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OF ITU

G.992.5

Amendment 1

(07/2005)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Access networks

Asymmetric digital subscriber line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)

Amendment 1

CAUTION !

PREPUBLISHED RECOMMENDATION

This prepublication is an unedited version of a recently approved Recommendation. It will be replaced by the published version after editing. Therefore, there will be differences between this prepublication and the published version.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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As of the date of approval of this Recommendation, ITU [had/had not] received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

Amendment 1 to Recommendation G.992.5

Asymmetric digital subscriber line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)

SUMMARY

The draft new amendment 1 to G.992.5 is the first amendment to the integrated ITU-T Rec. G.992.5 approved in January 2005. It specifies the following additions to G.992.5-2005:

1. Addition to § 7 for new optional valid S and D values in the PMS-TC framer configuration. This allow to achieve higher net data rates while satisfying a configured minimum impulse noise protection (INP_min);
2. Addition to § 8 for optional time domain filtering only. This allows the transceiver to meet the PSD mask with only filtering in the time domain;
3. Additions to Annex K to include net data rates corresponding with the new S and D values.
4. A new Annex C based ADSL2plus system operating in the TCM-ISDN environment with a downstream bandwidth of 2208 kHz and an upstream bandwidth of 138 (Annex C.A) or 276 kHz (Annex C.B).
5. A new Appendix VII gives example PSD Masks for operation according to Annex C.

Revision marks are relative to the latest pre-published integrated version of ITU-T Rec. G.992.5.

AMENDMENT 1 TO G.992.5-2005

Asymmetric digital subscriber line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)

7.6.2 Valid Framing Configurations

Table 7-1/G.992.5 – Valid framing configurations

Parameter	Capability
D_p	1, 2, 4, 8, 16, 32, 64. For the downstream latency path #0, additional valid D_0 values are: 96, 128, 160, 192, 224, 256, 288, 320, 352, 384, 416, 448, 480, 511. If $R_p = 0$ then $D_p = 1$
Relationship of $N_{FEC\ 0}$ and D_0	Configurations that satisfy the following relationship are valid: $(N_{FEC\ 0} - 1) \times (D_0 - 1) \leq 254 \times 63 = 16002$
Relation of S_p and M_p	Configurations that satisfy the following relationship are valid: $M_p/3 \leq S_p \leq 32 \times M_p$ (see Note 1). For the downstream latency path #0, additional valid configurations are: $M_0/16 \leq S_0 < M_0/3$
Delay Constraints	Configurations that satisfy the following relationship are valid: $1/3 \leq S_p \leq 64$ (see Note 3). For the downstream latency path #0, additional valid S_0 values are: $1/16 \leq S_0 < 1/3$

7.6.3 Mandatory Framing Configurations

See 7.6.3/G.992.3, with the following difference in Table 7-9:

S_0	$1/3 \leq S_0 < 64$. Support of additional optional S_0 values is indicated during initialization, through $S_{0\ min}$, with $1/16 \leq S_{0\ min} \leq 1/3$. All values of S_0, with $S_{0\ min} \leq S_0 < 1/3$, shall be supported.

7.10 Initialization procedures

See 7.10/G.992.3, with the paragraph below Table 7-18c/G.992.3 reading as follows:

The $S_{0\ min}$ value shall be less than or equal to 1/3 (i.e., n≥2). If the $S_{0\ min}$ octet (see Table 7-18c/G.992.3) is not included in the CL or CLR message, the $S_{0\ min}$ value shall be set equal to 1/3 (implicit indication). The S_0 value selected during the Exchange Phase (see Table 7-7/G.992.3 and § 7.10.3/G.992.3) shall be equal to or higher than the highest of the $S_{0\ min}$ values indicated in the CL and CLR message.

For use in this Recommendation, the unsigned 12-bit net_max value in Table 7-18/G.992.3 is the data rate divided by 8000 (rather than 4000 for use in ITU-T Rec. G.992.3).

8.13.2.1 Handshake – ATU-C

See 8.13.2.1/G.992.3.

The G.992.5 handshake codepoints are defined in ITU-T Rec. G.994.1 [2].

For operation in Annex A, the following additional NPAR(2) codepoint is defined:

NPAR(2)	**Definition for CL message**
Downstream Spectrum Shaping using Time Domain Filtering only	When Set to 1 the ATU-C indicates that only time domain filtering is used to shape the downstream in-band spectrum.

If the ATU-C sets the "Downstream Spectrum Shaping using Time Domain Filtering only" bit to ONE in the CL message, the downstream tssi values shall all be set to 1 and the ATU-C shall shape the in-band transmit PSD only in the time domain, identical to the shape of the downstream Annex A PSD mask. If the ATU-C sets this bit to ZERO in the CL message, it indicates that the ATU-R shall use the downstream tssi values as indicated in the CL message for all calculations.

The ATU-C shall set the "Downstream Spectrum Shaping using Time Domain Filtering only" bit to ONE in the MS message, if and only if both the previous CL and CLR message have this bit set to ONE.

8.13.2.2 Handshake – ATU-R

See 8.13.2.2/G.992.3.

For operation in Annex A, the following additional NPAR(2) codepoint is defined:

NPAR(2)	**Definition for CLR message**
Downstream Spectrum Shaping using Time Domain Filtering only	When Set to 1 the ATU-R indicates that it can support processing of received signals generated with time domain only filtering of the downstream in-band spectrum.

The ATU-R shall set the "Downstream Spectrum Shaping using Time Domain Filtering only" bit to ONE in the MS message, if and only if both the previous CL and CLR message have this bit set to ONE.

If the "Downstream Spectrum Shaping using Time Domain Filtering only" bit is set to ONE in the MS message, the ATU-R shall assume that the downstream tssi values are all set to 1 and the ATU-R shall compute the NOMATP using a set of downstream tssi values derived from the Annex A downstream PSD mask. If the bit is set to ZERO in the MS message, the ATU-R shall use the downstream tssi values as indicated in the previous CL message for all calculations.

Annex K: TPS-TC functional descriptions

Change as follows:

See Annex K/G.992.3, with the following changes:

1) The G.994.1 codepoints shall represent the data rate divided by 8000 bit/s. The last row of Table K.6/G.992.3 shall show "8000 bit/s" instead of "4000 bit/s".
2) The ATU shall support a net data rate of at least 16 Mbit/s. Net_min_n, Net_max_n and $Net\_reserve_n$ entry in Table K.4/G.992.3, Table K.11/G.992.3 and Table K.20/G.992.3 shall show "16 Mbit/s" instead of "8 Mbit/s".
3) Replace Table K.3a/G.992.3, Table K.3b/G.992.3 and Table K.3c/G.992.3 with Table K.3a/G.992.5, Table K.3b/G.992.5 and Table K.3c/G.992.5. For the Table K.3c/G.992.5, the number of subcarriers is 511 and all valid R, S, D and N_{FEC} values listed in Table 7-1/G.992.5 are allowed.
4) The referenced Appendix V is as contained in this Recommendation.

Add at end of section:

Table K.3c/G.992.5 - INP_min and delay_max related Downstream Net Datarates limits using the optional D_0 values for downstream latency path #0 (in kbit/s).

		INP_min						
		0	**½**	**1**	**2**	**4**	**8**	**16**
delay_max [ms]	**1(*)**	29556	0	0	0	0	0	0
	2	29556	25718	20928	7616	0	0	0
	4	29556	27613	25718	21093	7616	0	0
	8	29556	27809	26042	22244	14455	8112	0
	16	29556	27809	26042	22244	14455	8112	4024
	32	29556	27809	26042	22244	14455	8112	4024
	63	29556	27809	26042	22244	14455	8112	4024
(*) In G.997.1, a 1 ms delay is reserved to mean that $S_p \leq 1$ and $D_p = 1$.								

It specifies the following:

- A new Annex C based ADSL2plus system operating in the TCM-ISDN environment with a downstream bandwidth of 2208 kHz and an upstream bandwidth of 138 (Annex C.A) or 276 kHz (Annex C.B).
- A new Appendix VII gives example PSD Masks for operation according to Annex C.

The new Appendix VII consists of additional material, only referenced from the new Annex C.

The revision marks show changes relative to D.396.

ANNEX C TO G.992.5

Asymmetric digital subscriber line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)

Specific requirements for an ADSL system operating in the same cable as ISDN as defined in ITU-T Recommendation G.961 Appendix III

This annex is a delta to the main body of this Recommendation. For sections where no supplements or amendments are made, the section heading is repeated to maintain the numbering of section headings aligned with the main body.

C.1 Scope

This annex defines those parameters of the ADSL system that have been left undefined in the body of this Recommendation because they are unique to an ADSL service that is coexisting in the same binder as TCM-ISDN as defined in ITU-T Recommendation G.961 Appendix III. The subclauses in this annex provide supplementary and replacement material to the clauses in the main body. The modifications described in this annex allow a performance improvement from the ADSL system specified in Annex A in an environment coexisting with TCM-ISDN in the same cable. It is recommended that an ADSL system implementing Annex C also implements Annex A.

For this annex, support of STM-TC as defined in § K1 is left for further study.

C.2 References

This annex does not define any additional references.

C.3 Definitions

ITU-T Recommendation G.992.3 Annex C (§C.3) defines terms applicable to this annex.

C.4 Abbreviations

ITU-T Recommendation G.992.3 Annex C (§C.4) defines abbreviations applicable to this annex.

C.5 Reference Models

See ITU-T Recommendation G.992.3 Annex C §C.5.

C.6 Transport Protocol Specific Transmission Convergence (TPS-TC) function

C.6.1 Transport capabilities

C.6.2 Interface signals and primitives

C.6.3 Control parameters

C.6.4 Data plane procedures

C.6.5 Management plane procedures

C.6.6 Initialization procedure

C.6.6.1 G.994.1 Phase (supplements § 6.6.1/G.992.3)

C.6.6.1.1 G.994.1 Capabilities List Message (supplements § 6.6.1.1/G.992.3)

Replace Table 6-2/G.992.3 with Table C6-1/G.992.5 shown below:

Table C6-1/G.992.5 - Format for TPS-TC Capabilities Information

Spar(2) bits	Definition of Npar(3) bits
Maxtype Upstream (Note)	Parameter block of 2 octets that describes the *maxtype* values for upstream, using an unsigned 3-bit value in the 0 to 4 range for each of the TPS-TC types 2 (ATM) and 3 (PTM).
Maxtype Downstream (Note)	Parameter block of 2 octets that describes the *maxtype* values for downstream, using an unsigned 3-bit value in the 0 to 4 range for each of the TPS-TC types 2 (ATM) and 3 (PTM).
Note – TPS-TC type 1 (STM) is left for further study.	

C.6.6.1.2 G.994.1 Mode select message

C.6.6.2 Channel analysis phase

C.6.6.3 Exchange phase

C.6.7 On-line reconfiguration

C.6.8 Power management mode

C.7 Physical Media Specific Transmission Convergence (PMS-TC) function

See ITU-T Recommendation G.992.3 Annex C §C.7.

C.8 Physical media dependent function

C.8.1 ATU-C/R transmitter timing model (new)

See ITU-T Recommendation G.992.3 Annex C §C.8.1.

C.8.2 Operating modes (new)

See ITU-T Recommendation G.992.3 Annex C §C.8.2.

Example PSDs for Profiles 3, 5, and 6 are in Appendix VII.

The handshake code points to support these profiles are contained in G.994.1

C.8.3 Block interface signals and primitives

C.8.4 Block diagram and internal reference point signals

See ITU-T Recommendation G.992.3 Annex C §C.8.4.

C.8.5 Control Parameters

C.8.5.1 Definition of control parameters

C.8.5.2 Mandatory and Optional Settings of Control Parameters

C.8.5.3 Setting control parameters during initialization (supplements§ 8.5.3)

C.8.5.3.1 During the G.994.1 Phase

C.8.5.3.2 During the Channel Analysis Phase

C.8.5.3.3 During the Exchange Phase (supplements § 8.5.3.3)

The Table 8-5/G.992.5 shall be replaced with Table C8-1/G.992.5 below. The Table C8-1/G.992.5 shows the PMD function control parameters included in C-PARAMS.

Table C8-1/G.992.5 - PMD function control parameters included in C-PARAMS.

Octet Nr [i]	Parameter	Format PMD bits [8*i+7 to 8*i+0]
0	LATNus (lsb)	[xxxx xxxx], bit 7 to 0
1	LATNus (msb)	[0000 00xx], bit 9 and 8
2	SATNus (lsb)	[xxxx xxxx], bit 7 to 0
3	SATNus (msb)	[0000 00xx], bit 9 and 8
4	FEXT SNRMus (lsb)	[xxxx xxxx], bit 7 to 0
5	FEXT SNRMus (msb)	[ssss sxxx], bit 10 to 8
6	FEXT ATTNDRus (lsb)	[xxxx xxxx], bit 7 to 0
7	FEXT ATTNDRus	[xxxx xxxx], bit 15 to 8
8	FEXT ATTNDRus	[xxxx xxxx], bit 23 to 16
9	FEXT ATTNDRus (msb)	[xxxx xxxx], bit 31 to 24
10	FEXT ACTATPus (lsb)	[xxxx xxxx], bit 7 to 0
11	FEXT ACTATPus (msb)	[ssss ssxx], bit 9 and 8
12	NEXT SNRMus (lsb)	[xxxx xxxx], bit 7 to 0
13	NEXT SNRMus (msb)	[ssss sxxx], bit 10 to 8
14	NEXT ATTNDRus (lsb)	[xxxx xxxx], bit 7 to 0
15	NEXT ATTNDRus	[xxxx xxxx], bit 15 to 8
16	NEXT ATTNDRus	[xxxx xxxx], bit 23 to 16
17	NEXT ATTNDRus (msb)	[xxxx xxxx], bit 31 to 24
18	NEXT ACTATPus (lsb)	[xxxx xxxx], bit 7 to 0
19	NEXT ACTATPus (msb)	[ssss ssxx], bit 9 and 8
20	TRELLISus	[0000 000x], bit 0
21	Reserved	[0000 0000]
22	FEXT Upstream Bits and Gains For subcarrier 1 (lsb)	[gggg bbbb], bit 7 to 0
23	FEXT Upstream Bits and Gains For subcarrier 1 (msb)	[gggg gggg], bit 15 to 8
…..	…..	…..
18+2*NSCus	FEXT Upstream Bits and Gains Subcarrier NSCus-1 (lsb)	[gggg bbbb], bit 7 to 0
19+2*NSCus	FEXT Upstream Bits and Gains Subcarrier NSCus-1 (msb)	[gggg gggg], bit 15 to 8
20+2*NSCus	NEXT Upstream Bits and Gains For subcarrier 1 (lsb)	[gggg bbbb], bit 7 to 0

Octet Nr [i]	Parameter	Format PMD bits [8*i+7 to 8*i+0]
21+2*NSCus	NEXT Upstream Bits and Gains For subcarrier 1 (msb)	[gggg gggg], bit 15 to 8
…..	…..	…..
16+4*NSCus	NEXT Upstream Bits and Gains Subcarrier NSCus-1 (lsb)	[gggg bbbb], bit 7 to 0
17+4*NSCus	NEXT Upstream Bits and Gains Subcarrier NSCus-1 (msb)	[gggg gggg], bit 15 to 8
18+4*NSCus	Reserved	[0000 0000]
19+4*NSCus	Upstream Tone ordering First subcarrier to map	[xxxx xxxx], bit 7 to 0
…..	…..	…..
17+5*NSCus	Upstream Tone ordering Last subcarrier to map	[xxxx xxxx], bit 7 to 0

The Table 8-6/G.992.5 shall be replaced with Table C8-2/G.992.5. The Table C8-2/G.992.5 shows the PMD function control parameters included in R-PARAMS.

Table C8-2/G.992.5 - PMD function control parameters included in R-PARAMS.

Octet Nr [i]	Parameter	Format PMD bits [8*i+7 to 8*i+0]
0	LATNds (lsb)	[xxxx xxxx], bit 7 to 0
1	LATNds (msb)	[0000 00xx], bit 9 and 8
2	SATNds (lsb)	[xxxx xxxx], bit 7 to 0
3	SATNds (msb)	[0000 00xx], bit 9 and 8
4	FEXT SNRMds (lsb)	[xxxx xxxx], bit 7 to 0
5	FEXT SNRMds (msb)	[ssss sxxx], bit 10 to 8
6	FEXT ATTNDRds (lsb)	[xxxx xxxx], bit 7 to 0
7	FEXT ATTNDRds	[xxxx xxxx], bit 15 to 8
8	FEXT ATTNDRds	[xxxx xxxx], bit 23 to 16
9	FEXT ATTNDRds (msb)	[xxxx xxxx], bit 31 to 24
10	FEXT ACTATPds (lsb)	[xxxx xxxx], bit 7 to 0
11	FEXT ACTATPds (msb)	[ssss ssxx], bit 9 and 8
12	NEXT SNRMds (lsb)	[xxxx xxxx], bit 7 to 0
13	NEXT SNRMds (msb)	[ssss sxxx], bit 10 to 8
14	NEXT ATTNDRds (lsb)	[xxxx xxxx], bit 7 to 0
15	NEXT ATTNDRds	[xxxx xxxx], bit 15 to 8

Octet Nr [i]	Parameter	Format PMD bits [8*i+7 to 8*i+0]
16	NEXT ATTNDRds	[xxxx xxxx], bit 23 to 16
17	NEXT ATTNDRds (msb)	[xxxx xxxx], bit 31 to 24
18	NEXT ACTATPds (lsb)	[xxxx xxxx], bit 7 to 0
19	NEXT ACTATPds (msb)	[ssss ssxx], bit 9 and 8
20	TRELLISds	[0000 000x], bit 0
21	Reserved	[0000 0000]
22	FEXT Downstream Bits and Gains For subcarrier 1 (lsb)	[gggg bbbb], bit 7 to 0
23	FEXT Downstream Bits and Gains For subcarrier 1 (msb)	[gggg gggg], bit 15 to 8
…..	…..	…..
18+2*NSCds	FEXT Downstream Bits and Gains Subcarrier NSCus-1 (lsb)	[gggg bbbb], bit 7 to 0
19+2*NSCds	FEXT Downstream Bits and Gains Subcarrier NSCus-1 (msb)	[gggg gggg], bit 15 to 8
20+2*NSCds	NEXT Downstream Bits and Gains For subcarrier 1 (lsb)	[gggg bbbb], bit 7 to 0
21+2*NSCds	NEXT Downstream Bits and Gains For subcarrier 1 (msb)	[gggg gggg], bit 15 to 8
…..	…..	…..
16+4*NSCds	NEXT Downstream Bits and Gains Subcarrier NSCus-1 (lsb)	[gggg bbbb], bit 7 to 0
17+4*NSCds	NEXT Downstream Bits and Gains Subcarrier NSCus-1 (msb)	[gggg gggg], bit 15 to 8
18+4*NSCds	Reserved	[0000 0000]
19+4*NSCds	Downstream Tone ordering First subcarrier to map	[xxxx xxxx], bit 7 to 0
…..	…..	…..
17+5*NSCds	Downstream Tone ordering Last subcarrier to map	[xxxx xxxx], bit 7 to 0

C.8.6 Constellation encoder for data symbols

See ITU-T Recommendation G.992.3 Annex C §C.8.6.

C.8.7 Constellation encoder for synchronization and L2 exit symbols

See ITU-T Recommendation G.992.3 Annex C §C.8.7.

C.8.8 Modulation

C.8.9 Transmitter dynamic range

C.8.10 Transmitter spectral masks (supplements 8.10)

Spectral masks for the different service options are defined in the corresponding sub-annexes. The spectral mask defines the maximum passband PSD, maximum stopband PSD and maximum aggregate transmit power.

See sub-annexes C.A and C.B.

C.8.11 Control plane procedures

C.8.12 Management plane procedures

See ITU-T Recommendation G.992.3 Annex C §C.8.12.

C.8.13 Initialization

C.8.13.1 Initialization with Hyperframe (new)

See ITU-T Recommendation G.992.3 Annex C §C8.13.1.

C.8.13.2 G.994.1 phase

C.8.13.2.1 Handshake – ATU-C

See ITU-T Recommendation G.992.3 Annex C §C8.13.2.1.

The G.992.5 handshake codepoints are defined in ITU-T Rec. G.994.1.

C.8.13.2.2 Handshake – ATU-R

See ITU-T Recommendation G.992.3 Annex C §C8.13.2.2.

The G.992.5 handshake codepoints are defined in ITU-T Rec. G.994.1.

C.8.13.2.3 G.994.1 transmit PSD levels

C.8.13.2.4 Spectral bounds and shaping parameters

C.8.13.3 Channel discovery phase

See ITU-T Recommendation G.992.3 Annex C §C.8.13.3.

C.8.13.4 Transceiver training phase

See ITU-T Recommendation G.992.3 Annex C §C.8.13.4.

C.8.13.5 Channel analysis phase (supplements G.992.3 C.8.13.5)

C.8.13.5.1 ATU-C Channel Analysis (supplements G.992.3 C.8.13.5.1)

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.1.

C.8.13.5.1.1 C-MSG1 (supplements G.992.3 C.8.13.5.1.1)

The C-MSG1 state is of fixed length with 2 possible lengths, depending on whether the windowing parameters are included. In this state, the ATU-C shall transmit the C-MSG1 symbols only during the $FEXT_R$ symbols. During the $NEXT_R$ symbols, the ATU-C shall transmit the C-TREF pilot tone, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols. The ATU-C shall transmit LEN_C-MSG1 C-REVERB or C-SEGUE symbols to modulate the C-MSG1 prefix, message and crc. The C-MSGS1 state shall be the first state in which the ATU-C transmits the cyclic prefix. There are LEN_C-MSG1 = 240 or 240+NSCds/4 C-MSG1 FEXTR symbols which corresponding to 690 or 690+(NSCds/512)*345 symbols depending on whether windowing is applied or not respectively.

The C-MSG1 state shall have a minimum duration of 690 symbols (ie two hyperframes, each consisting of 128 $FEXT_R$ symbols). The 240 C-MSG1 symbols shall be transmitted in the first 240 $FEXT_R$ symbols of the C-MSG1 state. For the remaining 256 – 240 = 16 $FEXT_R$ symbols the ATU-C shall transmit the C-TREF pilot tone.

C.8.13.5.1.2 C-REVERB5

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.1.2.

C.8.13.5.1.3 C-SEGUE2

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.1.3.

C.8.13.5.1.4 C-MEDLEY

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.1.4.

C.8.13.5.1.5 C-EXCHMARKER

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.1.5.

C.8.13.5.2 ATU-R Channel Analysis (supplements G.992.3 C.8.13.5.2)

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.2.

C.8.13.5.2.1 R-REVERB5 (supplements G.992.3 C.8.13.5.2.1)

The R-REVERB5 state is of fixed length with 2 possible lengths, depending on whether the windowing parameters are included. In the R-REVERB5 state, the ATU-R shall transmit during both FEXTC and NEXTC symbols when bitmap NC is enabled (DBM). The ATU-R shall transmit R-REVERB symbols only during FEXTC symbols when bitmap NC is disabled (FBM).

In the R-REVERB5 state, the ATU-R shall transmit 1035-23 or {3+(NSCds/512)}*345-23 depending on whether windowing is applied or not R-REVERB symbols. The R-REVERB5 state shall be the first state in which the ATU-R transmits the cyclic prefix.

C.8.13.5.2.2 R-SEGUE2

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.2.2.

C.8.13.5.2.3 R-MSG1

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.2.3.

C.8.13.5.2.4 R-MEDLEY

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.2.4.

C.8.13.5.2.5 R-EXCHMARKER

See ITU-T Recommendation G.992.3 Annex C §C.8.13.5.2.5.

C.8.13.6 Exchange phase

See ITU-T Recommendation G.992.3 Annex C §C.8.13.6.

C.8.13.7 Timing diagram of the initialization procedures

See ITU-T Recommendation G.992.3 Annex C §C.8.13.7.

C.8.14 Short Initialization Procedures (supplements § 8.14)

The Short Initialization Procedure defined in §8.14 is not applicable to, and therefore shall not be used for Annex C.

C.8.15 Loop diagnostics mode procedures (supplements § 8.15)

C.8.15.1 Overview

C.8.15.2 Channel discovery phase

See ITU-T Recommendation G.992.3 Annex C § C.8.15.2.

C.8.15.3 Transceiver training phase

C.8.15.4 Channel analysis phase

See ITU-T Recommendation G.992.3 Annex C § C.8.15.4.

C.8.15.5 Exchange phase

C.8.15.5.1 ATU-C exchange phase

See ITU-T Recommendation G.992.3 Annex C § C.8.15.5.1.

C.8.15.5.2 ATU-R exchange phase (supplements G.992.3 C.8.15.5.2)

C.8.15.5.2.1 Channel information bearing messages (supplements G.992.3 C.8.15.5.2.1)

Table C8-3/G.992.5 - Format of the R-MSG1-LD message
(replaces Table C8-17/G.992.3)

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[0000 0001]
1	Reserved	[0000 0000]
2	Hlin scale (lsb)	[xxxx xxxx], bit 7 to 0
3	Hlin scale (msb)	[xxxx xxxx], bit 15 to 8
4	LATN (lsb)	[xxxx xxxx], bit 7 to 0
5	LATN (msb)	[0000 00xx], bit 9 and 8
6	SATN (lsb)	[xxxx xxxx], bit 7 to 0
7	SATN (msb)	[0000 00xx], bit 9 and 8
8	FEXT SNRM (lsb)	[xxxx xxxx], bit 7 to 0
9	FEXT SNRM (msb)	[0000 00xx], bit 9 and 8
10	FEXT ATTNDR (lsb)	[xxxx xxxx], bit 7 to 0
11	FEXT ATTNDR	[xxxx xxxx], bit 15 to 8
12	FEXT ATTNDR	[xxxx xxxx], bit 23 to 16
13	FEXT ATTNDR (msb)	[xxxx xxxx], bit 31 to 24
14	FEXT Far-end ACTATP (lsb)	[xxxx xxxx], bit 7 to 0
15	FEXT Far-end ACTATP (msb)	[ssss ssxx], bit 9 to 8
16	NEXT SNRM (lsb)	[xxxx xxxx], bit 7 to 0
17	NEXT SNRM (msb)	[0000 00xx], bit 9 and 8
18	NEXT ATTNDR (lsb)	[xxxx xxxx], bit 7 to 0
19	NEXT ATTNDR	[xxxx xxxx], bit 15 to 8
20	NEXT ATTNDR	[xxxx xxxx], bit 23 to 16
21	NEXT ATTNDR (msb)	[xxxx xxxx], bit 31 to 24
22	NEXT Far-end ACTATP (lsb)	[xxxx xxxx], bit 7 to 0
23	NEXT Far-end ACTATP (msb)	[ssss ssxx], bit 9 to 8

Table C8-4/G.992.5 – Format of the FEXT QLN(i) R-MSGx-LD message (replaces Table C8-18/G.992.3)

Octet Nr [i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[xxxx xxxx] (as 8-bit unsigned integer)
1	Reserved	[0000 0000]
2	FEXT QLN(256*k)	[xxxx xxxx], bit 7 to 0
…..	…..	…..
257	FEXT QLN(256*k+255)	[xxxx xxxx], bit 7 to 0
NOTE - For each of the values k = 0 to NSCds/256-1, a single R-MSGx-LD message shall be transmitted, with sequence number x = 3*NSCds/128+2+k.		

Table C8-5/G.992.5 – Format of the FEXT SNR(i) R-MSGx-LD message (replaces Table C8-19/G.992.3)

Octet Nr [i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[xxxx xxxx] (as 8-bit unsigned integer)
1	Reserved	[0000 0000]
2	FEXT SNR(256*k)	[xxxx xxxx], bit 7 to 0
…..	…..	…..
257	FEXT SNR(256*k+255)	[xxxx xxxx], bit 7 to 0
NOTE - For each of the values k = 0 to NSCds/256-1, a single R-MSGx-LD message shall be transmitted, with sequence number x = 7*NSCds/256+2+k.		

Table C8-6/G.992.5 – Format of the NEXT QLN(i) R-MSGx-LD message (replaces Table C8-20/G.992.3)

Octet Nr [i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[xxxx xxxx] (as 8-bit unsigned integer)
1	Reserved	[0000 0000]
2	NEXT QLN(256*k)	[xxxx xxxx], bit 7 to 0
…..	…..	…..
257	NEXT QLN(256*k+255)	[xxxx xxxx], bit 7 to 0
NOTE - For each of the values k = 0 to NSCds/256-1, a single R-MSGx-LD message shall be transmitted, with sequence number x = 4*NSCds/128+2+k.		

Table C8-7/G.992.5 – Format of the NEXT SNR(i) R-MSGx-LD message (replaces Table C8-21/G.992.3)

Octet Nr [i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[xxxx xxxx] (as 8-bit unsigned integer)
1	Reserved	[0000 0000]
2	NEXT SNR(256*k)	[xxxx xxxx], bit 7 to 0
…..	…..	…..
257	NEXT SNR(256*k+255)	[xxxx xxxx], bit 7 to 0
NOTE - For each of the values k = 0 to NSCds/256-1, a single R-MSGx-LD message shall be transmitted, with sequence number x = 9*NSCds/256+2+k.		

Table C8-8/G.992.5 – ATU-R loop diagnostics state durations (replaces Table C8-22/G.992.3)

State	Duration (round up in Hyperframes)
R-MSG1-LD	[(24*8)+16]/34 = 7
R-MSGx-LD (x=2 to 10*NSCds/256+1)	[258*8+16]/34 = 62

C.8.15.5.2.2 Message flow, acknowledgement and retransmission

See ITU-T Recommendation G.992.3 Annex C § C.8.15.5.2.2.

C.8.15.6 Timing diagram of the loop diagnostics procedures

C.8.16 On-line reconfiguration of the PMD function

C.8.17 Power management in the PMD function

C.9 Management Protocol Specific Transmission Convergence (MPS-TC) functions (supplements § 9)

C.9.1 Transport functions

C.9.2 Additional functions

C.9.3 Block interface signals and primitives

C.9.4 Management Plane Procedures (supplements 9.4)

C.9.4.1 Commands (supplements 9.4.1)

C.9.4.1.1 On-line reconfiguration command (supplements 9.4.1.1)

See ITU-T Recommendation G.992.3 Annex C § C.9.4.1.1.

The Table C9-1/G.992.5 replaces Table C9-1/G.992.3.

Table C9-1/G.992.5 – On line reconfiguration commands transmitted by the Initiating Receiver

Message length (Octets)	**ELEMENT NAME (Command)**
44	01_{16} FEXT bitmap Request Type 1 followed by 2 octet for the number of sub-carriers N_f 4* N_f octets describing FEXT bitmap sub-carrier parameter field for each sub-carrier
$4 + 8*N_{LP} + 4*N_f$	08_{16} FEXT bitmap Request Type 3 followed by $2*N_{LP}$ octets containing new $Lf3_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Ln3_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Lf4_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Ln4_P$ values for the N_{LP} enabled latency paths, 2 octet for the number of carriers N_f 4* N_f octets describing FEXT bitmap sub-carrier parameter field for each sub-carrier
$4 + 4*N_f$	09_{16} NEXT bitmap Request Type 1 followed by 2 octet for the number of sub-carriers N_f 4* N_f octets describing NEXT bitmap sub-carrier parameter field for each sub-carrier
$4 + 8*N_{LP} + 4*N_f$	$0A_{16}$ NEXT bitmap Request Type 3 followed by $2*N_{LP}$ octets containing new $Lf3_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Ln3_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Lf4_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Ln4_P$ values for the N_{LP} enabled latency paths, 2 octet for the number of carriers N_f 4* N_f octets describing NEXT bitmap sub-carrier parameter field for each sub-carrier
	All other octet values are reserved by the ITU-T.

C.9.4.1.2 eoc commands

C.9.4.1.3 Time commands

C.9.4.1.4 Inventory command

C.9.4.1.5 Control value read commands

C.9.4.1.6 Management counter read commands

C.9.4.1.7 Power management commands (supplements 9.4.1.7)

See ITU-T Recommendation G.992.3 Annex C § C.9.4.1.2.

The Table C9-2/G.992.5 replaces Table C9-3/G.992.3.

Table C9-2/G.992.5 - Change in L2 Grant command

Message length (Octets)	**ELEMENT NAME** **(Command)**
5+ $2*N_{LP} + 3*N_f$	82_{16} L2 Grant followed by $2*N_{LP}$ octets containing new Lf_p values for the N_{LP} enabled latency paths (See NOTE), 1 octet containing the actual PCBds value, 1 octet containing the exit symbol PCBds value, 1 octet containing the exit symbol bi/gi table flag, 1 octet for the number of carriers N_f , 3 * N_f octets describing sub-carrier parameter field for each sub-carrier
NOTE - Since L2 state is not meant for data transmission, jitter requirements shall be ignored in this state for simplicity. The following relation shall be used during L2 state: $Lf3_p = Lf4_p = Lf_p$	

A sub-carrier parameter field contains 3 octets formatted as [0000 0ccc cccc cccc 0000 bbbb]. The carrier index i (11-bits) and the b_i (4 bits). The carrier index shall be the three least significant bits of the first octet and the second octet of the sub-carrier field. The b_i shall be the least significant 4 bits of the second octet.

C.9.4.1.8 Clear eoc messages

C.9.4.1.9 Non-standard facility overhead commands

C.9.4.1.10Test Parameter Messages (supplements -9.4.1.10)

See ITU-T Recommendation G.992.3 Annex C § C.9.4.1.3.

The Table C9-3/G.992.5 replaces Table C9-4/G.992.3.

Table C9-3/G.992.5 - PMD Test Parameter ID Values

Test Parameter ID	Test Parameter Name	Length for Single Read	Length for Multiple Read	Length for Block Read
01_{16}	Channel Transfer Function *Hlog(f)* per sub-carrier	2 + *NSC* * 2 octets	5 octets	2 + (stop subcarrier – start subcarrier + 1) × 2 octets
02_{16}	Reserved by ITU-T			
03_{16}	FEXT Quiet Line Noise PSD *QLN(f)* per sub-carrier	2 + *NSC* octets	4 octet	2 + (stop subcarrier – start subcarrier + 1) octets
04_{16}	FEXT Signal to noise ratio *SNR(f)* per sub-carrier	2 + *NSC* octets	4 octet	2 + (stop subcarrier – start subcarrier + 1) octets
05_{16}	Reserved by ITU-T			
21_{16}	Line Attenuation *LATN*	2 octets	N/a	N/a
22_{16}	Signal Attenuation *SATN*	2 octets	N/a	N/a
23_{16}	FEXT Signal-to-Noise Margin *SNRM*	2 octets	N/a	N/a
24_{16}	FEXT Attainable Net Data Rate *ATTNDR*	4 octets	N/a	N/a
25_{16}	FEXT Near-end Actual Aggregate Transmit Power *ACTATP*	2 octets	N/a	N/a
26_{16}	FEXT Far-end Actual Aggregate Transmit Power *ACTATP*	2 octets	N/a	N/a
83_{16}	NEXT Quiet Line Noise PSD *QLN(f)* per sub-carrier	2 + *NSC* octets	4 octet	2 + (stop subcarrier – start subcarrier + 1) octets
84_{16}	NEXT Signal to noise ratio *SNR(f)* per sub-carrier	2 + *NSC* octets	4 octet	2 + (stop subcarrier – start subcarrier + 1) octets
$A3_{16}$	NEXT Signal-to-Noise Margin *SNRM*	2 octets	N/a	N/a
$A4_{16}$	NEXT Attainable Net Data Rate *ATTNDR*	4 octets	N/a	N/a
$A5_{16}$	NEXT Near-end Actual Aggregate Transmit Power *ACTATP*	2 octets	N/a	N/a
$A6_{16}$	NEXT Far-end Actual Aggregate Transmit Power *ACTATP*	2 octets	N/a	N/a

C.9.5 Power management

C.10 Dynamic behaviour

C.K TPS-TC functional description

NOTE – This section includes Annex C specific supplements and replacements relative to Annex K.

See C.K/G.992.3, with the following change:

The ATU shall support a net data rate of at least 16 Mbit/s. The Net_min_n, Net_max_n and $Net\_reserve_n$ entries in Table C.K2.3/G.992.3 shall show "16 Mbit/s" instead of "8 Mbit/s".

Annex C.A

Specific requirements for an Annex C based ADSL system operating with a downstream bandwidth of 2208 kHz and an upstream bandwidth of 138 kHz

This annex defines those parameters of the ADSL system that have been left undefined in the body of Annex C because they are unique to an ADSL service that uses a downstream bandwidth up to 2208 kHz (subcarrier 512) and an upstream bandwidth up to 138 kHz (subcarrier 32).

CA.1 ATU-C functional characteristics (pertains to § 8)

CA.1.1 ATU-C control parameter settings

As defined in § A.1.1.

CA.1.2 ATU-C downstream transmit spectral mask for overlapped spectrum operation (supplements § 8.10)

As defined in § A.1.2.

CA.1.2.1 Passband PSD and response

As defined in § A.1.2.1.

CA.1.2.2 Aggregate transmit power

As defined in § A.1.2.2.

CA.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements § 8.10)

As defined in § A.1.3.

CA.1.3.1 Passband PSD and response

As defined in § A.1.3.1.

CA.1.3.2 Aggregate transmit power

As defined in § A.1.3.2.

CA.2 ATU-R functional characteristics (pertains to § 8)

CA.2.1 ATU-R control parameter settings

As defined in § A.2.1.

CA.2.2 ATU-R upstream transmit spectral mask (supplements § 8.10)

As defined in § A.2.2.

CA.2.2.1 Passband PSD and response

As defined in A.2.2.1.

CA.2.2.2 Aggregate transmit power

As defined in A.2.2.2

CA.3 Initialization

For this annex, no additional requirements apply (relative to the Annex C).

Annex C.B

Specific requirements for an Annex C based ADSL system operating with a downstream bandwidth of 2208 kHz and an upstream bandwidth of 276 kHz

This annex defines those parameters of the ADSL system that have been left undefined in the body of Annex C because they are unique to an ADSL service that uses a downstream bandwidth up to 2208 kHz (subcarrier 512) and an upstream bandwidth up to 276 kHz (subcarrier 64).

CB.1 ATU-C functional characteristics (pertains to § 8)

CB.1.1 ATU-C control parameter settings

As defined in § A.1.1.

CB.1.2 ATU-C downstream transmit spectral mask for overlapped spectrum operation (supplements § 8.10)

As defined in § A.1.2.

CB.1.2.1 Passband PSD and response

As defined in § A.1.2.1.

CB.1.2.2 Aggregate transmit power

As defined in § A.1.2.2.

CB.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements § 8.10)

As defined in § A.1.3.

CB.1.3.1 Passband PSD and response

As defined in § A.1.3.1.

CB.1.3.2 Aggregate transmit power

As defined in § A.1.3.2.

CB.2 ATU-R functional characteristics (pertains to § 8)

CB.2.1 ATU-R control parameter settings

As defined in § M.2.1.

CB.2.2 ATU-R upstream transmit spectral mask (supplements § 8.10)

As defined in § M.2.2, except that the ATU-R transmit PSD shall comply with EU-64.

CB.2.2.1 Passband PSD and response

As defined in § M.2.2.1 for EU-64.

CB.2.2.2 Aggregate transmit power

As defined in § M.2.2.2.

CB.3 Initialization

CB.3.1 Handshake – ATU-C

See ITU-T Recommendation G.992.3 Annex C §CB.3.1.

CB.3.2 Handshake – ATU-R

See ITU-T Recommendation G.992.3 Annex C §CB.3.2.

Appendix VII to G.992.5

Example overlapped PSD masks for use in a TCM-ISDN crosstalk environment

This appendix defines example shaped overlapped downstream PSD masks for use in a TCM-ISDN crosstalk environment. These masks may be used with Annex C modes of operation that use overlapped PSDs.

VII.1 Example downstream PSD masks for use with Profiles 5 and 6

In this clause, two example downstream PSD masks are described. They may be used for downstream Dual Bitmap modes with overlapped spectrum. In general, using overlapped spectrum downstream may result in NEXT to the upstream channel. To meet spectrum compatibility requirements, the frequency components overlapping the upstream channel are shaped to reduce the crosstalk. The first example is a spectrally shaped mask used during the NEXT phase of the TTR clock. The second PSD mask has an alternative spectral shaping and is designed for use during the FEXT phase of the TTR clock.

VII.1.1 Downstream shaped overlapped PSD mask for use during NEXT periods

The shaped overlapped spectral mask for use during NEXT periods of the TTR clock is defined in Table VII.1a and Table VII.1b and shown plotted in Figure VII.1. Spectral shaping is provided in the frequency band overlapping the ADSL upstream channel. Adherence to this mask will result in spectral compatibility with other systems deployed in an access network in a TCM-ISDN crosstalk environment.

NOTE - The definitions given in Table VII.1a, Table VII.1b and Figure VII.1 are those of a PSD mask. The corresponding PSD template is 3.5 dB below the mask at all frequencies.

Table VII.1a/G.992.5 – Tabulation of a shaped overlapped downstream PSD mask for use during NEXT periods of the TTR clock.

Frequency *f* (kHz)	PSD (dBm/Hz) Peak values
$0 \le f < 4$	–97.5, with max power in the 0-4 kHz band of +15 dBrn
$4 \le f < 32$	–94.5
$32 \le f < 109$	$-94.5 + 20.65 \log2(f/32)$
$109 \le f < 138$	$-58 + 58 \log2(f/109)$
$138 \le f < 200$	$-38.3 + 3.36 \log2(f/138)$
$200 \le f < 1104$	–36.5
$1104 \le f < 1622$	$-36.5 - 18 \log2(f/1104)$
$1622 \le f < 2208$	$-46.5 - 3 \log2(f/1622)$
$2208 \le f < 2500$	$-47.8 - 65 \log2(f/2208)$
$2500 \le f < 3001.5$	$-59.4 - 78 \log2(f/2500)$
$3001.5 \le f < 3175$	$-80 - 246.7 \log2(f/3001.5)$
$3175 \le f < 11040$	–100 dBm/Hz peak PSD in 10 kHz window

Table VII.1b/G.992.5 – Additional PSD requirements for use during NEXT periods of the TTR clock.

Frequency *f* (kHz)	Peak PSD (dBm/Hz) values in 1 MHz window above 3750 kHz
$3750 \le f < 4545$	$-100 - 36 \log2(f/3750)$
$4545 \le f < 7225$	$-110 - 3.0 \log2(f/4545)$
$7225 \le f < 11040$	–112

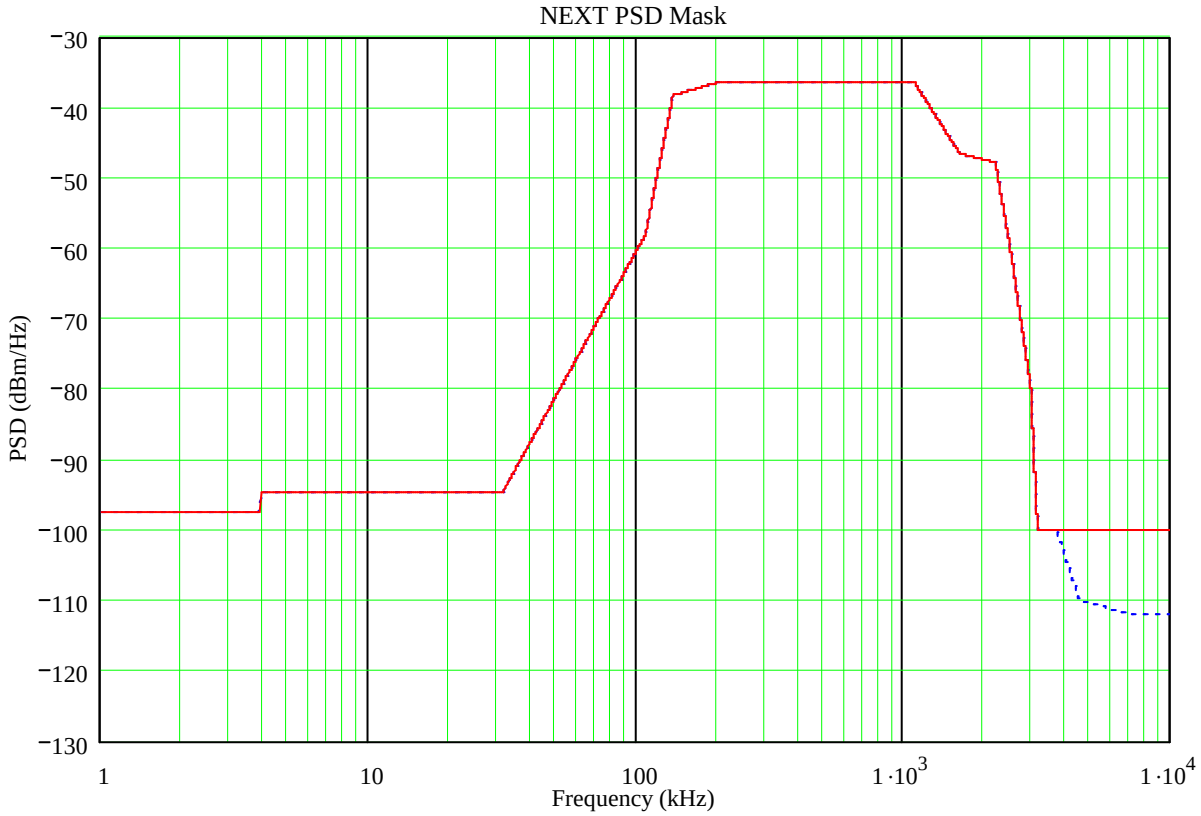

Figure VII.1/G.992.5 – A shaped overlapped downstream PSD mask for use during NEXT periods of the TTR clock.

VII.1.2 Downstream shaped PSD mask for use during FEXT periods

The shaped overlapped spectral mask for use during FEXT periods of the TTR clock is defined in Table VII.2a and Table VII.2b and shown plotted in Figure VII.2. Spectral shaping is provided in the frequency band overlapping the ADSL upstream channel. Adherence to this mask will result in spectral compatibility with other systems deployed in an access network in a TCM-ISDN crosstalk environment.

NOTE - The definitions given in Table VII.2a and Table VII.2b and Figure VII.2 are those of a PSD mask. The corresponding PSD template is 3.5 dB below the mask at all frequencies.

Table VII.2a/G.992.5 – Tabulation of a shaped overlapped downstream PSD mask for use during FEXT periods of the TTR clock.

Frequency *f* (kHz)	PSD (dBm/Hz) Peak values
$0 \le f < 4$	–97.5, with max power in the 0-4 kHz band of +15 dBrn
$4 \le f < 4.8$	–94.5
$4.8 \le f < 50$	$-94.5 + 11.0 \log_2(f/4.8)$
$50 \le f < 126$	$-57.5 + 15.7 \log_2(f/50)$
$126 \le f < 1104$	–36.5
$1104 \le f < 1622$	$-36.5 - 18 \log_2(f/1104)$
$1622 \le f < 2208$	$-46.5 - 3 \log_2(f/1622)$
$2208 \le f < 2500$	$-47.8 - 65 \log_2(f/2208)$
$2500 \le f < 3001.5$	$-59.4 - 78 \log_2(f/2500)$
$3001.5 \le f < 3175$	$-80 - 246.7 \log_2(f/3001.5)$
$3175 \le f < 11040$	–100 dBm/Hz peak PSD in 10 kHz window

Table VII.2b/G.992.5 – Additional PSD requirements for use during FEXT periods of the TTR clock.

Frequency *f* (kHz)	Peak PSD (dBm/Hz) values in 1 MHz window above 3750 kHz
$3750 \le f < 4545$	$-100 - 36 \log_2(f/3750)$
$4545 \le f < 7225$	$-110 - 3.0 \log_2(f/4545)$
$7225 \le f < 11040$	–112

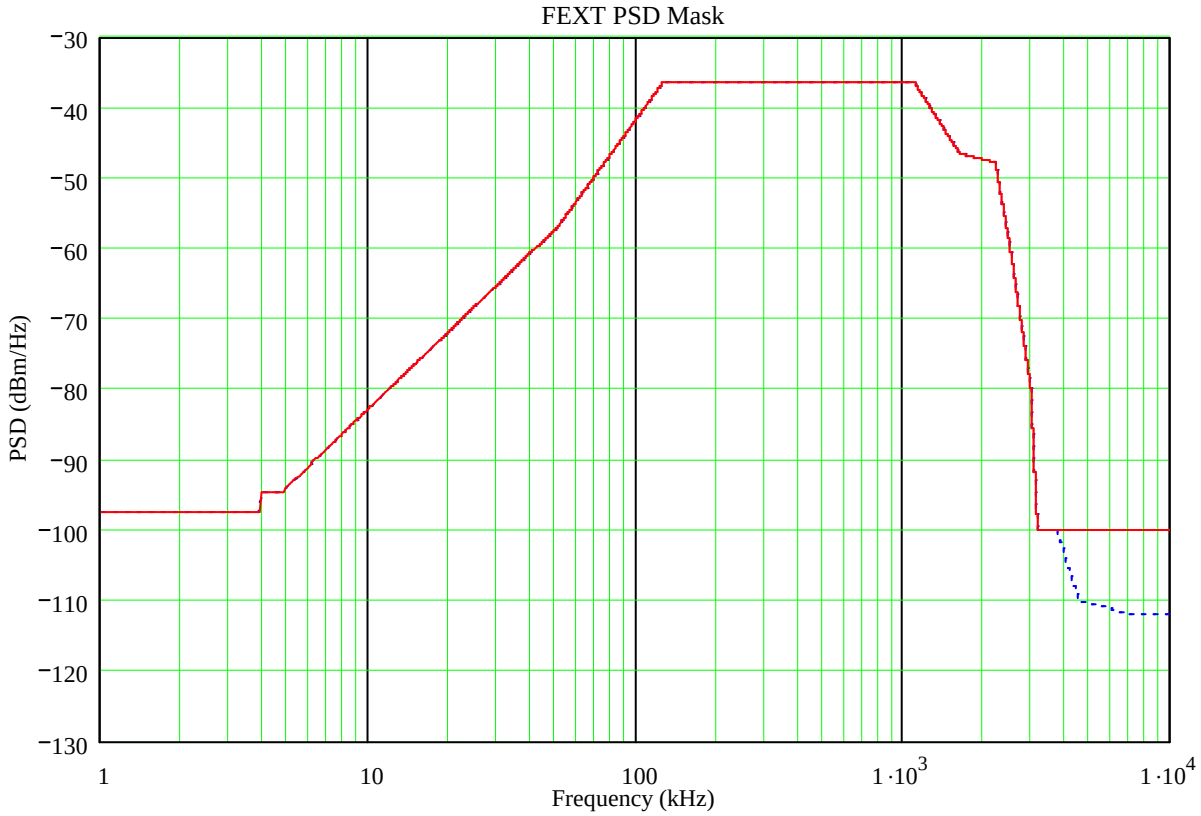

Figure VII.2/G.992.5 – A shaped overlapped downstream PSD mask for use during FEXT periods of the TTR clock.

VII.2 Example downstream PSD mask for use with Profile 3

An example shaped overlapped spectral mask for use with Profile 3 is defined in Table VII.3a and Table VII.3b and shown in Figure VII.3. Spectral shaping is provided in the frequency band overlapping the ADSL upstream channel. Adherence to this mask will result in spectral compatibility with other systems deployed in an access network in a TCM-ISDN crosstalk environment.

NOTE - The definitions given in Table VII.3a and Table VII.3b and Figure VII.3 are those of a PSD mask. The corresponding PSD template is 3.5 dB below the mask at all frequencies.

Table VII.3a/G.992.5 – Tabulation of a shaped downstream PSD mask for Profile 3.

Frequency *f* (KHz)	PSD (dBm/Hz) Peak values
$0 \le f < 4$	–97.5, with max power in the in 0-4 kHz band of +15 dBrn
$4 \le f < 5$	$-92.5 + 18.64 \log_2(f/4)$
$5 \le f < 5.25$	–86.5
$5.25 \le f < 16$	$-86.5 + 15.25 \log_2(f/5.25)$
$16 \le f < 32$	$-62 + 25.5 \log_2(f/16)$
$32 \le f < 1104$	–36.5
$1104 \le f < 1622$	$-36.5 - 18 \log_2(f/1104)$
$1622 \le f < 2208$	$-46.5 - 3 \log_2(f/1622)$
$2208 \le f < 2500$	$-47.8 - 65 \log_2(f/2208)$
$2500 \le f < 3001.5$	$-59.4 - 78 \log_2(f/2500)$
$3001.5 \le f < 3175$	$-80 - 246.7 \log_2(f/3001.5)$
$3175 \le f < 11040$	–100 dBm/Hz peak PSD in 10 kHz window

Table VII.3b/G.992.5 – Additional PSD requirements for profile 3.

Frequency *f* (kHz)	Peak PSD (dBm/Hz) values in 1 MHz window above 3750 kHz
$3750 \le f < 4545$	$-100 - 36 \log_2(f/3750)$
$4545 \le f < 7225$	$-110 - 3.0 \log_2(f/4545)$
$7225 \le f < 11040$	–112

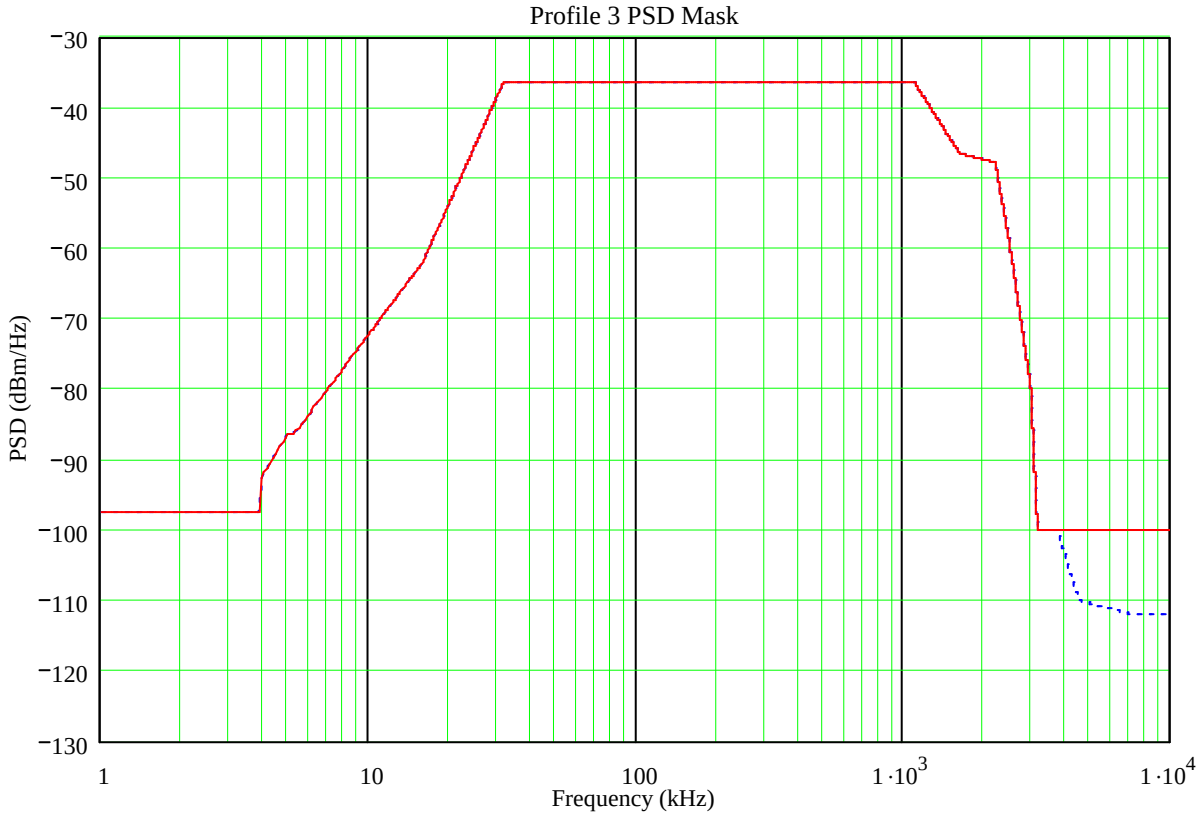

Figure VII.3/G.992.5 – A shaped downstream PSD mask for Profile 3.