoded analogue contents. 6) Digital tie trunk interfaces with encoded analogue contents. 	

Analysis: Comparison not applicable. In Europe the signal levels are considered as parameters, which may cause harm to the (public) network. Since ETSI, as a general rule, is specifying those parameters in separate "access requirements", these requirements are no more part of ES 201 168. They are contained in ENs and TBRs or, (mainly in case of analogue access) part of national regulation. A comparison between these regulations and ANSI/TIA-968-A [9] is outside the scope of the present document.

5.1.4 Hybrid balance

AN	SI/TIA-464-C	ES 201 168			
6.4.1 Hybrid balance requirements Table 20 PBX minimum hybrid balance requirements		 3.1.7.1 Terminal balance return loss (TBRL) definition 5.8.1 Terminal balance return loss (for 2-wire analogue interfaces) 			
		Figure 13 Limits for TBF	Figure 13 Limits for TBRL		
All ports Template: Fig	ure 5.	Template: Figure 5.			
Frequency range (Hz)	Hybrid balance (dB)	Frequency range (Hz)	Hybrid balance (dB)		
200 to 500	Equal to or greater than the values located on a straight line intersection17 dB at 200 Hz and 22 dB at 500 Hz	300 to 500	Equal to or greater than the values located on a straight line intersection 16 dB at 300 Hz and 20 dB at 500 Hz		
500 to 2 500	> 22 dB	500 to 2 500	> 20 dB		
2 500 to 3 400	Equal to or greater than the values located on a straight line intersection 22 dB at 2 500 Hz and 17 dB at 3 400 Hz	2 500 to 3 400	Equal to or greater than the values located on a straight line intersection 20 dB at 2 500 Hz and 16 dB at 3 400 Hz		
Lines plotted on a log/line	ear scale.	Lines plotted on a log/linear scale.			
Conditions: Measurements procedure Test configurations show method) and 44 (half cha	e outlined in clause 6.4.2. n in figures 43 (full channel nnel method).	Conditions: Test procedure outlined in clause A.4.3.2.			

Analysis: For all ports, the TIA requirements are more stringent than the ETSI requirement.



Figure 5: Hybrid balance

5.1.5 Input impedance

	ANSI/TIA-464-C	ES 201 168			
6.4.3 Input im Table 21 PBX retu	pedance requirements urn loss requirements	 5.1 PBX input impedance of interfaces K2, L2, M2 and M4 Figure 5 Minimum value of return loss against the nominal PBX impedance 			
All ports Temp	olate: Figure 6	ImpedanceNominal PBX impedance:2-wire ports: $270 \Omega + (750 \Omega // 150 nF)$ 4-wire ports: 600Ω Return loss: Template: Figure 6			
Freq. range (Hz)	Mandatory Z-in (dB)	Freq. range (Hz)	RL (dB)		
200 to 500	Equal to or greater than the values located on a straight line intersection 14 dB at 200 Hz and 22 dB at 500 Hz	300 to 500	Equal to or greater than the values located on a straight line intersection 14 dB at 300 Hz and 18 dB at 500 Hz		
500 to 2 500	> 22	500 to 2 000	> 18		
2 500 to 3 400	Equal to or greater than the values located on a straight line intersection 22 dB at 2 500 Hz and 14 dB at 3 400 Hz	2 000 to 3 400	Equal to or greater than the values located on a straight line intersection 18 dB at 2 000 Hz and 14 dB at 3 400 Hz		
Conditions:		Conditions:			
Reference impedan $600 \Omega / 2,16\mu$ F is au impedance may be used for hybrid bala network. Test configurations and 4-wire ports	ce is 600Ω ; for CO trunks & DID trunks, cceptable. Optionally, ONS reference a three element network either that ince or ETSI nominal input impedance are given in figures 45 to 48 for 2-wire	Measured against the nominal PBX impedance (270 Ω + (750 Ω // 150 nF). Test procedure for return loss outlined in clause A.4.3.1.			

Analysis: ETSI requirements are less stringent than TIA for all frequencies. Measurement conditions differ; TIA connections measured through PBX to 4-wire port with 600 Ω termination. ETSI connections measured half-channel, with open loop inside the PBX to avoid signal reflections.





5.1.6 Echo loss

ANSI/TIA-464-C	ES 201 168
Annex C: Loss definitions	3.1.7.3 Echo loss
The Echo Return Loss (ERL) is a weighted average of	The echo loss is defined as the semi-loop loss averaged with
the return loss values over the frequency range 400 Hz	1/f power weighting over the telephone band. Reference is
to 3 400 Hz.	made to ITU-T Recommendation G.122 [1], paragraph 4 with
	the corresponding weighting algorithm. ETSI is giving only the
Conditions:	definition of echo loss, no numerical requirements.
For calculation of echo loss, sub-multiples of 8 kHz	
should be avoided.	Conditions:
	Calculation of echo loss is based on the values of semi-loop in
	the band 300 Hz to 3 400 Hz, using the given formula or the
	trapezoidal rule given in ITU-T Recommendation G.122 [1].

Analysis: In both cases, TIA and ETSI the echo loss is defined as a weighted average of the return loss of all equipment forming an echo source. This is resulting in one single value of echo loss to be used mainly for planning purposes. The weighting algorithms are not comparable.

5.1.7 Stability loss

ANSI/TIA-464-C-2002		ES 201 168
No comparable requirements.	3.1.7.2	Stability loss (Definition)
	5.8.2	Stability loss (K2, L2, M2 interfaces)
	9.6.1	Stability loss of interfaces connected to a KD Interface
	9.6.2	Stability loss of interfaces connected to M4, MD or MS interfaces
	Clause A.4.3.2	
	The stability loss points (clause 3 with worst case and adjusted for 2-wire interfaces The values of th the frequency ra For connections loss shall be at	s is defined as the loss between the PBX test .1.7.2) of a half connection to a L2 or M2 interface terminating conditions simulated by a short circuit r the relative input and output levels of these s (clause 4.3.2). The stability loss should be stated by the supplier, in ange between 200 Hz and 3 600 Hz (clause 5.8.2). The with a KD, M4, MD or MS interface, the stability least 6 dB (clauses 9.6.1 and 9.6.2).

Analysis: ETSI is referred to ITU-T Recommendation G.122 [1], taking into account, that a private network, connected digitally to a public network, may provide the total stability loss of the entire path across the public network (see clause 5.8.2 of ES 201 168 [8]).

5.2 Voice impairment parameters

5.2.1 Noise

5.2.1.1 Weighted noise

ANS	SI/TIA-464-C		ES 20	ES 201 168		
6.5.1.1 C-weighted-message noise Table 23 PBX C-message weighted noise requirements			 5.4.1 Weighted noise of analogue interfaces without a feeding bridge 5.4.2 Weighted noise of analogue interfaces with a feeding bridge 			
Connection	Mean (desirable) dBmC	95 % (max.) dBmC	K2, L2, M2 and M4	(dBm0p)		
Analogue-to-analogue	≤ 16	≤ 20	Input connection with signalling on speech wires	< -65,2		
Analogue-to-digital	≤ 15	≤ 19	Input connection with signalling on separate wires	< -67,0		
Digital-to-analogue	≤ 9	≤ 13	Output connection with signalling on speech wires	< -67,0		
Conditions: All analogue interfaces, e terminated with appropria input ports, other than the	xcept the one(s) b te impedances, a one(s) being test	eing tested, are nd all digital ed, are supplied	Output connection with signalling on separate wires Interfaces with feeding bridge: Limit for weighted noise is calo	< -70,0 culated for every input and		
a digital equivalent of zero	o volt.		output connection depending on the relative levels. Values are expressed in dBmp.			
Test arrangement shown	in figure 49.		Conditions: Measurement method: clause	A.4.5.1		

20

Analysis: These requirements are not directly comparable, because of different weightings and reference values. However, with respect to the reference the following conversion can be used:

Value in dBrnC - 90 = Value in dBmp

According to annex A to ITU-T Recommendation O.41 [4] the different readings due to the weighting filters can be neglected (0,5 dB for white noise), therefore the above conversion can be used in all practical applications. Furthermore comparison is difficult, since ETSI specifies noise limits for input and output connections, in contrast to port-to-port connections in TIA also follows ITU-T Recommendations, taking into account, that noise is a combination of noise sources, each of which may be influenced by the adjustment of relative levels or may be level independent. Consequently, for interfaces with feeding bridge (L2 and some M-interfaces), the noise limits may differ for every interface.

5.2.1.2 3-kHz flat noise

ANSI/TIA-464-C			ES 201 168
6.5.1.2 3 kHz flat noise			No comparable requirements
Percentage of connections	50 %(dBrn)	90 %(dBrn)	
3 kHz flat noise	≤ 35	≤ 39	
Conditions:			
For interface transmission levels other than 0 dB, the			
requirement should be shifted by a value that corresponds			
to the difference between the transmission level at that			
interface and 0 dB.			

Analysis: Not specified by ETSI, so comparison is not pertinent.

5.2.1.3 Single frequency noise

ANSI/TIA-464-C	ES 201 168
No comparable requirements.	5.4.2 Single frequency noise of interfaces K2, L2, M2 and M4.
	The level of any "unwanted" single frequency (in particular the sampling frequency and its multiples), measured selectively with a bandwidth of 80 Hz from 4 kHz to 72 kHz shall not exceed -50 dBm0 at the interface of an output connection.
	Conditions: No test signals are inserted into the half connection during measurements.

Analysis: The term "unwanted" refers to self generated noise (see note of clause 5.4.5) as it may occur by the sampling frequency itself or by other noise source (e.g. dc - dc power supply) in correlation with the sampling process. Comparison with TIA is not possible.

5.2.1.4 Spurious out of band signals

AN	SI/TIA-464-C	ES 201 168				
6.3.1 Frequency res	sponse	There are no requirements with respect to received out of				
Although not directly com	parable, limits for signals above	band signals at the output of all types of analogue				
4 kHz (out of band) are co	ontained in the frequency	interfaces. Those requirements are subject to access				
response masks in clause	e 6.3.1. For analogue to digital	requirements (TBRs, ENs) and therefore not part of				
connections, the minimun	n loss, relative to the loss at	ES 201 168 [8].				
1 004 Hz, should follow th	ne equation:					
Range						
3 400 Hz to 4 000 Hz	-14sin[π*(4 000-F)/1 200]+14					
4 000 Hz to 4 600 Hz	-18sin[π*(4 000-F)/1 200]+14					
over 4 600 Hz	32 dB					
For digital to analogue co	nnections, the minimum relative					
loss should follow the equ	uations:					
Range						
3 400 Hz to 4 600 Hz	-14sin[π*(4 000-F)/1 200]+14					
4 600 Hz	28 dB					
Conditions:						
See also section 5.1.2 of	the present document.					

Analysis: There are no directly comparable requirements for out of band signals received at the output ports of a connection. However, values for minimum relative loss in the range from 4 kHz to 12 kHz in the frequency response masks of ANSI/TIA-464-C [7], section 6.3.1 can be interpreted as limits for out of band signals.

5.2.2 Balance

5.2.2.1 Longitudinal balance

	ANSI/TIA 464 C		ES 201 169
	AN3//11A-404-C		E3 201 100
6.5.2.1 Longitud	linal-to-metallic balan	се	Requirements not given.
Table 24 PBX long	gitudinal-to-metallic b	alance	
requirem	ients		
Figure 50 Longitud	linal balance limits		
Frequency	Minimum balance	Average balance	
(Hz)	(dB)	(dB)	
200 to 1 000	58	63	
1 000 to 3 000	58 to 53	63 to 58	
Conditions:			
TIA considers longit	udinal-to-metallic bal	ance as a	
performance param	eter for measuring pr	oduct immunity	
against the convers	ion of disturbing long	itudinal voltage into	
unwanted metallic n	oise. It applies to loo	p/ground start	
CO/FXO trunks, rev	erse battery (DID) tru	inks, OPS/FXS	
lines, and digital ser	vice trunks. Figure 5	0 shows a	
"desirable" region fo	or average balance.		

Analysis: Comparison not applicable. However, from previous ETSI standards I-ETS 300 004 (see bibliography), the LCL requirement was about 18 dB less stringent than the TIA requirement. In Europe the longitudinal to metallic balance is considered as a parameter, which may cause harm to the (public) network. Since ETSI, as a general rule, specifies those parameters in separate "Access Requirements", these requirements are not part of ES 201 168 [8]. They are contained on TBRs and ENs or, (mainly in case of analogue access) part of national regulation. Also high LCL may indirectly be required to meet the immunity requirements called for under the European EMC Directive.

5.2.2.2 Transverse balance

ANSI/TIA-464-C				ES 201 168
6.5.2.2 Transverse balance				Requirements not given.
Table 25 Termination and frequency ranges				
Table 26 Free	quency ranges	s of transverse ba	alance for	
digit	al services			
Table 27Transv	erse balance	limits	, , , , ,	
Figure 51 Tran	nsverse balan	ce requirements	for digital	
serv	rice internaces	Frequency	Minimum	
Interface	State	Frequency		
CO trunk loop	On-hook	200 to 1 000	≥ 60 > 40	
start	Off book	200 to 4 000	> 40	
CO truck	OII-HOOK	200 10 4 000	≥ 40	
ground start	Off-hook	200 to 4 000	≥ 40	
Reverse battery (DID)	Off-hook	200 to 4 000	≥ 40	
OPS line	Off-hook	200 to 4 000	≥ 40	
NOTE: Thes	se are regulate	ory requirements		
Conditions:				See also clause 5.2.2.1 of the present document.
The ANSI/TIA-4	464-C [7] requ	irements are tak	en directly	
from the FCC F	Part 68 technic	cal requirements	to protect the	
network from ha	arm caused by	y the conversion	of metallic	
signals into longitudinal signals that could cause excessive				
noise in other pairs of a multi-pair cable. The requirement				
defines ten measurement conditions, together with a			r with a	
transverse balance test circuit and termination schematics.				
Test arrangement and termination arrangement shown in Figures 52 to 56.				

Analysis: Comparison not applicable. However, from previous ETSI standards (I-ETS 300 004), the LCTL requirement was nearly identical to the TIA requirement in the off-hook case.

5.2.3 Crosstalk

ANSI/TIA-464-C			ES 201 168				
6.5.3 Crosstalk		5.5 Crosstalk					
Between any	Between any	Between any	Connection type	(dBm0)			
established	established	established	Input (FEXT): All interfaces	< -73			
connection and	connection and at	connection and at	Input (NEXT): L2, K2	< -73 (see note 1)			
any other	least 95 % of all	least 95 % of all	Input (NEXT): M4, 4w-2w	< -73			
connection (dB)	other connections (mandatory) (dB)	other connections (desirable) (dB)	Output (FEXT): L2, K2	< -73 (see note 1)			
≥ 70	≥ 75	≥ 80	Output (FEXT): M4, 4w-2w	< -73			
Conditions:			Output (NEXT): L2, all M	< -73			
Full channel tests for	or every combination	of through	interfaces				
connection, for all ir	nterface categories o	ver the 200 to	Output (NEXT): K2	< -66			
3 200 Hz frequency band.		NOTE 1: Values specified in dBm					
Test circuit is show	n in figure 57.		NOTE 2: NEXT: Near End Crosstalk				
			FEXT: Far End Crosstalk				
			Conditions:				
			Measurement details are in clause A.4.4.				
				Requirements measured as "Crosstalk-Level" for an input			
			signal of 1 020 Hz with a level of 0 dBm0.				

Analysis: TIA does not specify the input level, but when the ETSI input signal level is applied the TIA requirement is about 3 dB to 5 dB more stringent than TIA measurement conditions, if liberally interpreted, requires a near-infinite number of test. The ETSI requirement is more detailed but the test conditions more practical.

5.2.4 Distortion

5.2.4.1 Quantization distortion

ANSI/TIA-464-C			ES 201 168				
6.5.4 Quantization distortion Table 28 PBX quantization distortion limits		5.6 Total distortion 9.3 Quantizing dis Figures 9 to 12 Limits for sign Analogue inter interfaces/con	n including quantizin tortion units (qdu) al-to-total distortion n faces (various ditions)	g distortion ratio of			
Input signal level	Input/output level	Input/output level	Input level	Minimum sigr	nal to total		
(dBm)	ratio (mandatory)	ratio (desirable)	dBm0	distortion ratio			
Analogue-to-analo	que connection			A	В		
0 to -30	≥ 33	≥ 37	0	35,0	35,0		
-40	≥ 27	≥ 31	-20	35,0	35,0		
- 45	≥ 22	≥ 26	-30	35,0	33,8		
Digital-to-analogue	e and analogue-to-c	ligital connections	-40	29,0	26,5		
0 to -30	≥ 35	-	-45	24,0	21,5		
-40	≥ 29	-	A: For interfaces with signalling on separate wires.				
-45	≥ 25	-	B: For interfaces with signalling on the speech wires.				
Conditions: To be met on 95 % of connections in each category. Input: 1 kHz sine wave.			For interfaces with feedin on the basis of different clause 5.2.1 of the prese	ng bridge, the curves noise sources (see a nt document).	s are calculated also		
Output: C message	weighted distortion l	evel.	Conditions:				
			Measured with a sine wave signal of 1 020 Hz. A				
			connection between two analogue interfaces and without an				
			inserted digital loss pad or with a pad of 6,02 dB, is forming				
			1 quantizing distortion unit (qdu). The number of qdu for a				
			connection shall be state	d by the supplier.			

Analysis: Some of the ETSI requirements are virtually identical to the TIA half channel requirements, while others are less stringent. The coding schemes and weightings are different and the test methods are also different. In practice, it is not possible to measure quantization distortion alone because of the presence of other sources of distortions, such as noise. Therefore in ETSI this parameter is called "Total distortion including quantizing distortion". The number of qdu in a connection through the PBX is mainly used for planning purposes.

5.2.4.2 Single frequency distortion

ANSI/TIA-464-C	ES 201 168				
6.5.5 Single frequency distortion	5.7.1 Input signals above 4,6 kHz				
≤-28 dBm	For an input signal in the range from 4,6 kHz to 72 kHz with				
	a level of -25 dBm0 any image frequency produced in the				
Conditions:	time slot of an input connection shall be at least 25 dB				
For each connection category, 95 % of connections shall	below the test level.				
meet the above requirements.					
Input: Any single frequency in the range of 0 kHz to 12 kHz	Conditions:				
at a constant 0 dBm level.	Test method given in clause A.4.2.1.5.				
Output: At any other single frequency. Adjust input level if					
overload the point differs from +3 dBm.					

Analysis: These requirements are not directly comparable due to the differences in input level and frequency range, but at least part of their intents are the same. Ignoring the differences, the TIA requirement is 3 dB more stringent.

5.2.5 Delay

ANSI/TIA-464-C		ES 201 168			
6.4.6 Echo path delay		3.1.10.3.1 Mean one-way transmission time (definition)			
Table 20 Echo path delay for PBX		9.5 Mean one-way transmission time			
Connection	Round trip delay	No numeric requirement for echo path delay.			
	(ms)				
1 Station - station	3,0	The mean one-way transmission time in a connection			
2 Station - analogue trunk 3,0		between two interfaces shall be a value stated by the supplier.			
3 Analogue trunk - analogue trunk 3,0					
4 Station - digital interface	2,4				
5 Analogue trunk - digital interface	2,4				
6 Digital interface - digital interface	2,0				
Conditions:					
Requirement for all frequencies in rang	e of 300 Hz to				
3 400 Hz. For each connection categor	y, 95 % of				
connections shall meet the above requi	rement.				

Analysis: ETSI requirements have shifted from specifying mandatory upper limits to the echo path delay to complete deletion of numeric values.

5.3 Loudness levels

ANSI/TIA-464-C	ES 201 168
A.4.2 Acoustic reference levels Table A4 Interface acoustic reference values for ISPBX	 3.1.15 Acoustic reference level (ARL) - definition 8.2.2 Send and Receive Loudness Ratings (SLR and RLR) for 3,1 kHz handset system specific telephones
Nominal acoustic reference values treat the PBX/line port combination as a single system for defining loudness ratings at PBX interfaces. The values are presented in table 5.	Sending and receiving loudness ratings (SLR and RLR) of system specific telephones shall be stated by the manufacturer.

Analysis: Requirements are not directly comparable. The TIA requirements address the PBX with its terminal as a "black box" where the requirements are given at the interface to external connections. Clause 8.2.2 of ES 201 168 [8] addresses system specific handsets (i.e. no telephones connected to an L interface) with the SLR and RLR values referred to the PBX digital test point.

However, the requirements are related. The overall objective is that of providing satisfactory end-to-end transmission quality for nearly every call via all categories of external connection. The TIA requirements are designed to optimize the loudness levels at each such connection interface regardless of the terminal loudness values. With respect to ETSI requirements, it would be expected that the supplier-specified loudness values of a system-specific handset, together with the supplier-specified port-to-port loss for each PBX connection involving that handset, will be such that the resulting system interface levels are optimized for end-to-end transmission performance.

PBX Interface	Port		SLR (dE	3)	RLR (dB)			ERL(A)
	designation	min.	nom.	max.	min.	nom.	max.	(dB)
On-premises line (from ONS port - note 2)	ONS	9	14	19	-5	0	5	N/A
On-premises line (from ICS port - note 2)	ONS	12	17	25	-2	3	8	N/A
ISDN - compatible line (including DAL)	ICS	3	11	19	-8	0	5	N/A
Off-premises line	OPS	6	11	19	-8	-3	2	N/A
Analogue tie trunk	ATT	6	11	19	-8	-3	2	18
Digital tie trunk (note 3)	ISD/TT	6	11	19	-2	3	8	24
Analogue Access Line; analogue interface	AAL(A)	3	8	16	-11	-6	-1	12
Analogue Access Line; digital interface	AAL(D)	6	11	19	-8	-3	2	18
(note 4)								
Analogue to trunk	A/TO	9	14	22	-5	0	5	24
Satellite tie trunk	S/ATT, S/DTT	6	11	19	-8	-3	2	18
Integrated services trunk	IST	6	11	19	-5	0	5	21
NOTE 1: The values in this table pertain to co	nnections betwe	en the	designa	ated inte	rface ar	nd an Ol	NS or IC	S port.
Tolerances on RLR and on ONS po	rt SLR are assur	med to	be ±5,0	dB; to b	e comp	atible w	ith the S	SLR
tolerance range for ISDN terminals i	n (Ref. 3), the m	naximur	۳ SLR ۱	alues ir	this tab	le are e	xtended	l to nominal
+8 dB. For this reason, the SLR ran	ges for the two C	DNS ca	ses (firs	st two ro	ws) are	dissimila	ar.	
NOTE 2: For an ONS interface, the ARLP val	ues differ betwe	en coni	nection	to anoth	er ONS	port or	to an IC	S port;
reflecting the intent to align ICS con	reflecting the intent to align ICS connections to equivalent loudness on intra-PBX connections.							
NOTE 3: For connections from ICS to ISD/TT	E 3: For connections from ICS to ISD/TT, RLR values are -5 dB, 0 dB and 5 dB, respectively.							
NOTE 4: The ARLP value for the AAL(D) inte	IOTE 4: The ARLP value for the AAL(D) interface is such that it conforms to the criteria for analogue access lines in						s lines in	
Ref. 8; thus, for AAL(D) connections	to the PSTN, a	DEO ir	nserts th	ne requir	ed publ	ic netwo	rk loss (e.g. 6 dB
receive-side loss for connections to	a digital tandem	conne	cting tru	ink).	•			

Table 5: Interface acoustic reference values for PBX (see note 1)

5.4 Other impairment parameters

5.4.1 Intermodulation distortion

ANSI/TIA-464-C			ES 201 168
6.6.1 Intermodulation dis	tortion		Requirements not given.
Table 29 Intermodulation dis	able 29 Intermodulation distortion limits		
Connection interface	Distorti	on limits	
categories	(dB below re	eceived level)	
	(R2)	(R3)	
Up to 4,8 kb/s data	39	51	
Up to 9,6 kb/s data	46	56	
Conditions:			
Intermodulation is measured u	ising four-tone	method that	
employs two pairs of equal-lev	el tones transr	nitted at a total,	
composite power level of -13 c	Bm. One pair	at 857 Hz and	
863 Hz, the second pair at 1 3	72 Hz and 1 38	38 Hz.	
Intermodulation distortion is m	easured as the	e second-order	
(R2) and third-order (R3) prod	ucts resulting f	rom the	
application of the four tones.			
R2 is the average power level	in the 503 Hz t	o 537 Hz and	
2 223 Hz to 2 257 Hz frequence	cy bands, expre	essed in dB	
below the received power leve	el in the 1 877 H	Iz to 1 923 Hz	
frequency bands, expressed in dB below the received			
power level.			
R3 is the total power level in the 1 877 Hz to 1 923 Hz			
frequency bands, expressed in dB below the received			
power level.			

Analysis: Comparison not applicable. Intermodulation or harmonic distortion is caused by non-linearity present in the electric-to-electric transfer function of the PBX. This form of distortion is of primary concern to the transmission of data. ITU-T Recommendation G.712 [3] Recommendation noted that the intermodulation distortion are in practice always met if the requirements according to total distortion including quantization distortion and variation of gain with input level are met. In ETSI this requirements omitted due to these issues in the ITU-T Recommendation.

5.4.2 Group delay distortion

ANSI/TIA-464-C			ES 201 168
6.6.2.2 Relative Envelope Delay (RED)			5.3 Group delay distortion
Figure 58 Relative envelope delay vs. frequency			
For station-to-trunk and trunk-to-trunk interface the			No requirements.
Relative Envelope Delay (RED) shall lie below the following		below the following	
values:			
Frequency	Mandatory RED	Desirable RED	
(Hz)	(µs)	(µs)	
500	-	300	
800	375	150	
1 000	190	75	
1 150	150	75	
2 300	150	75	
2 500	190	75	
2 700	375	150	
3 000	-	300	
For station-to-station twice the RED values are permitted.		es are permitted.	
Conditions:			
For each connection category, 95 % of connections shall			
meet the above requirements. The test signal is a carrier			
50 % amplitude modulated with a sinusoidal frequency of			
83,3 Hz.			

Analysis: In ETSI group delay distortion is considered as an impairment mainly to non-voice or data transmission. Since ES 201 168 [8] does not apply to services other than 3,1 kHz voice telephony (see clause 1), requirements for this parameter are not included.

5.4.3 Impulse noise

ANSI/TIA-464-C	ES 201 168
6.6.3 Impulse noise	No requirements for impulse noise.
On 95 % or more of all connections through each connection category, the impulse noise level shall not exceed zero counts above a threshold of 55 dBmC in a measurement interval of 5 minutes. It is desirable not to exceed a noise level of 47 dBmC.	
Conditions: Impulse noise limits shall be met under fully loaded busy-hour PBX traffic condition.	

Analysis: In ETSI group impulse noise is considered as an impairment mainly to non-voice or data transmission. Since ES 201 168 [8] does not apply to services other than 3,1 kHz voice telephony (see clause 1), requirements for this parameter are not contained in not included.

5.4.4 Jitter

ANSI/TIA-464-C	ES 201 168
6.6.4 Jitter	No requirements for jitter.
Jitter on a port-to-port connection shall not exceed	
2 degrees within the 4 Hz to 300 Hz frequency band.	

Analysis: Comparison not applicable. In Europe the jitter is considered as a parameter, which may cause harm to the (public) network. Since ETSI, as a general rule, is specifying those parameters in separate "access requirements", these requirements are not part of ES 201 168 [8]. They are contained in TBRs and ENs or, part of national regulation.

5.4.5 Gain hit

ANSI/TIA-464-C	ES 201 168
6.6.5 Gain hit	No requirements for gain hit.
No more than one gain hit per hour at a threshold level of 3 dB. If there is more than one gain hit in a period of 1 hour, the subsequent hour shall have zero hits.	
Conditions: A gain hit is an incidental modulation resulting in a rapid positive or negative shift of signal gain lasting for a period of at least 4 ms.	

Analysis: Comparison not applicable.

5.4.6 Phase hit

ANSI/TIA-464-C	ES 201 168
6.6.6 Phase hit	No requirements for phase hit.
No more than one gain hit per hour exceeding a threshold	
of 20 degrees. If there is more than one phase hit in a	
period of 1 hour, the subsequent hour shall have zero hits.	
Conditions:	
A phase hit is an incidental modulation resulting in a rapid	
positive or negative shift of signal phase lasting for a period	
of at least 4 ms.	

Analysis: Comparison not applicable.

5.4.7 Dropout

ANSI/TIA-464-C	ES 201 168
6.6.7 Dropout	No requirements for dropout.
No more than one dropout per hour exceeding a threshold of 6 dB. If there is more than one dropout in a period of 1 hour, the subsequent hour shall have zero dropouts.	
Conditions: A dropout is a negative gain hit lasting a period of at least 10 ms.	

Analysis: Comparison not applicable.

Annex A (informative): Bibliography

ETSI I-ETS 300 004: "Business Telecommunications (BT); Transmission characteristics at 2-wire analogue interfaces of a digital Private Automatic Branch Exchange (PABX)".

28

ANSI/TIA-470.110-C: "Telecommunications - Telephone Terminal Equipment - Handset Acoustic Performance Requirements".

ANSI/TIA/EIA-810-A: "Telecommunications - Telephone Terminal Equipment-Transmission Requirements for Narrowband".

History

Document history					
V1.1.2	September 2004	Membership Approval Procedure	MV 20041119: 2004-09-21 to 2004-11-19		
V1.1.2	November 2004	Publication			

29