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G.992.3
Amendment 2
(04/2004)

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

Digital sections and digital line system – Access networks

Asymmetric digital subscriber line transceivers 2 (ADSL2)

Amendment 2: Amendments to Annex J and new Annexes L and M

ITU-T Recommendation G.992.3 (2002) – Amendment 2

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ITU-T Recommendation G.992.3

Asymmetric digital subscriber line transceivers 2 (ADSL2)

Amendment 2

Amendments to Annex J and new Annexes L and M

Summary

A new clause J.3, Initialization, is added to Annex J. Moreover, new Annexes L and M, dealing with Specific requirements for Reach extended ADSL2 and for ADSL systems with extended upstream bandwidth, are added.

CONTENTS

ITU-T Recommendation G.992.3

Asymmetric digital subscriber line transceivers 2 (ADSL2)

Amendment 2

Amendments to Annex J and new Annexes L and M

The following clauses are added:

1)   Clause J.3 – Initialization

J.3   Initialization

The ATU-C and ATU-R shall support all upstream PSD masks listed in Table J.3.

J.3.1   Handshake – ATU-C (supplements 8.13.2.1)

The G.994.1 codepoints required for the initialization of ATU-C and ATU-R shall be contained in an "Annex J Submode PSD Masks" Spar(2) parameter block. This parameter block shall be added to the G.994.1 codetree defined for this annex.

J.3.1.1   CL messages (supplements 8.13.2.1.1)

The CL message {Par(2)} fields are defined in Table 8-20. Additional G.994.1 CL message {Par(2)} fields for all digital mode operation are defined in Table J.4.

Table J.4/G.992.3 – ATU-C CL message additional Par(2) PMD bit definitions

Spar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	This parameter block indicates to the ATU-R which PSD masks are supported.
	The Submode PSD Masks field indicates which upstream PSD masks are supported. Its value will depend on CO-MIB element settings and local capabilities of the ATU-C. This field shall be coded in PSD Mask NPar(3) Octets 1 and 2. The coding shall be as follows: the bit associated to an upstream PSD mask shall be set to ONE to indicate that this mask is supported.
	The ATU-C shall set to ONE one of the upstream PSD mask bits to indicate to the ATU-R the selection of one of the PSD masks listed in Table J.3.

J.3.1.2   MS messages (supplements 8.13.2.1.2)

The MS message {Par(2)} fields are defined in Table 8-21. Additional G.994.1 MS message {Par(2)} fields for all digital mode operation are defined in Table J.5.

Table J.5/G.992.3 – ATU-C MS message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	This parameter block indicates to the ATU-R which PSD masks are selected. The Submode PSD Masks field indicates which upstream PSD masks are selected. This field shall be coded in PSD Mask NPar(3) Octets 1 and 2. The coding shall be as follows: the bit associated to an upstream PSD mask shall be set to ONE to indicate that this mask is selected. Each of these bits may be set to ONE only if that bit was set to ONE in the last previous CL message and the last previous CLR message. The ATU-C shall set to ONE one of the upstream PSD mask bits to indicate to the ATU-R the selection of one of the PSD masks listed in Table J.3.

J.3.2 Handshake – ATU-R (supplements 8.13.2.2)

The G.994.1 codepoints required for the initialization of ATU-C and ATU-R shall be contained in an "Annex J Submode PSD Masks" Spar(2) parameter block. This parameter block shall be added to the G.994.1 codetree defined for this annex.

J.3.2.1 CLR messages (supplements 8.13.2.2.1)

The CLR message {Par(2)} fields are defined in Table 8-22. Additional G.994.1 CLR message {Par(2)} fields are defined in Table J.6.

Table J.6/G.992.3 – ATU-R CLR message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	This parameter block indicates to the ATU-C which PSD masks are supported. This field shall be coded in PSD Mask NPar(3) Octets 1 and 2. The coding shall be as follows: the bit associated to an upstream PSD mask shall be set to ONE to indicate that this mask is supported. As the ATU-R shall support all PSD mask configurations, it shall set all mask bits to ONE (1).

J.3.2.2 MS messages (supplements 8.13.2.2.2)

The MS message {Par(2)} fields are defined in Table 8-23. Additional G.994.1 MS message {Par(2)} fields are defined in Table J.7.

Table J.7/G.992.3 – ATU-R MS message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	This parameter block indicates to the ATU-C which PSD masks are selected. This field shall be coded in PSD Mask NPar(3) Octets 1 and 2. The coding shall be as follows: the bit associated to an upstream PSD mask shall be set to ONE to indicate that this mask is selected. Each of these bits may be set to ONE only if that bit was set to ONE in the last previous CL message and the last previous CLR message. The ATU-R shall set to ONE one of the PSD mask bits to indicate to the ATU-C the selection of one PSD mask listed in Table J.3.

J.3.3   Spectral bounds and shaping parameters (supplements 8.13.2.4)

In the CLR message, the ATU-R shall indicate all supported PSD masks. The CLR message may include the upstream spectral shaping (tss_i) and upstream spectrum bounds information of the preferred upstream PSD mask.

In the CL message, the ATU-C shall indicate the selected mode. The CL message may include the upstream spectral shaping (tss_i) and spectrum bounds information of the selected mode.

If the upstream spectrum bounds and shaping parameters of the CLR message, and the PSD mask selection in the CL message are found to be inconsistent, then the ATU-R shall do either of the following:

* The ATU-R sends an MS message indicating that it is not prepared to select a mode at this time (according to 10.1.1/G.994.1). After termination of the G.994.1 session, the ATU-R calculates new upstream spectrum bounds and shaping parameters offline, taking into account the upstream spectrum bounds, shaping parameters, and PSD mask specified by the ATU-C in the CL message of previous G.994.1 session. In a subsequent G.994.1 session, the ATU-R sends a CLR message including the new spectrum bounds and shaping parameters corresponding to the selected PSD mask;

* The ATU-R calculates new upstream spectrum bounds and shaping parameters online, taking into account the upstream spectrum bounds, shaping parameters, and PSD mask specified by the ATU-C in the CL message. In the same G.994.1 session, the ATU-R repeats the CLR/CL exchange transaction with a CLR message including the new spectrum bounds and shaping parameters corresponding to the selected PSD mask.

2)   New Annex L

Annex L

Specific requirements for a Reach Extended ADSL2 (READSL2) system operating in the frequency band above POTS

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 a Reach Extended ADSL2 service that is frequency-division duplexed with POTS.

For an ATU supporting this annex, support of Annex A is a mandatory capability.

For an ATU supporting Annex A, support of this annex is an optional capability.

Performance requirements shall only be defined for the mandatory non-overlapped transmit spectral masks. The optional overlapped masks should not be used in performance requirements.

L.1   ATU-C functional characteristics (pertains to clause 8)

The support of the downstream non-overlapped spectrum reach-extended operation according to L.1.3 is a mandatory capability.

The support of the downstream overlapped spectrum reach-extended operation according to L.1.2 is an optional capability.

L.1.1 ATU-C control parameter settings

The ATU-C control parameter settings to be used in the parameterized parts of the main body and/or to be used in this annex are listed in Table L.1. Control parameters are defined in 8.5.
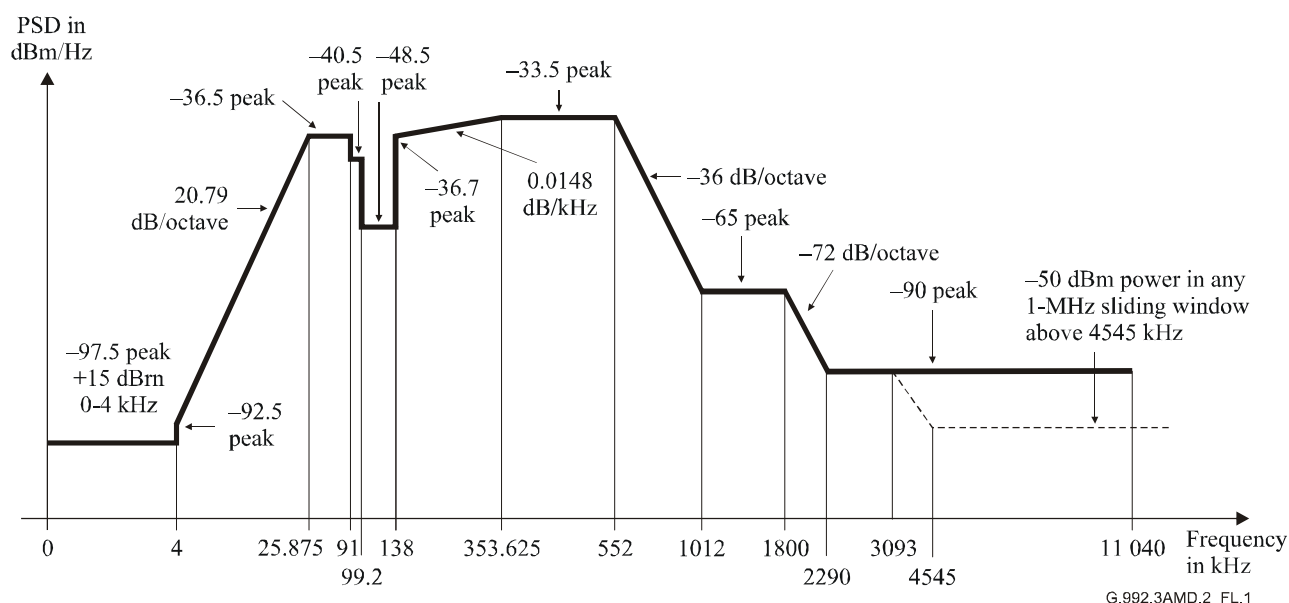
Table L.1/G.992.3 – ATU-C control parameter settings

Parameter	Default setting	Characteristics
NSCds	256	
NOMPSDds	–40 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMPSDds	–40 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMATPds	20.4 dBm	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.

L.1.2 ATU-C downstream transmit spectral mask for overlapped spectrum reach-extended operation (supplements clause 8)

The passband is defined as the band from 25.875 to 552 kHz and is the widest possible band used (i.e., for Reach Extended ADSL over POTS implemented with overlapped spectrum). Limits defined within the passband apply also to any narrower bands used.

Figure L.1 defines the spectral mask for the transmit signal. The low-frequency stop-band is defined as frequencies below 25.875 kHz and includes the POTS band; the high-frequency stop-band is defined as frequencies greater than 552 kHz.

Frequency band f (kHz)	Equation for line (dBm/Hz)
$0 < f \le 4$	−97.5, with max power in the 0-4 kHz band of +15 dBrn
$4 < f \le 25.875$	$-92.5 + 20.79 \times \log_2 (f/4)$
$25.875 < f \le 91$	−36.5
$91 < f \le 99.2$	−40.5
$99.2 < f \le 138$	−48.5
$138 < f \le 353.625$	$-36.7 + 0.0148 \times (f - 138)$
$353.625 < f \le 552$	−33.5
$552 < f \le 1012$	$-33.5 - 36 \times \log_2 (f/552)$
$1012 < f \le 1800$	−65
$1800 < f \le 2290$	$-65 - 72 \times \log_2 (f/1800)$
$2290 < f \le 3093$	−90
$3093 < f \le 4545$	−90 peak, with max power in the $[f, f + 1$ MHz] window of $(-36.5 - 36 \times \log_2 (f/1104) + 60)$ dBm
$4545 < f \le 11\ 040$	−90 peak, with max power in the $[f, f + 1$ MHz] window of −50 dBm

NOTE 1 – All PSD measurements are in 100 Ω; the POTS band total power measurement is in 600 Ω.

NOTE 2 – The breakpoint frequencies and PSD values are exact; the indicated slopes are approximate.

NOTE 3 – Above 25.875 kHz, the peak PSD shall be measured with a 10-kHz resolution bandwidth.

NOTE 4 – The power in a 1-MHz sliding window is measured in a 1-MHz bandwidth, starting at the measurement frequency.

NOTE 5 – The step in the PSD mask at 4 kHz is to protect V.90 performance. Originally, the PSD mask continued the 21-dB/octave slope below 4 kHz hitting a floor of −97.5 dBm/Hz at 3400 Hz. It was recognized that this might impact V.90 performance, and so the floor was extended to 4 kHz.

NOTE 6 – All PSD and power measurements shall be made at the U-C interface (see Figures 5-4 and 5-5); the signals delivered to the PSTN are specified in Annex E.

**Figure L.1/G.992.3 – ATU-C transmitter PSD mask for
overlapped spectrum reach-extended operation**

L.1.2.1 Passband PSD and response

See A.1.2.1. For spectrum management purposes, the PSD template for overlapped spectrum reach-extended operation is defined in Table L.2 (informative).

**Table L.2/G.992.3 – ATU-C PSD template for
overlapped spectrum reach-extended operation**

Frequency (kHz)	PSD (dBm/Hz)
$0 < f \le 4$	-101
$4 < f \le 25.875$	$-96 + 20.79 \times \log_2(f/4)$
$25.875 < f \le 91$	-40
$91 < f \le 99.2$	-44
$99.2 < f \le 138$	-52
$138 < f \le 353.625$	$-40.2 + 0.0148 \times (f - 138)$
$353.625 < f \le 552$	-37
$552 < f \le 1012$	$-37 - 36 \times \log_2(f/552)$
$1012 < f \le 1800$	-68.5
$1800 < f \le 2290$	$-68.5 - 72 \times \log_2(f/1800)$
$2290 < f \le 3093$	-93.5
$3093 < f \le 4545$	$-40 - 36 \times \log_2(f/1104)$
$4545 < f \le 12\,000$	-113.5

L.1.2.2 Aggregate transmit power

See A.1.2.2. In addition, for overlapped spectrum reach-extended operation, the aggregate transmit power across the whole passband shall not exceed 19.4 dBm.

For spectrum management purposes, the PSD template nominal passband aggregate transmit power is 18.9 dBm.

The power emitted by the ATU-C is limited by the requirements in this clause. Notwithstanding these requirements, it is assumed that the ADSL will comply with applicable national requirements on emission of electromagnetic energy.

L.1.2.3 Mandatory and optional settings of control parameters

Clause 8.5.2 applies except for the ATU-C valid control parameter settings for the transmit PMD function which are shown in Table L.3.

Table L.3/G.992.3 – Valid ATU-C PMD transmit function control parameters
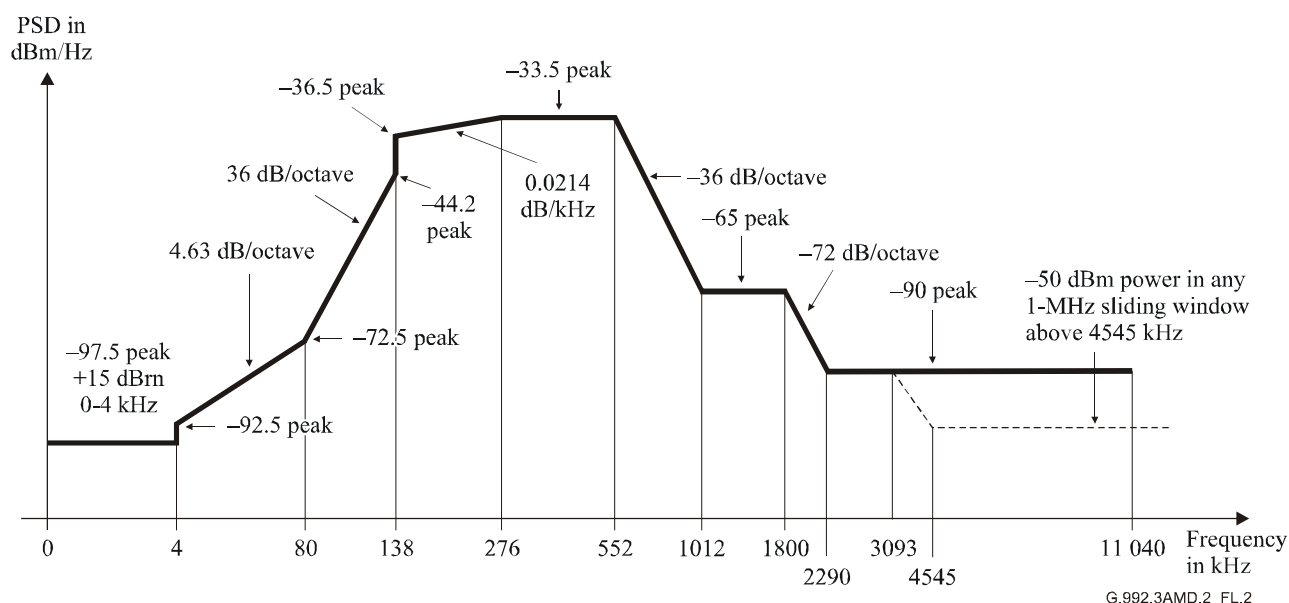
MAXNOMPSDds	All values from –60 dBm/Hz to –37 dBm/Hz in steps of 0.1 dBm/Hz
NOMPSDds	All values from –60 dBm/Hz to –37 dBm/Hz in steps of 0.1 dBm/Hz

L.1.3 ATU-C downstream transmit spectral mask for non-overlapped spectrum reach-extended operation (supplements clause 8)

Figure L.2 defines the spectral mask for the ATU-C transmitted signal, which results in reduced NEXT into the ADSL upstream band, relative to the mask in L.1.2. Adherence to this mask will in many cases result in improved upstream performance of the other ADSL systems in the same or adjacent binder group, with the improvement dependent upon the other interferers.

The passband is defined as the band from 138 to 552 kHz. Limits defined within the passband apply also to any narrower bands used.

Figure L.2 defines the spectral mask for the transmit signal. The low-frequency stop-band is defined as frequencies below 138 kHz and includes the POTS band; the high-frequency stop-band is defined as frequencies greater than 552 kHz.

Frequency band f (kHz)	Equation for line (dBm/Hz)
$0 < f \leq 4$	-97.5, with max power in the 0-4 kHz band of $+15$ dBrn
$4 < f \leq 80$	$-92.5 + 4.63 \times \log_2 (f/4)$
$80 < f \leq 138$	$-72.5 + 36 \times \log_2 (f/80)$
$138 < f \leq 276$	$-36.5 + 0.0214 \times (f - 138)$
$276 < f \leq 552$	-33.5
$552 < f \leq 1012$	$-33.5 - 36 \times \log_2 (f/552)$
$1012 < f \leq 1800$	-65
$1800 < f \leq 2290$	$-65 - 72 \times \log_2 (f/1800)$
$2290 < f \leq 3093$	-90
$3093 < f \leq 4545$	-90 peak, with max power in the $[f, f+1$ MHz$]$ window of $(-36.5 - 36 \times \log_2 (f/1104) + 60)$ dBm
$4545 < f \leq 11\,040$	-90 peak, with max power in the $[f, f+1$ MHz$]$ window of -50 dBm

NOTE 1 – All PSD measurements are in 100 Ω; the POTS band total power measurement is in 600 Ω.

NOTE 2 – The breakpoint frequencies and PSD values are exact; the indicated slopes are approximate.

NOTE 3 – Above 25.875 kHz, the peak PSD shall be measured with a 10-kHz resolution bandwidth.

NOTE 4 – The power in a 1-MHz sliding window is measured in a 1-MHz bandwidth, starting at the measurement frequency.

NOTE 5 – The step in the PSD mask at 4 kHz is to protect V.90 performance. Originally, the PSD mask continued the 21-dB/octave slope below 4 kHz hitting a floor of –97.5 dBm/Hz at 3400 Hz. It was recognized that this might impact V.90 performance, and so the floor was extended to 4 kHz.

NOTE 6 – All PSD and power measurements shall be made at the U-C interface (see Figures 5-4 and 5-5); the signals delivered to the PSTN are specified in Annex E.

**Figure L.2/G.992.3 – ATU-C transmitter PSD mask for
non-overlapped spectrum reach-extended operation**

L.1.3.1 Passband PSD and response

See A.1.2.1. For spectrum management purposes, the PSD template for non-overlapped spectrum reach-extended operation is defined in Table L.4 (informative).

**Table L.4/G.992.3 – ATU-C PSD template for
non-overlapped spectrum reach-extended operation**

Frequency (kHz)	PSD (dBm/Hz)
$0 < f \le 4$	-101.5
$4 < f \le 80$	$-96 + 4.63 \times \log_2(f/4)$
$80 < f \le 138$	$-76 + 36 \times \log_2(f/80)$
$138 < f \le 276$	$-40 + 0.0214 \times (f - 138)$
$276 < f \le 552$	-37
$552 < f \le 1012$	$-37 - 36 \times \log_2(f/552)$
$1012 < f \le 1800$	-68.5
$1800 < f \le 2290$	$-68.5 - 72 \times \log_2(f/1800)$
$2290 < f \le 3093$	-93.5
$3093 < f \le 4545$	$-40 - 36 \times \log_2(f/1104)$
$4545 < f \le 12\,000$	-113.5

L.1.3.2 Aggregate transmit power

See A.1.2.2. In addition, for non-overlapped spectrum reach-extended operation, the aggregate transmit power across the whole passband shall not exceed 19.3 dBm.

For spectrum management purposes, the PSD template nominal passband aggregate transmit power is 18.8 dBm.

The power emitted by the ATU-C is limited by the requirements in this clause. Notwithstanding these requirements, it is assumed that the ADSL will comply with applicable national requirements on emission of electromagnetic energy.

L.1.3.3 Mandatory and optional settings of control parameters

Clause 8.5.2 applies except for the ATU-C valid control parameter settings for the transmit PMD function which are shown in Table L.5.

Table L.5/G.992.3 – Valid ATU-C PMD transmit function control parameters

MAXNOMPSDds	All values from –60 dBm/Hz to –37 dBm/Hz in steps of 0.1 dBm/Hz
NOMPSDds	All values from –60 dBm/Hz to –37 dBm/Hz in steps of 0.1 dBm/Hz

L.2 ATU-R functional characteristics (pertains to clause 8)

The support of the upstream reach-extended operation with transmit spectral mask 1 according to L.2.2 is a mandatory capability.

The support of the upstream reach-extended operation with transmit spectral mask 2 according to L.2.3 is a mandatory capability.

L.2.1 ATU-R control parameter settings

The ATU-R control parameter settings to be used in the parameterized parts of the main body and/or to be used in this annex are listed in Table L.6. Control parameters are defined in 8.5.
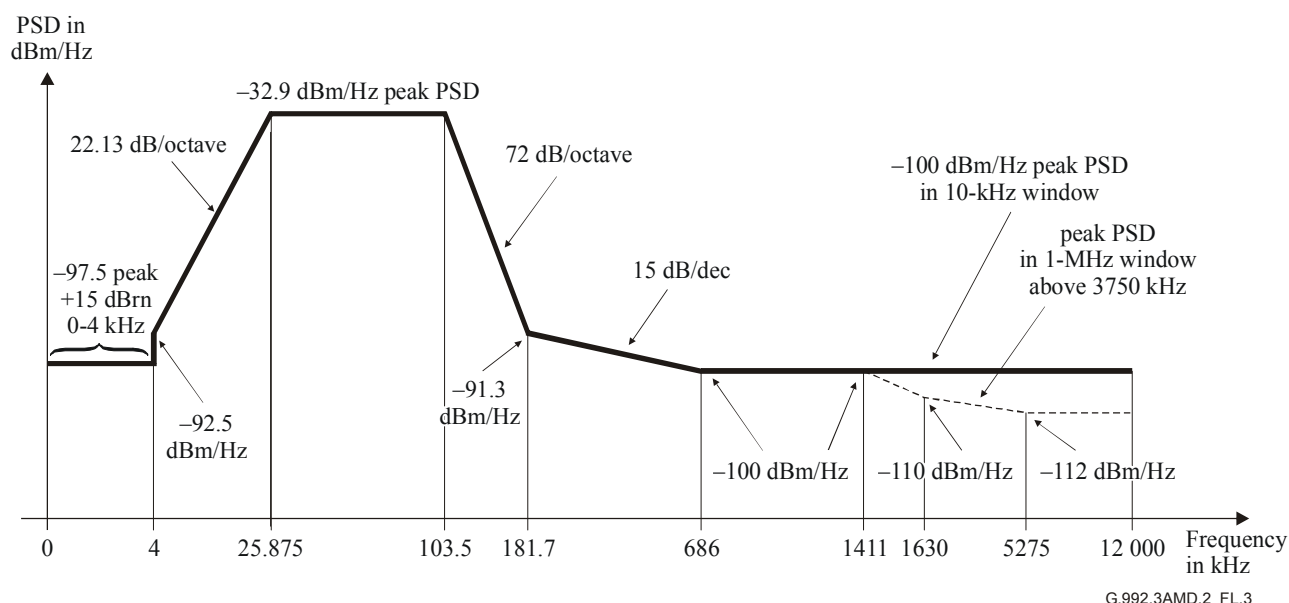
Table L.6/G.992.3 – ATU-R control parameter settings

Parameter	Default setting	Characteristics
NSCus	32	
NOMPSDus	–38 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMPSDus	–38 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMATPus	12.5 dBm	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.

L.2.2 ATU-R upstream transmit spectral mask 1 for reach-extended operation (supplements clause 8)

The passband is defined as the band from 25.875 to 103.5 kHz. Limits defined within the passband apply also to any narrower bands used.

Figure L.3 defines the spectral mask for the transmit signal. The low-frequency stop-band is defined as frequencies below 25.875 kHz and includes the POTS band (see also Figure L.1), the high-frequency stop-band is defined as frequencies greater than 103.5 kHz.

The figure shows PSD in dBm/Hz on the vertical axis versus Frequency in kHz on the horizontal axis, with the following labels:

−32.9 dBm/Hz peak PSD

22.13 dB/octave

72 dB/octave

−100 dBm/Hz peak PSD in 10-kHz window

peak PSD in 1-MHz window above 3750 kHz

−97.5 peak +15 dBrn 0-4 kHz

15 dB/dec

−92.5 dBm/Hz

−91.3 dBm/Hz

−100 dBm/Hz

−110 dBm/Hz

−112 dBm/Hz

Horizontal axis breakpoints: 0 4 25.875 103.5 181.7 686 1411 1630 5275 12 000

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Frequency band f (kHz)	Equation for line (dBm/Hz)
$0 < f \le 4$	−97.5, with max power in the 0-4 kHz band of +15 dBrn
$4 < f \le 25.875$	$-92.5 + 22.13 \times \log_2(f/4)$
$25.875 < f \le 103.5$	−32.9
$103.5 < f \le 686$	$\max\{-32.9 - 72 \times \log_2(f/103.5),\ 10 \times \log_{10}[0.05683 \times (f \times 10^3)^{-1.5}]\}$
$686 < f \le 1411$	−100
$1411 < f \le 1630$	−100 peak, with max power in the $[f, f + 1$ MHz$]$ window of $(-100 - 48 \times \log_2(f/1411) + 60)$ dBm
$1630 < f \le 5275$	−100 peak, with max power in the $[f, f + 1$ MHz$]$ window of $(-110 - 1.18 \times \log_2(f/1630) + 60)$ dBm
$5275 < f \le 12\ 000$	−100 peak with max power in the $[f, f + 1$ MHz$]$ window of −52 dBm
NOTE 1 – All PSD measurements are in 100 Ω; the POTS band total power measurement is in 600 Ω.	
NOTE 2 – The breakpoint frequencies and PSD values are exact; the indicated slopes are approximate.	
NOTE 3 – Above 25.875 kHz, the peak PSD shall be measured with a 10-kHz resolution bandwidth.	
NOTE 4 – The power in a 1-MHz sliding window is measured in a 1-MHz bandwidth, starting at the measurement frequency.	
NOTE 5 – The step in the PSD mask at 4 kHz is to protect V.90 performance. Originally, the PSD mask continued the 21.5-dB/octave slope below 4 kHz hitting a floor of −97.5 dBm/Hz at 3400 Hz. It was recognized that this might impact V.90 performance, and so the floor was extended to 4 kHz.	
NOTE 6 – All PSD and power measurements shall be made at the U-C interface (see Figures 5-4 and 5-5); the signals delivered to the PSTN are specified in Annex E.	

Figure L.3/G.992.3 – ATU-R transmitter PSD mask 1 for reach-extended operation

L.2.2.1 Passband PSD and response

See A.2.2.1. For spectrum management purposes, the ATU-R upstream PSD template for mask 1 for reach-extended operation is defined in Table L.7 (informative).

Table L.7/G.992.3 – ATU-R upstream PSD template for mask 1 for reach-extended operation

Frequency (kHz)	PSD (dBm/Hz)
$0 < f \leq 4$	-101.5
$4 < f \leq 25.875$	$-96 + 22.13 \times \log_2(f/4)$
$25.875 < f \leq 103.5$	-36.4
$103.5 < f \leq 400.9$	$\max\{-36.4 - 72 \times \log_2(f/103.5),\ 10 \times \log10[0.05683 \times (f \times 10^3)^{-1.5}] -3.5 \}$
$400.9 < f \leq 1411$	-100
$1411 < f \leq 1630$	$-100 - 48 \times \log_2(f/1411)$
$1630 < f \leq 5275$	$-110 - 1.18 \times \log_2(f/1630)$
$5275 < f \leq 12\,000$	-112

L.2.2.2 Aggregate transmit power

See A.2.2.2. In addition, for mask 1 of reach-extended operation, the aggregate transmit power across the whole passband shall not exceed 13.0 dBm.

For spectrum management purposes, the PSD template nominal passband aggregate transmit power is 12.5 dBm.

The power emitted by the ATU-R is limited by the requirements in this clause. Notwithstanding these requirements, it is assumed that the ADSL will comply with applicable national requirements on emission of electromagnetic energy.

L.2.2.3 Mandatory and optional settings of control parameters

Clause 8.5.2 applies except for the ATU-R valid control parameter settings for the transmit PMD function which are shown in Table L.8.
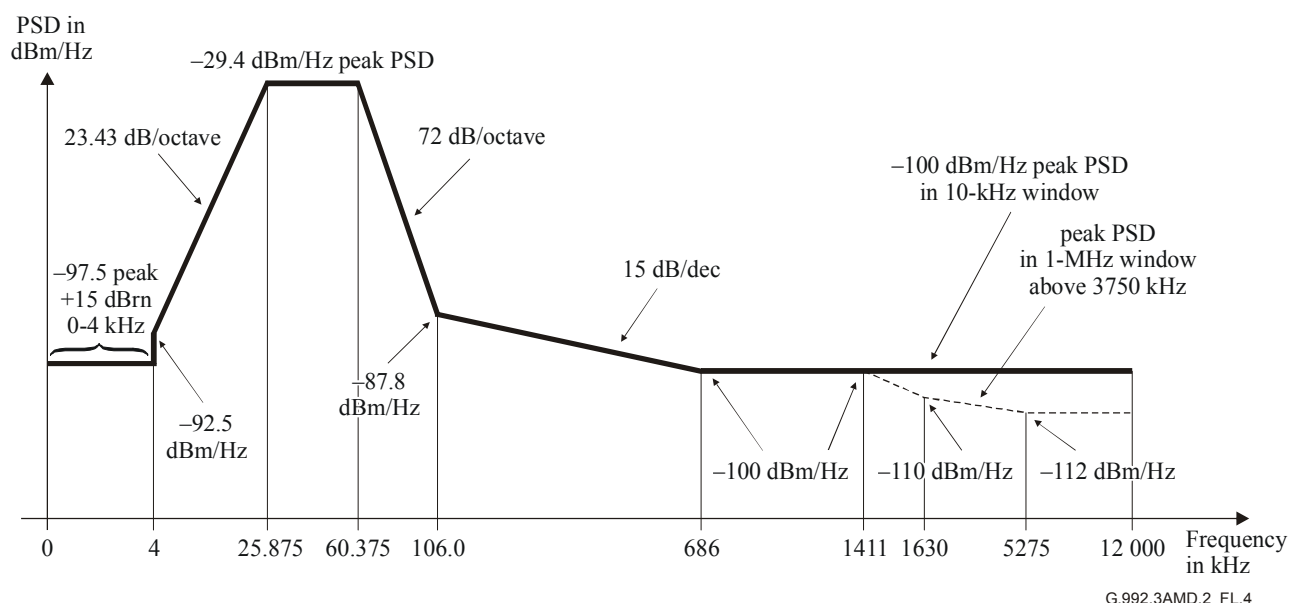
Table L.8/G.992.3 – Valid ATU-R PMD transmit function control parameters

MAXNOMPSDus	All values from –60 dBm/Hz to –36.4 dBm/Hz in steps of 0.1 dBm/Hz
NOMPSDus	All values from –60 dBm/Hz to –36.4 dBm/Hz in steps of 0.1 dBm/Hz

L.2.3 ATU-R upstream transmit spectral mask 2 for reach-extended operation (supplements clause 8)

The passband is defined as the band from 25.875 to 60.375 kHz. Limits defined within the passband apply also to any narrower bands used.

Figure L.4 defines the spectral mask for the transmit signal. The low-frequency stop-band is defined as frequencies below 25.875 kHz and includes the POTS band (see also Figure L.1); the high-frequency stop-band is defined as frequencies greater than 60.375 kHz.

Frequency band f (kHz)	Equation for line (dBm/Hz)
$0 < f \leq 4$	-97.5, with max power in the 0-4 kHz band of $+15$ dBrn
$4 < f \leq 25.875$	$-92.5 + 23.43 \times \log_2(f/4)$
$25.875 < f \leq 60.375$	-29.4
$60.375 < f \leq 686$	$\max\{-29.4 - 72 \times \log_2(f/60.375), 10 \times \log10[0.05683 \times (f \times 10^3)^{-1.5}]\}$
$686 < f \leq 1411$	-100
$1411 < f \leq 1630$	-100 peak, with max power in the $[f, f+1$ MHz$]$ window of $(-100 - 48 \times \log_2(f/1411) + 60)$ dBm
$1630 < f \leq 5275$	-100 peak, with max power in the $[f, f+1$ MHz$]$ window of $(-110 - 1.18 \times \log_2(f/1630) + 60)$ dBm
$5275 < f \leq 12\,000$	-100 peak with max power in the $[f, f+1$ MHz$]$ window of -52 dBm
NOTE 1 – All PSD measurements are in 100 Ω; the POTS band total power measurement is in 600 Ω.	
NOTE 2 – The breakpoint frequencies and PSD values are exact; the indicated slopes are approximate.	
NOTE 3 – Above 25.875 kHz, the peak PSD shall be measured with a 10-kHz resolution bandwidth.	
NOTE 4 – The power in a 1-MHz sliding window is measured in a 1-MHz bandwidth, starting at the measurement frequency.	
NOTE 5 – The step in the PSD mask at 4 kHz is to protect V.90 performance. Originally, the PSD mask continued the 21.5-dB/octave slope below 4 kHz hitting a floor of -97.5 dBm/Hz at 3400 Hz. It was recognized that this might impact V.90 performance, and so the floor was extended to 4 kHz.	
NOTE 6 – All PSD and power measurements shall be made at the U-C interface (see Figures 5-4 and 5-5); the signals delivered to the PSTN are specified in Annex E.	

Figure L.4/G.992.3 – ATU-R transmitter PSD mask 2 for reach-extended operation

L.2.3.1 Passband PSD and response

See A.2.2.1. For spectrum management purposes, the ATU-R upstream PSD template for mask 2 for reach-extended operation is defined in Table L.9 (informative).

Table L.9/G.992.3 – ATU-R upstream PSD template for mask 2 for reach-extended operation

Frequency (kHz)	PSD (dBm/Hz)
$0 < f \le 4$	-101.5
$4 < f \le 25.875$	$-96 + 23.43 \times \log_2(f/4)$
$25.875 < f \le 60.375$	-32.9
$60.375 < f \le 400.9$	$\max\{-32.9 - 72 \times \log_2(f/60.375),\ 10 \times \log10[0.05683 \times (f \times 10^3)^{-1.5}] -3.5 \}$
$400.9 < f \le 1411$	-100
$1411 < f \le 1630$	$-100 - 48 \times \log_2(f/1411)$
$1630 < f \le 5275$	$-110 - 1.18 \times \log_2(f/1630)$
$5275 < f \le 12\,000$	-112

L.2.3.2 Aggregate transmit power

See A.2.2.2. In addition, of mask 2 of reach-extended operation, the aggregate transmit power across the whole passband shall not exceed 13.0 dBm.

For spectrum management purposes, the PSD template nominal passband aggregate transmit power is 12.5 dBm.

The power emitted by the ATU-R is limited by the requirements in this clause. Notwithstanding these requirements, it is assumed that the ADSL will comply with applicable national requirements on emission of electromagnetic energy.

L.2.3.3 Mandatory and optional settings of control parameters

Clause 8.5.2 applies except for the ATU-R valid control parameter settings for the transmit PMD function which are shown in Table L.10.

Table L.10/G.992.3 – Valid ATU-R PMD transmit function control parameters

MAXNOMPSDus	All values from –60 dBm/Hz to –32.9 dBm/Hz in steps of 0.1 dBm/Hz
NOMPSDus	All values from –60 dBm/Hz to –32.9 dBm/Hz in steps of 0.1 dBm/Hz

L.3 Initialization

The valid modes of reach-extended operation are listed in Table L.11. The ATU-C and ATU-R shall support reach-extended operation according to the modes indicated as a mandatory capability. The ATU-C and ATU-R may support reach-extended operation according to the modes indicated as optional capability.

Table L.11/G.992.3 – Valid and mandatory/optional modes of reach-extended operation

Mode of operation	Mandatory/optional capability	Downstream mask	Upstream mask	Notes
Mode 1	Mandatory	L.1.3	L.2.2	Non-overlapped spectrum downstream Wide spectrum upstream
Mode 2	Mandatory	L.1.3	L.2.3	Non-overlapped spectrum downstream Narrow spectrum upstream

Table L.11/G.992.3 – Valid and mandatory/optional modes of reach-extended operation

Mode of operation	Mandatory/optional capability	Downstream mask	Upstream mask	Notes
Mode 3	Optional (see Note)	L.1.2	L.2.2	Overlapped spectrum downstream Wide spectrum upstream
Mode 4	Optional (see Note)	L.1.2	L.2.3	Overlapped spectrum downstream Narrow spectrum upstream
NOTE – Modes 3 and 4 are defined as a single option for the ATU-R. If one mode is supported, the ATU-R shall also support the other mode (see CLR message definition in Table L.14).				

L.3.1   Handshake – ATU-C (supplements 8.13.2.1)

The G.994.1 codepoints required for the initialization of ATU-C and ATU-R shall be contained in an "Annex L Reach Extended PSD Masks" Spar(2) parameter block. This parameter block shall be added to the G.994.1 codetree defined for G.992.3 Annex A (ADSL operation over POTS).

Automode between ADSL2 Annex A and Annex L operation shall be a one-sided ATU-C controlled process, using the G.994.1 CL/CLR mechanisms. ITU-T Rec. G.997.1 contains the definition of automode and defines a configuration parameter to force an automode cold-start for use in test-lab environment.

L.3.1.1   CL messages (supplements 8.13.2.1.1)

The CL message {Par(2)} fields are defined in Table 8-20. Additional G.994.1 CL message {Par(2)} fields for reach-extended operation are defined in Table L.12.

Table L.12/G.992.3 – ATU-C CL message additional Par(2) PMD bit definitions

Spar(2) bit	Definition of related Npar(3) bits
Reach Extended PSD masks	This parameter block indicates to the ATU-R which PSD masks are supported. Codepoints shall be structured as: • The PSD Masks Upstream field indicates which upstream PSD masks are supported. Its value will depend on CO-MIB element settings and local capabilities of the ATU-C. This field shall be coded in PSD Mask NPar(3) Octet 1. The coding shall be as follows: – Bit 1: set to ONE indicates the support of the upstream reach-extended operation according to L.2.2; – Bit 2: set to ONE indicates the support of the upstream reach-extended operation according to L.2.3. • The PSD Masks Downstream field indicates which downstream PSD masks are supported. Its value will depend on CO-MIB element settings and local capabilities of the ATU-C. This field shall be coded in PSD Mask NPar(3) Octet 2. The coding shall be as follows: – Bit 1: set to ONE indicates the support of the downstream non-overlapped reach-extended operation according to L.1.3; – Bit 2: set to ONE indicates the support of the downstream overlapped reach-extended operation according to L.1.2.

Table L.12/G.992.3 – ATU-C CL message additional Par(2) PMD bit definitions

Spar(2) bit	Definition of related Npar(3) bits
	The ATU-C shall do one of the following: • Set to ONE one of the upstream PSD mask bits and set to ONE one of the downstream PSD mask bits to indicate to the ATU-R the selection of one of the reach-extended modes listed in Table L.11. • Set to ZERO all of the upstream PSD mask bits and all of the downstream PSD mask bits to indicate to the ATU-R the selection of operation according to Annex A.

L.3.1.2 MS messages (supplements 8.13.2.1.2)

The MS message {Par(2)} fields are defined in Table 8-21. Additional G.994.1 MS message {Par(2)} fields for reach-extended operation are defined in Table L.13.

Table L.13/G.992.3 – ATU-C MS message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Reach Extended PSD masks	This parameter block indicates to the ATU-R which PSD masks are selected. Codepoints shall be structured as: • The PSD Masks Upstream field indicates which upstream PSD mask is selected. This field shall be coded in PSD Mask NPar(3) Octet 1. The coding shall be as follows: – Bit 1: set to ONE indicates the selection of the upstream reach-extended operation mask 1 according to L.2.2; – Bit 2: set to ONE indicates the selection of the upstream reach-extended operation mask 2 according to L.2.3. • The PSD Masks Downstream field indicates which downstream PSD mask is selected. This field shall be coded in PSD Mask NPar(3) Octet 2. The coding shall be as follows: – Bit 1: set to ONE indicates the selection of the downstream non-overlapped reach-extended operation according to L.1.3; – Bit 2: set to ONE indicates the selection of the downstream overlapped reach-extended operation according to L.1.2. Each of these bits may be set to ONE only if that bit was set to ONE in the last previous CL message and the last previous CLR message. The ATU-C shall do one of the following: • Set to ONE one of the upstream PSD mask bits and set to ONE one of the downstream PSD mask bits to indicate to the ATU-R the selection of one of the reach-extended modes listed in Table L.11. • Set to ZERO all of the upstream PSD mask bits and all of the downstream PSD mask bits to indicate to the ATU-R the selection of operation according to Annex A.

L.3.2 Handshake – ATU-R (supplements 8.13.2.2)

The G.994.1 codepoints required for the initialization of ATU-C and ATU-R shall be contained in an "Annex L Reach Extended PSD Masks" Spar(2) parameter block. This parameter block shall be added to the G.994.1 codetree defined for G.992.3 Annex A (ADSL operation over POTS).

Automode between ADSL2 Annex A and Annex L operation shall be a one-sided ATU-C controlled process, using the G.994.1 CL/CLR mechanisms. ITU-T Rec. G.997.1 defines a configuration parameter to force a cold-start for use in test-lab environment.

L.3.2.1 CLR messages (supplements 8.13.2.2.1)

The CLR message {Par(2)} fields are defined in Table 8-22. Additional G.994.1 CLR message {Par(2)} fields are defined in Table L.14.

Table L.14/G.992.3 – ATU-R CLR message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits

Reach Extended PSD masks	This parameter block indicates to the ATU-C which PSD masks are supported. Codepoints shall be structured as:
	
	• The PSD Masks Upstream field indicates which upstream PSD masks are supported. This field shall be coded in PSD Mask NPar(3) Octet 1. The coding shall be as follows:
	
	  – Bit 1: set to ONE indicates the support of the upstream reach-extended operation mask 1 according to L.2.2;
	
	  – Bit 2: set to ONE indicates the support of the upstream reach-extended operation mask 2 according to L.2.3.
	
	As the ATU-R shall support all 2 upstream PSD masks defined in L.2, it shall set the upstream mask bits 1 and 2 to ONE (1).
	
	• The PSD Masks Downstream field indicates which downstream PSD masks are supported. This field shall be coded in PSD Mask NPar(3) Octet 2. The coding shall be as follows:
	
	  – Bit 1: set to ONE indicates the support of the downstream non-overlapped reach-extended operation according to L.1.3;
	
	  – Bit 2: set to ONE indicates the support of the downstream overlapped reach-extended operation according to L.1.2.
	
	As the ATU-R shall support mandatory configuration for operation in downstream non-overlapped reach-extended mode, it shall set the downstream mask bit 1 to ONE (1). If the ATU-R supports the optional downstream overlapped reach-extended mode, it shall also set to ONE (1) the bit 2.

L.3.2.2 MS messages (supplements 8.13.2.2.2)

The MS message {Par(2)} fields are defined in Table 8-23. Additional G.994.1 MS message {Par(2)} fields are defined in Table L.15.

Table L.15/G.992.3 – ATU-R MS message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits

Reach Extended PSD masks	This parameter block indicates to the ATU-C which PSD masks are selected. Codepoints shall be structured as:
	
	• The PSD Masks Upstream field indicates which upstream PSD mask is selected. This field shall be coded in PSD Mask NPar(3) Octet 1. The coding shall be as follows:
	
	  – Bit 1: set to ONE indicates the selection of the upstream reach-extended operation mask 1 according to L.2.2;
	
	  – Bit 2: set to ONE indicates the selection of the upstream reach-extended operation mask 2 according to L.2.3.
	
	• The PSD Masks Downstream field indicates which downstream PSD mask is selected. This field shall be coded in PSD Mask NPar(3) Octet 2. The coding shall be as follows:
	
	  – Bit 1: set to ONE indicates the selection of the downstream non-overlapped reach-extended operation according to L.1.3;
	
	  – Bit 2: set to ONE indicates the selection of the downstream overlapped reach-extended operation according to L.1.2.
	
	Each of these bits may be set to ONE only if that bit was set to ONE in the last previous CL message and the last previous CLR message.
	
	The ATU-R shall do one of the following:
	
	• Set to ONE one of the upstream PSD mask bits and set to ONE one of the downstream PSD mask bits to indicate to the ATU-C the selection of one of the reach-extended modes listed in Table L.11.
	
	• Set to ZERO all of the upstream PSD mask bits and all of the downstream PSD mask bits to indicate to the ATU-C the selection of operation according to Annex A.

L.3.3 Spectral bounds and shaping parameters (supplements 8.13.2.4)

In the CLR message, the ATU-R shall indicate all supported PSD masks.

• If the ATU-R supports operation per Annex A, but does not support operation per this annex, then the CLR message does not include the Reach Extended PSD Masks parameter block. The CLR message includes the upstream spectral shaping (tss_i) and upstream spectrum bounds information of the Annex A upstream PSD mask (see 8.13.2.4).

• If the ATU-R supports operation per Annex A and this annex, then the CLR message shall include the Reach Extended PSD Masks parameter block, with the supported reach-extended PSD masks indicated by the PSD Masks bits (see Table L.14). If any of the upstream spectral shaping (tss_i) or upstream spectrum bounds parameter blocks is included in the CLR message, it shall be related to the preferred upstream PSD mask. The preferred upstream PSD mask shall be the Annex A upstream mask (see A.2.2) or this annex's upstream mask 1 (see L.2.2) or upstream mask 2 (see L.2.3).

In the CL message, the ATU-C shall indicate the selected mode.

- To indicate selection of operation per Annex A, the CL message shall either not include the Reach Extended PSD Masks parameter block, or the CL message shall include the Reach Extended PSD Masks parameter block with all PSD Masks bits set to ZERO. If any of the downstream or upstream spectral shaping (tss_i) or spectrum bounds parameter blocks is included in the CL message, it shall be related to operation according to Annex A (see 8.13.2.4).

- To indicate selection of a reach-extended mode listed in Table L.11, the CL message shall include the Reach Extended PSD Masks parameter block with the selected mode indicated by the PSD Masks bits. If any of the downstream or upstream spectral shaping (tss_i) or spectrum bounds parameter blocks is included in the CL message, it shall be related to the selected mode.

If the CL or CLR message does not include the Reach Extended PSD Masks parameter block, then the MS message shall not include the Reach Extended PSD Masks parameter block.

If the MS message does not include the Reach Extended PSD Masks parameter block or includes the Reach Extended PSD Masks parameter block with all PSD Masks bits set to ZERO, then the ATU-C and ATU-R shall operate according to Annex A.

If the ATU-R supports operation per Annex A, but does not support operation per this annex, then the CLR message does not include the Reach Extended PSD Masks parameter block. If only the operation according to this annex is enabled through the CO-MIB (Annex A disabled), the ATU-C shall indicate in the CL message the selection of a reach-extended mode listed in Table L.11. In a subsequent G.994.1 transaction, the ATU-C shall do one of the following:

- in response to an MS message selecting Annex A operation, the ATU-C shall send a NAK-NS message to indicate the requested mode is disabled (see 7.10/G.994.1);

- in response to an MR message, the ATU-C shall send an MS message to indicate it is not prepared to select a mode at this time (see 10.1.2/G.994.1).

If the upstream spectrum bounds and shaping parameters of the CLR message, and the PSD mask selection in the CL message are found to be inconsistent, then the ATU-R shall do either of the following:

- The ATU-R sends an MS message indicating that it is not prepared to select a mode at this time (according to 10.1.1/G.994.1). After termination of the G.994.1 session, the ATU-R calculates new upstream spectrum bounds and shaping parameters offline, taking into account the upstream spectrum bounds, shaping parameters, and PSD mask specified by the ATU-C in the CL message of a previous G.994.1 session. In a subsequent G.994.1 session, the ATU-R sends a CLR message including the new spectrum bounds and shaping parameters corresponding to the selected PSD mask.

- The ATU-R calculates new upstream spectrum bounds and shaping parameters online, taking into account the upstream spectrum bounds, shaping parameters, and PSD mask specified by the ATU-C in the CL message. In the same G.994.1 session, the ATU-R repeats the CLR/CL exchange transaction with a CLR message including the new spectrum bounds and shaping parameters corresponding to the selected PSD mask.

3)   New Annex M

Annex M[1]

Specific requirements for an ADSL system with extended upstream bandwidth operating in the frequency band above POTS

M.1   ATU-C functional characteristics (pertains to clause 8)

M.1.1   ATU-C control parameter settings

The ATU-C control parameter settings to be used in the parameterized parts of the main body and/or to be used in this annex are listed in Table M.1. Control parameters are defined in 8.5.

Table M.1/G.992.3 – ATU-C control parameter settings

Parameter	Default setting	Characteristics
NSCds	256	
NOMPSDds	–40 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMPSDds	–40 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMATPds (operation per M.1.2)	20.4 dBm	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.

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

The ATU-C transmit spectral mask shall be identical to the ATU-C transmit spectral mask for overlapped spectrum operation over POTS, as defined in Figure A.1 in A.1.2.

The passband is defined as the band from 25.875 to 1104 kHz and is the widest possible band used (i.e., implemented with overlapped spectrum). Limits defined within the passband apply also to any narrower bands used.

The low-frequency stop-band is defined as frequencies below 25.875 kHz; the high-frequency stop-band is defined as frequencies greater than 1104 kHz.

NOTE – When deployed in the same cable as ADSL-over-POTS (Annex A/G.992.1, Annexes A and B/G.992.2, Annex A/G.992.3 and Annex A/G.992.4), there may be a spectral compatibility issue between the two systems due to the overlap of this annex's downstream channel with the ADSL-over-POTS upstream channel at frequencies below 138 kHz. Detailed study of spectrum compatibility is referred to regional bodies. Deployment restrictions for systems using the downstream PSD masks defined in this annex may be imposed (e.g., by the regional regulatory authority).

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[1] Softbank BB (Japan), Conexant Systems (USA) and UT Starcom (USA), in line with the provisions of 5.5/A.8, registered a degree of concern with regard to Annex M. Their concern is:

Today, there are over 60 million lines of ADSL deployed worldwide based on Annex A. If ADSL systems based on Annex M are deployed in the same cable with Annex A-based systems, the service quality of existing ADSL systems may become significantly degraded. The impact of high-volume deployment of Annex M-based systems has not been thoroughly evaluated or considered. Proper definition of Annex M should be such that it can be deployed on a worldwide volume basis.

M.1.2.1 Passband PSD and response

See A.1.2.1.

M.1.2.2 Aggregate transmit power

See A.1.2.2.

M.1.3 ATU-C downstream transmit spectral mask for non-overlapped spectrum operation (supplements 8.10)

The ATU-C transmit spectral mask shall be identical to the ATU-C transmit spectral mask for non-overlapped spectrum operation over ISDN, as defined in Figure B.2 in B.1.3.

Adherence to this mask will, in many cases, result in improved upstream performance of the other ADSL systems in the same or adjacent binder group, with the improvement dependent upon the other interferers. This mask differs from the mask in M.1.2 only in the band below 254 kHz.

The passband is defined as the band from 254 to 1104 kHz; Limits defined within the passband apply also to any narrower bands used.

The low-frequency stop-band is defined as frequencies below 254 kHz; the high-frequency stop-band is defined as frequencies greater than 1104 kHz.

In addition, the maximum PSD level in the 0-4 kHz band shall not exceed –97.5 dBm/Hz measured in a reference impedance of 100 ohms, and the aggregate transmit power in the 0-4 kHz band shall not exceed –15 dBm measured in a reference impedance of 600 ohms.

M.1.3.1 Passband PSD and response

See B.1.2.1.

M.1.3.2 Aggregate transmit power

See B.1.3.2.

M.2 ATU-R functional characteristics (pertains to clause 8)

M.2.1 ATU-R control parameter settings

The ATU-R control parameter settings to be used in the parameterized parts of the main body and/or to be used in this annex are listed in Table M.2. Control parameters are defined in 8.5.

Table M.2/G.992.3 – ATU-R control parameter settings
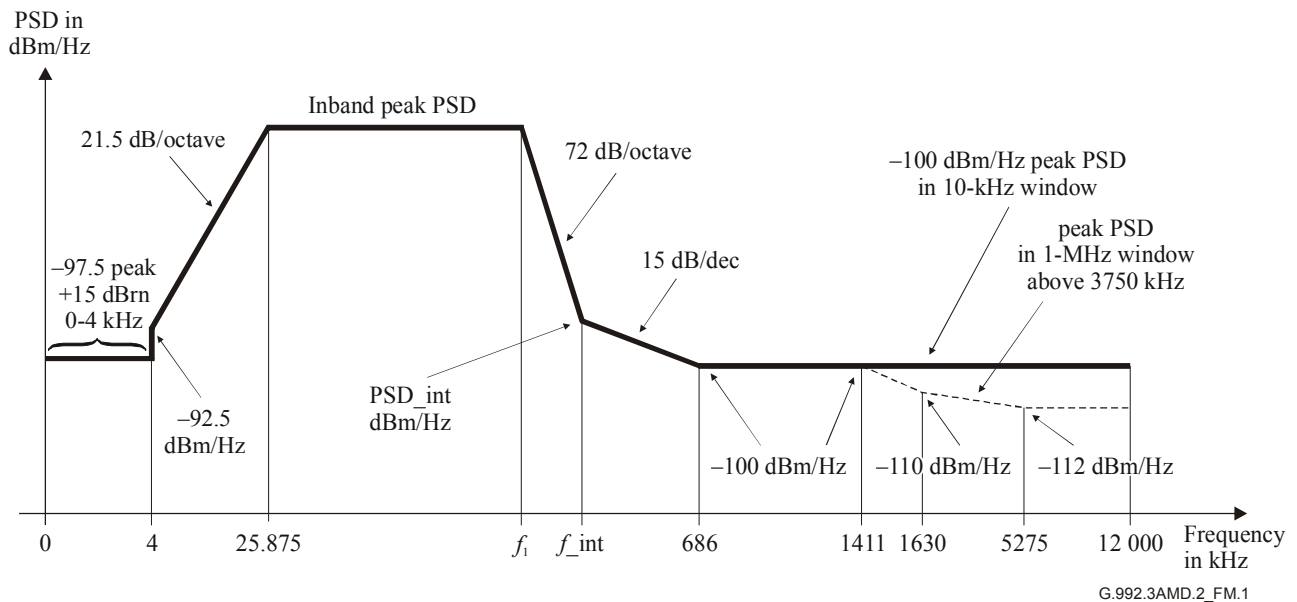
Parameter	Setting	Characteristics
NSCus	64	
NOMPSDus	–38 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMPSDus	–38 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMATPus	12.5 dBm	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.

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

The ATU-R transmit PSD shall comply to one of the allowed family of spectral masks EU-32, EU-36, … EU-64 (see Note 1 after Table M.3). Each of the spectral masks shall be as defined in Figure M.1 and Table M.3.

The passband is defined as the band from 25.875 kHz to an upperbound frequency f_1, defined in Table M.3. It is the widest possible band used. Limits defined within the passband apply also to any narrower bands used.

Figure M.1 defines the family of ATU-R spectral masks for the transmit signal. The low-frequency stop-band is defined as frequencies below 25.875 kHz; the high-frequency stop-band is defined as frequencies greater than the passband upperbound frequency f_1 defined in Table M.3. The Inband_peak_PSD, PSD_int and the frequencies f_1 and $f\_$int shall be as defined in Table M.3.

PSD in dBm/Hz

Inband peak PSD

21.5 dB/octave

72 dB/octave

−100 dBm/Hz peak PSD in 10-kHz window

peak PSD in 1-MHz window above 3750 kHz

15 dB/dec

−97.5 peak +15 dBrn 0-4 kHz

PSD_int dBm/Hz

−92.5 dBm/Hz

−100 dBm/Hz −110 dBm/Hz −112 dBm/Hz

0 4 25.875 f_1 f_int 686 1411 1630 5275 12 000 Frequency in kHz

G.992.3AMD.2_FM.1

Frequency (kHz)	PSD level (dBm/Hz)	MBW
0	−97.5	100 Hz
4	−97.5	100 Hz
4	−92.5	100 Hz
10	interpolated	10 kHz
25.875	Inband_peak_PSD	10 kHz
f_1	Inband_peak_PSD	10 kHz
f_int	PSD_int	10 kHz
686	−100	10 kHz
5275	−100	10 kHz
12 000	−100	10 kHz

Additionally, the PSD mask shall be satisfying following requirements:

Frequency (kHz)	PSD level (dBm/Hz)	MBW
1411	−100	1 MHz
1630	−110	1 MHz
5275	−112	1 MHz
12 000	−112	1 MHz

NOTE 1 – All PSD measurements are in 100 Ω; the POTS band total power measurement is in 600 Ω.

NOTE 2 – The breakpoint frequencies and PSD values are exact; the indicated slopes are approximate. The breakpoints in the tables shall be connected by linear straight lines on a dB/log(*f*) plot.

NOTE 3 – MBW specifies the Measurement Bandwidth. The MBW specified for a certain breakpoint with frequency f_i is applicable for all frequencies satisfying $f_i < f \le f_j$, where f_j is the frequency of the next specified breakpoint.

NOTE 4 – The power in a 1-MHz sliding window is measured in a 1-MHz bandwidth, starting at the measurement frequency i.e., power in the [$f, f + 1$ MHz] window shall conform to the specification at frequency f.

NOTE 5 – The step in the PSD mask at 4 kHz is to protect V.90 performance. Originally, the PSD mask continued the 21-dB/octave slope below 4 kHz hitting a floor of −97.5 dBm/Hz at 3400 Hz. It was recognized that this might impact V.90 performance, and so the floor was extended to 4 kHz.

NOTE 6 – All PSD and power measurements shall be made at the U-C interface.

Figure M.1/G.992.3 – ATU-R transmitter PSD mask

Table M.3/G.992.3 – Inband_peak_PSD, PSD_int and the frequencies f_1 and f_int

Upstream mask-number	Designator	Template nominal PSD (dBm/Hz)	Template maximum aggregate transmit power (dBm)	Inband peak PSD (dBm/Hz)	Frequency f_1 (kHz)	Intercept frequency f_int (kHz)	Intercept PSD level *PSD_int* (dBm/Hz)
1	EU-32	–38.0	12.5	–34.5	138.00	242.92	–93.2
2	EU-36	–38.5	12.62	–35.0	155.25	274.00	–94.0
3	EU-40	–39.0	12.66	–35.5	172.50	305.16	–94.7
4	EU-44	–39.4	12.75	–35.9	189.75	336.40	–95.4
5	EU-48	–39.8	12.78	–36.3	207.00	367.69	–95.9
6	EU-52	–40.1	12.87	–36.6	224.25	399.04	–96.5
7	EU-56	–40.4	12.94	–36.9	241.50	430.45	–97.0
8	EU-60	–40.7	12.97	–37.2	258.75	461.90	–97.4
9	EU-64	–41.0	12.98	–37.5	276.00	493.41	–97.9

NOTE – The aggregate transmit power shall be limited for all PSD masks as defined in M.2.2.2.

NOTE 1 – The ATU-R selects a transmit PSD mask from the family of upstream transmit PSD masks specified in Table M.3, based on the limitations imposed by the CO-MIB (which are exchanged during the G.994.1 Phase of initialization; see 8.13.2.4) and based on the capabilities of its transmit PMD function.

NOTE 2 – When deployed in the same cable as ADSL-over-POTS (Annex A/G.992.1, Annexes A and B/G.992.2, Annex A/G.992.3, Annex A/G.992.4 and Annex A/G.992.5), there may be a spectral compatibility issue between the two systems due to the overlap of this annex's upstream channel with the ADSL-over-POTS downstream channel at frequencies above 138 kHz. Detailed study of spectrum compatibility is referred to regional bodies. Deployment restrictions for systems using the upstream PSD masks defined in this annex may be imposed (e.g., by the regional regulatory authority).

M.2.2.1 Passband PSD and response

See A.2.2.1.

For spectrum management purposes, the PSD template is defined in Tables M.4 and M.5 (informative):

Table M.4/G.992.3 – ATU-R transmit PSD template definition

Frequency (kHz)	PSD level (dBm/Hz)
0	–101
4	–101
4	–96
25.875	Inband_peak_PSD –3.5 dB
f_1	Inband_peak_PSD –3.5 dB
f_int_templ	PSD_int_templ
686	–100
1411	–100
1630	–110
5275	–112
12 000	–112

**Table M.5/G.992.3 – The *f_int_templ* and *PSD_int_templ* values
for the ATU-R transmit PSD template**

Upstream mask-number	Designator	Template intercept frequency *f_int_templ* (kHz)	Template intercept PSD level *PSD_int_templ* (dBm/Hz)
1	EU-32	234.34	–93.0
2	EU-36	264.33	–93.8
3	EU-40	294.39	–94.5
4	EU-44	324.52	–95.1
5	EU-48	354.71	–95.7
6	EU-52	384.95	–96.2
7	EU-56	415.25	–96.7
8	EU-60	445.59	–97.2
9	EU-64	475.99	–97.6

M.2.2.2   Aggregate transmit power

There are three different PSD masks for the ATU-R transmit signal, depending on the type of signal sent (see M.2.2.1). In all cases:

•   the aggregate transmit power in the voiceband, measured at the U-R interface, and that is delivered to the Plain Old Telephone Service (POTS) interface shall not exceed +15 dBrn (see ITU-T Rec. G.996.1 [3] for method of measurement);

•   the aggregate transmit power across the whole passband shall not exceed (MAXNOMATPus – PCBus) by more than 0.5 dB, in order to accommodate implementational tolerances, and shall not exceed 13.0 dBm;

•   the aggregate transmit power over the 0 to 12 MHz band, shall not exceed (MAXNOMATPus – PCBus) by more than 0.8 dB, in order to account for residual transmit power in the stop bands and implementational tolerances.

The power emitted by the ATU-R is limited by the requirements in this clause. Notwithstanding these requirements, it is assumed that the ADSL will comply with applicable national requirements on emission of electromagnetic energy.

For spectrum management purposes, the PSD template nominal passband aggregate transmit power is 12.5 dBm.

M.3   Initialization

The ATU-C and ATU-R shall support all upstream PSD masks listed in Table M.3.

M.3.1   Handshake – ATU-C (supplements 8.13.2.1)

The G.994.1 codepoints required for the initialization of ATU-C and ATU-R shall be contained in an "Annex M Submode PSD Masks" Spar(2) parameter block. This parameter block shall be added to the G.994.1 codetree defined for this annex.

M.3.1.1 CL messages (supplements 8.13.2.1.1)

The CL message {Par(2)} fields are defined in Table 8-20. Additional G.994.1 CL message {Par(2)} fields for extended upstream operation over POTS are defined in Table M.6.

Table M.6/G.992.3 – ATU-C CL message additional Par(2) PMD bit definitions

Spar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	This parameter block indicates to the ATU-R which PSD masks are supported.
	The Submode PSD Masks field indicates which upstream PSD masks are supported. Its value will depend on CO-MIB element settings and local capabilities of the ATU-C. This field shall be coded in PSD Mask NPar(3) Octets 1 and 2. The coding shall be as follows: the bit associated to an upstream PSD mask shall be set to ONE to indicate that this mask is supported.
	The ATU-C shall set to ONE one of the upstream PSD mask bits to indicate to the ATU-R the selection of one of the PSD masks listed in Table M.3.

M.3.1.2 MS messages (supplements 8.13.2.1.2)

The MS message {Par(2)} fields are defined in Table 8-21. Additional G.994.1 MS message {Par(2)} fields for extended upstream operation over POTS are defined in Table M.7.

Table M.7/G.992.3 – ATU-C MS message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	This parameter block indicates to the ATU-R which PSD masks are selected.
	The Submode PSD Masks field indicates which upstream PSD masks are selected. This field shall be coded in PSD Mask NPar(3) Octets 1 and 2. The coding shall be as follows: the bit associated to an upstream PSD mask shall be set to ONE to indicate that this mask is selected.
	Each of these bits may be set to ONE only if that bit was set to ONE in the last previous CL message and the last previous CLR message.
	The ATU-C shall set to ONE one of the upstream PSD mask bits to indicate to the ATU-R the selection of one of the PSD masks listed in Table M.3.

M.3.2 Handshake – ATU-R (supplements 8.13.2.2)

The G.994.1 codepoints required for the initialization of ATU-C and ATU-R shall be contained in an "Annex M Submode PSD Masks" Spar(2) parameter block. This parameter block shall be added to the G.994.1 codetree defined for this annex.

M.3.2.1   CLR messages (supplements 8.13.2.2.1)

The CLR message {Par(2)} fields are defined in Table 8-22. Additional G.994.1 CLR message {Par(2)} fields are defined in Table M.8.

Table M.8/G.992.3 – ATU-R CLR message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	This parameter block indicates to the ATU-C which PSD masks are supported. This field shall be coded in PSD Mask NPar(3) Octets 1 and 2. The coding shall be as follows: the bit associated to an upstream PSD mask shall be set to ONE to indicate that this mask is supported. As the ATU-R shall support all PSD mask configurations, it shall set all mask bits to ONE (1).

M.3.2.2   MS messages (supplements 8.13.2.2.2)

The MS message {Par(2)} fields are defined in Table 8-23. Additional G.994.1 MS message {Par(2)} fields are defined in Table M.9.

Table M.9/G.992.3 – ATU-R MS message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	This parameter block indicates to the ATU-C which PSD masks are selected. This field shall be coded in PSD Mask NPar(3) Octets 1 and 2. The coding shall be as follows: the bit associated to an upstream PSD mask shall be set to ONE to indicate that this mask is selected. Each of these bits may be set to ONE only if that bit was set to ONE in the last previous CL message and the last previous CLR message. The ATU-R shall do set to ONE one of the PSD mask bits to indicate to the ATU-C the selection of one PSD mask listed in Table M.3.

M.3.3   Spectral bounds and shaping parameters (supplements 8.13.2.4)

See J.3.3.

M.4   Electrical characteristics

The ATU shall meet the electrical characteristics defined in A.4.

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