Standards Committee T1
Telecommunications

TECHNICAL REQUIREMENT

T1.TRQ.6-2001

Technical Requirements for

SHDSL, HDSL2, HDSL4
Digital Subscriber Line Terminal Equipment
to Prevent Harm to the Telephone Network

Prepared by

T1E1.4

Working Group on
Digital Subscriber Line Access

Alliance for Telecommunications Industry Solutions

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T1.TRQ.6-2001

Published by

Alliance for Telecommunications Industry Solutions
1200 G Street, NW, Suite 500
Washington, DC 20005

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Printed in the United States of America.

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Foreword (This foreword is not part of T1.TRQ.6-2001.)

The Federal Communications Commission (FCC), in its Report & Order on CC Docket No. 99-216, mandated the creation of the Administrative Council for Terminal Attachments (ACTA). In 47 CFR 68.7(b), ACTA is charged with adopting and publishing technical criteria to prevent harms to the telephone network submitted to it by standards development organizations accredited by the American National Standards Institute (ANSI). This technical requirements document was created for submission to ACTA in accordance with 47 CFR 68.604. It is intended to be supplemental to the technical criteria in TIA/EIA-IS-968-2001, *Telecommunications – Telephone Terminal Equipment – Technical Criteria for Connection of Terminal Equipment To the Telephone Network*.

This requirements document specifies technical criteria to prevent harms to the telephone network in the United States by terminal equipment with Single-Pair High Speed Digital Subscriber Line (SHDSL) transceivers. This document references technical criteria in the following standards:

- ITU-T Recommendation G.991.2-2001, *Single-Pair High-Speed Digital Subscriber Line (SHDSL) Transceivers*.
- TIA/EIA-IS-968-2001, *Telecommunications – Telephone Terminal Equipment – Technical Criteria for Connection of Terminal Equipment To the Telephone Network.*
- T1.417-2001, *American National Standard for Telecommunications – Spectrum Management for Loop Transmission Systems*.

Normative annexes are considered part of Committee T1 technical requirements documents. Informative annexes of Committee T1 technical requirements documents provide useful information but do not contain requirements. Similarly, footnotes are informative.

This technical requirements document was developed by the Working Group T1E1.4 *Digital Subscriber Line Access*, in cooperation and joint-session with the Engineering Subcommittee TR41.9 *Technical Regulatory Considerations* of the Telecommunications Industry Association (TIA). It was developed in accordance with ANSI and Committee T1 procedural guidelines and represents the consensus position of the formulating group.

This document was processed and approved for submittal to ATIS by the Accredited Standards Committee on Telecommunications, T1. Committee approval of this specification does not necessarily imply that all committee members voted for its approval.

Future control of this technical requirements document will reside with Alliance for Telecommunications Industry Solutions (ATIS). Suggestions for improvement of this document are welcome. These should be sent to the Alliance for Telecommunications Industry Solutions, T1 Secretariat, 1200 G Street, NW, Suite 500, Washington DC 20005.

These requirements were developed in Technical Subcommittee T1E1 *Interfaces, Power, and Protection of Networks*.

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Technical Requirements for

SHDSL, HDSL2, HDSL4 Digital Subscriber Line Terminal Equipment to Prevent Harm to the Telephone Network

1 Scope

This document provides technical criteria for connecting the following types of terminal equipment to the telephone network in accordance with 47 CFR 68.

- Single-Pair High-Speed Digital Subscriber Line (SHDSL[1]);
- High Bit Rate Digital Subscriber Line - 2nd Generation (HDSL2); and
- 4-Wire High Bit Rate Digital Subscriber Line - 2nd Generation (HDSL4).

SHDSL, HDSL2, and HDSL4 terminal equipment are not specifically addressed in TIA/EIA-IS-968-2001, *Telecommunications – Telephone Terminal Equipment – Technical Criteria for Connection of Terminal Equipment To the Telephone Network.*

Terminal equipment that complies with the technical requirements in this document and all other applicable technical criteria is not expected to cause harm to the telephone network.

In accordance with ANSI guidelines, two categories of specifications are used in this document, mandatory requirements and recommendations. Mandatory requirements are designated by the word "shall" and recommendations by the word "should."

2 Normative References

The following standards contain provisions that, through reference in this text, constitute provisions of this technical requirements document. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ITU-T Recommendation G.991.2-2001, *Single-Pair High-Speed Digital Subscriber Line (SHDSL) Transceivers.*[2]

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[1] Annex A of ITU-T Recommendation G.991.2-2001 contains the regional SHDSL requirements for North America. In that document, the term SHDSL is used generically to refer to three types of transmission systems that do not support the use of analog splitting technology for coexistence on the same pair with voice services. In this document, those three types of transmission systems are referred to as SHDSL, HDSL2, and HDSL4. In T1.417-2001 those systems are referred to as G.SHDSL, Spectrum Management Class 4, and HDSL4 respectively.

[2] ITU-T recommendations are available from the ITU Telecommunication Standardization Sector < http://www.itu.int/ITU-T/publications/index.html >.

TIA/EIA-IS-968-2001, *Telecommunications – Telephone Terminal Equipment – Technical Criteria for Connection of Terminal Equipment To the Telephone Network.*[3]

T1.417-2001, *American National Standard for Telecommunications – Spectrum Management for Loop Transmission Systems.*[4]

3 Definitions, Abbreviations, and Acronyms

3.1 Definitions

3.1.1 G.SHDSL – The term used in T1.417-2001 in reference to systems that use the symmetric PSD masks and 16 level Trellis Coded Pulse Amplitude Modulation defined in Annex A of ITU recommendation G.991.2-2001 and in addition meet the requirements in 5.4.2 of T1.417-2001. In referring to such systems, this document uses the term SHDSL.

3.1.2 HDSL2 – The acronym for the 2nd generation High Bit Rate Digital Subscriber Line transmission system defined in T1.418-2000. The system uses asymmetric PSD masks and 16 level Trellis Coded Pulse Amplitude Modulation to transport 1536 or 1544 kbit/s over a single non-loaded twisted pair. HDSL2 systems do not support the use of analog splitting technology for coexistence on the same pair with voice services. Spectrum Management Class 4 (SMC 4) in T1.417-2001 is based on the HDSL2 transmission system.

3.1.3 HDSL4 – The acronym for the 4-wire 2nd generation High Bit Rate Digital Subscriber Line transmission system defined in 5.4.3 of T1.417-2001. The system uses asymmetric PSD masks and 16 level Trellis Coded Pulse Amplitude Modulation to transport 776 or 784 kbit/s over a single non-loaded twisted pair and can be used to transport 1536 or 1544 kbit/s over two non-loaded twisted pairs. HDSL4 systems do not support the use of analog splitting technology for coexistence on the same pair with voice services.

3.1.4 longitudinal voltage – The common-mode voltage that is one half of the vector sum of the potential difference between the tip connection and earth ground and the ring connection and earth ground.

3.1.5 metallic signal – The differential-mode signal between the tip and ring connections of the tip/ring pair.

3.1.6 Power Spectral Density (PSD) – The power level and frequency content of a transmitted signal.

3.1.7 PSD mask – The graph or table that indicates the maximum power level (in dBm/Hz) that is permitted over a specified range of frequencies.

3.1.8 SHDSL – In this document, the term SHDSL refers to any terminal equipment having transmit signal characteristics that meet one or more of the TU-R PSD masks and associated output power limits defined in 5.4.2.1 of T1.417-2001. SHDSL systems do not support the use of analog splitting technology for coexistence on the same pair with voice services.

3.1.9 Spectrum Management Class 4 (SMC 4) – The term used in T1.417-2001 and this document in reference to systems that use the asymmetric PSD masks and other requirements in 5.3.4 of T1.417-2001. SMC 4 was designed to support HDSL2 as defined in T1.418-2000.

3.1.10 terminal equipment – Communications equipment located on customer premises at the end of a communications link that is used to permit the stations involved to accomplish the provision of telecommunications or information services.

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[3] Available at < http://www.part68.org/links.htm >.

[4] T1 standards are available from the Alliance for Telecommunications Industry Solutions < http://www.atis.org >.

3.1.11 transverse balance – A comparison of the transmitted metallic or transverse voltage to the resulting longitudinal voltage. For more information, see 4.6 of TIA/EIA-IS-968-2001.

3.2 Abbreviations and Acronyms

ACTA	Administrative Council for Terminal Attachments
ANSI	American National Standards Institute
ATIS	Alliance for Telecommunications Industry Solutions
CFR	Code of Federal Regulations
dB	Decibel
dBm/Hz	decibel referenced to 1 milliwatt per hertz
EIA	Electronic Industries Alliance
FCC	Federal Communications Commission
HDSL2	High Bit Rate Digital Subscriber Line - 2nd Generation
HDSL4	4-Wire High Bit Rate Digital Subscriber Line - 2nd Generation
IS	Interim Standard
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
Kbit/s	Kilobits per second
kHz	Kilohertz
PSD	Power Spectral Density
SHDSL	Single-Pair High-Speed Digital Subscriber Line
SMC	Spectrum Management Class
T1	Committee T1
TE	Terminal Equipment
TIA	Telecommunications Industry Association
TU-R	Transceiver Unit - Remote
Z_L	Longitudinal Impedance
Z_O	Metallic Source Impedance

4 Technical Criteria

Approved SHDSL, HDSL2, and HDSL4 terminal equipment shall meet all applicable requirements in TIA/EIA-IS-968-2001.

SHDSL, HDSL2, and HDSL4 terminal equipment transmit significant power above the voiceband and do not support the use of analog splitting technology for coexistence on the same pair with voiceband services. Therefore, the analog voiceband signal power limits in TIA/EIA-IS-968-2001 are not applicable to SHDSL, HDSL2, or HDSL4 terminal equipment. Likewise, SHDSL, HDSL2, and HDSL4 terminal equipment would not ordinarily conform to the signal power specifications for any of the other services or interfaces defined in 4.5 of TIA/EIA-IS-968-2001. Thus, 4.1 of this document provides signal power limitations for SHDSL, HDSL2, and HDSL4 terminal equipment on an interim basis until such criteria is added to a future version of TIA/EIA-IS-968-2001.

The transverse balance limits in TIA/EIA-IS-968-2001 are applicable to SHDSL, HDSL2, and HDSL4 terminal equipment however that standard does not define important testing criteria, such as the

longitudinal termination, the metallic source impedance, the applicable frequency range, and the metallic voltage to be used. Thus, 4.2 of this document provides transverse balance testing criteria on an interim basis until such criteria is added to a future version of TIA/EIA-IS-968-2001.

4.1 Signal power limitations

Approved SHDSL, HDSL2, and HDSL4 terminal equipment shall meet the metallic signal limits and longitudinal output voltage limits specified in this clause. The requirements referenced for Spectrum Management Class 4 in T1.417-2001 are applicable to HDSL2 terminal equipment and the requirements referenced for G.SHDSL in T1.417-2001 are applicable to SHDSL terminal equipment.

4.1.1 Metallic signal limits

Approved terminal equipment shall meet the TU-R Power Spectral Density (PSD) masks and output power limits for each of the supported PSD masks defined in:

- 5.3.4.1 and 6.2.4 of T1.417-2001 for Spectrum Management Class 4 (SMC 4);
- 5.4.2.1 and 6.3.2 of T1.417-2001 for G.SHDSL; and
- 5.4.3.1 and 6.3.3 of T1.417-2001 for HDSL4.

4.1.2 Longitudinal output voltage limits

For each of the supported PSD masks defined in 4.1.1, approved terminal equipment shall meet the corresponding longitudinal output voltage limits in:

- 5.3.4.3 of T1.417-2001 for SMC 4
- 5.4.2.3 of T1.417-2001 for G.SHDSL; and
- 5.4.3.3 of T1.417-2001 for HDSL4.

Longitudinal output voltage testing is described in 6.7 of T1.417-2001. Illustrative test configurations for longitudinal output voltage limit conformance testing are shown in Figure 16 of T1.417-2001.

4.2 Transverse balance requirements

Approved SHDSL, HDSL2, and HDSL4 terminal equipment shall equal or exceed the minimum transverse balance requirements in Figure 4-11 of TIA/EIA-IS-968-2001 during all operating states and under all reasonable conditions of the application of earth ground to the equipment under test. In addition, transverse balance requirements shall be met for all values of span power voltage or sealing current that the interface under test is capable of drawing when attached to:

- An external span power source that meets the criteria in A.5.3.2 of G.991.2-2001.
- A sealing current source that meets the criteria in A.5.3.3 of G.991.2-2001.

Transverse balance requirements shall be met over the entire range of applicable operating frequencies at all 2-wire network interfaces. For the purposes of this requirement, the applicable operating range is defined as the entire range of frequencies between the highest and lowest frequencies having PSD values within 20 dB of the peak PSD. Thus, the applicable frequency range for transverse balance testing varies depending upon the supported PSD masks.

For supported SMC 4 and HDSL4 non-symmetrical PSD masks defined in 5.3.4.1 and 5.4.3.1 of T1.417-2001, the upper and lower frequencies for transverse balance testing shall consider the downstream frequency spectrum as well as the upstream frequency spectrum since both signals will be present at the network interface.

The longitudinal termination, metallic source impedance, and metallic voltage to be used for transverse balance measurements of SHDSL terminal equipment shall be as defined in Table 1 for each of the supported PSD masks.

Transverse balance testing is described in TIA/EIA TSB 31-B and illustrative test circuits for transverse balance conformance testing with and without loop simulator circuits are shown in Figures 4.7 and 4.8 of TIA/EIA-IS-968-2001. Testing is done with the TE transmitter turned off.

Table 1 - Summary of Transverse Balance Testing Criteria

	Supported PSD Masks		
	5.3.4.1 of T1.417-2001 (SMC 4)	**5.4.2.1 of T1.417-2001 (G.SHDSL)**	**5.4.3.1 of T1.417-2001 (HDSL4)**
Longitudinal Termination - Z_L	500/90 (see Note 1)	500/90 (see Note 1)	500/90 (see Note 1)
Metallic Source Impedance - Z_O	135	135	135
Metallic Voltage for test - E	0.367	0.367	0.367

NOTE 1- The longitudinal impedance (Z_L) shall be 500 ohms for frequencies up to 12 kHz and 90 ohms for frequencies above 12 kHz.

Annex A
(informative)

Annex A Bibliography

47 CFR Part 68, Code of Federal Regulations (CFR), Title 47, FCC Part 68, *Connection of Terminal Equipment to the Telephone Network.*[5]

TIA/EIA TSB 31-B, *Part 68 Rationale and Measurement Guidelines*.[6]

T1.418-2000, *American National Standard for Telecommunications – High bit rate Digital Subscriber Line - 2nd Generation (HDSL2).*[7]

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[5] Information on Part 68 is available at < http://www.fcc.gov/ccb/nsd/documents/PART68.HTML >.
[6] TIA standards are available from the Telecommunications Industry Association < http://www.tiaonline.org/standards/ >.
[7] T1 standards are available from the Alliance for Telecommunications Industry Solutions < http://www.atis.org >.