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G.992.5

Amendment 1
(04/2004)

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
(ADSL2+)

**Amendment 1: Amendments to Annexes J
and M**

ITU-T Recommendation G.992.5 (2003) – Amendment 1

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ITU-T Recommendation G.992.5

Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2+)

Amendment 1

Amendments to Annexes J and M

Summary

This amendment contains the new Annexes J and M to ITU-T Rec. G.992.5 as follows:

- a new Annex J – All Digital Mode ADSL with improved spectral compatibility with ADSL over ISDN (this was "for further study" in ITU-T Rec. G.992.5);
- an Annex L intentionally left blank;
- a new Annex M – Specific requirements for an ADSL system with extended upstream bandwidth operating in the frequency band above POTS (this was "for further study" in ITU-T Rec. G.992.5 as Annex L).

Source

Amendment 1 to ITU-T Recommendation G.992.5 (2003) was approved on 30 April 2004 by ITU-T Study Group 15 (2001-2004) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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ITU-T Recommendation G.992.5

Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2+)

Amendment 1

Amendments to Annexes J and M

Annex J

All Digital Mode ADSL with improved spectral compatibility with ADSL over ISDN

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

J.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 J.1. Control parameters are defined in 8.5.

Table J.1/G.992.5 – ATU-C control parameter settings

Parameter	Default setting	Characteristics
NSCds	512	
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 J.1.2)	20.4 dBm	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.

J.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, as defined in Figure I.1 in I.1.2.

The passband is defined as the band from 3 to 2208 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 3 kHz; the high-frequency stop-band is defined as frequencies greater than 2208 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 the All Digital Loop 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).

J.1.2.1 Passband PSD and response

See I.1.2.1.

J.1.2.2 Aggregate transmit power

See I.1.2.2.

J.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 J.1.2 only in the band below 254 kHz.

The passband is defined as the band from 254 to 2208 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 2208 kHz.

J.1.3.1 Passband PSD and response

See B.1.3.1.

J.1.3.2 Aggregate transmit power

See B.1.3.2.

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

J.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 J.2. Control parameters are defined in 8.5.

Table J.2/G.992.5 – ATU-R control parameter settings

Parameter	Setting	Characteristics
NSC _{us}	64	
NOMPSD _{us}	–38 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMPSD _{us}	–38 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMATP _{us}	13.4 dBm	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.

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

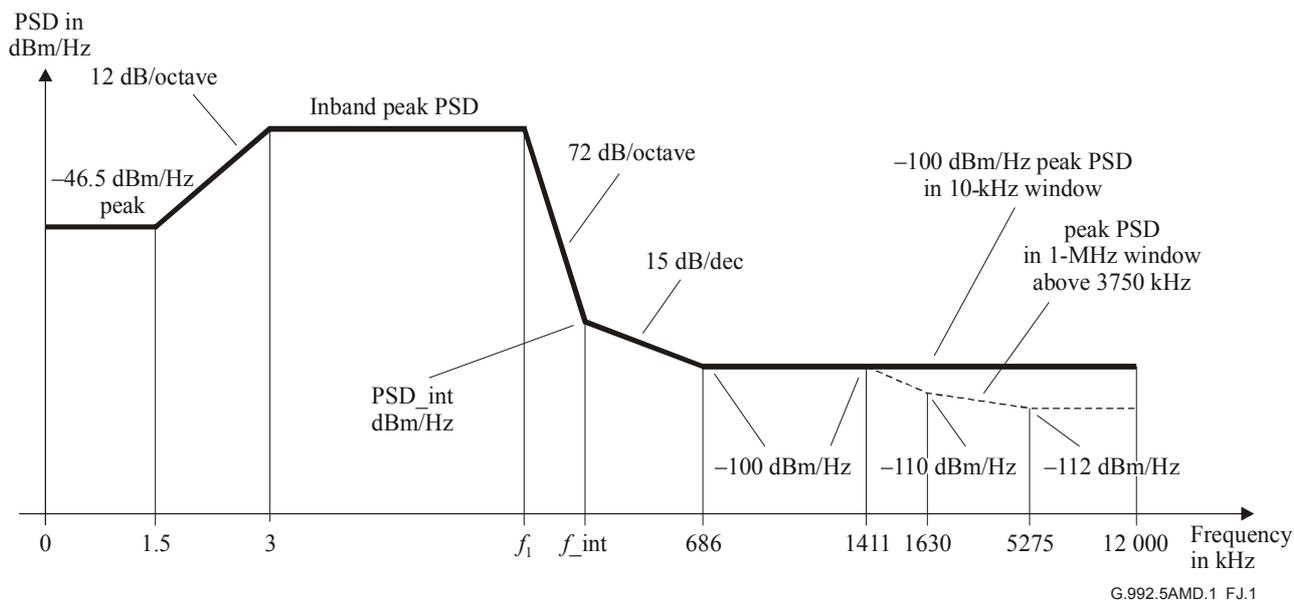
The ATU-R transmit PSD shall comply to one of the allowed family of spectral masks ADLU-32, ADLU-36, ... ADLU-64 (see Note 1). Each of the spectral masks shall be as defined in Figure J.1 and in Table J.3.

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

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

NOTE 1 – The ATU-R selects a transmit PSD mask from the family of upstream transmit PSD masks specified in Table J.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 the All Digital Mode 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).



Frequency (kHz)	PSD level (dBm/Hz)	MBW
0	-46.5	100 Hz
1.5	-46.5	100 Hz
3	Inband_peak_PSD	100 Hz
10	Inband_peak_PSD	10 kHz
f_i	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 $f_i < f \leq f_j$, 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 $[f, f + 1 \text{ MHz}]$ window shall conform to the specification at frequency f .

NOTE 5 – All PSD and power measurements shall be made at the U-C interface.

Figure J.1/G.992.5 – ATU-R transmitter PSD mask

Table J.3/G.992.5 – 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	ADLU-32	-38.0	13.4	-34.5	138.00	242.92	-93.2
2	ADLU-36	-38.5	13.4	-35.0	155.25	274.00	-94.0
3	ADLU-40	-39.0	13.4	-35.5	172.50	305.16	-94.7
4	ADLU-44	-39.4	13.4	-35.9	189.75	336.40	-95.4
5	ADLU-48	-39.8	13.4	-36.3	207.00	367.69	-95.9
6	ADLU-52	-40.1	13.4	-36.6	224.25	399.04	-96.5
7	ADLU-56	-40.4	13.4	-36.9	241.50	430.45	-97.0
8	ADLU-60	-40.7	13.4	-37.2	258.75	461.90	-97.4
9	ADLU-64	-41.0	13.4	-37.5	276.00	493.41	-97.9

J.2.2.1 Passband PSD and response

See I.2.2.1.

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

Table J.4/G.992.5 – ATU-R transmit PSD template definition

Frequency (kHz)	PSD level (dBm/Hz)
0	-50
1.5	-50
3	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 J.5/G.992.5 – 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	ADLU-32	234.34	-93.0
2	ADLU-36	264.33	-93.8
3	ADLU-40	294.39	-94.5
4	ADLU-44	324.52	-95.1
5	ADLU-48	354.71	-95.7
6	ADLU-52	384.95	-96.2
7	ADLU-56	415.25	-96.7
8	ADLU-60	445.59	-97.2
9	ADLU-64	475.99	-97.6

J.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 J.2.2.1). In all cases:

- the aggregate transmit power across the whole passband shall not exceed ($MAXNOMAT_{Pus} - PC_{Bus}$) by more than 0.5 dB, in order to accommodate implementational tolerances, and shall not exceed 13.9 dBm;
- the aggregate transmit power over the 0 to 12 MHz band shall not exceed ($MAXNOMAT_{Pus} - PC_{Bus}$) 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 13.4 dBm.

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.6.

Table J.6/G.992.5 – ATU-C CL message additional Par(2) PMD bit definitions

Spar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	<p>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.</p> <p>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.</p>

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.7.

Table J.7/G.992.5 – ATU-C MS message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	<p>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.</p> <p>Each of these bits may be set to ONE only if that bit was set to ONE in the last previous CL message and in the last previous CLR message.</p> <p>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.</p>

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.8.

Table J.8/G.992.5 – ATU-R CLR message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	<p>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.</p> <p>As the ATU-R shall support all PSD mask configurations, it shall set all mask bits to ONE (1).</p>

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.9.

Table J.9/G.992.5 – ATU-R CLR message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	<p>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.</p> <p>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.</p> <p>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.</p>

J.4 Electrical characteristics

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

Annex L

(Intentionally left blank)

This annex is intentionally left blank to facilitate alignment of the G.992.3 and G.992.5 table of contents.

Annex M¹

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

This annex defines those parameters of the ADSL system with extended upstream bandwidth that have been left undefined in the body of this Recommendation because they are unique to an ADSL service that is frequency-division duplexed with POTS.

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

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 this annex 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.1.1 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.992.5 – ATU-C control parameter settings

Parameter	Default setting	Characteristics
NSCds	512	
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 2208 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 2208 kHz.

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 2208 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 2208 kHz.

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

M.1.3.1 Passband PSD and response

See B.1.3.1.

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.992.5 – ATU-R control parameter settings

Parameter	Setting	Characteristics
NSC _{us}	64	
NOMPSD _{us}	–38 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMPSD _{us}	–38 dBm/Hz	Setting may be changed relative to this value during G.994.1 phase; see 8.13.2.
MAXNOMATP _{us}	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)

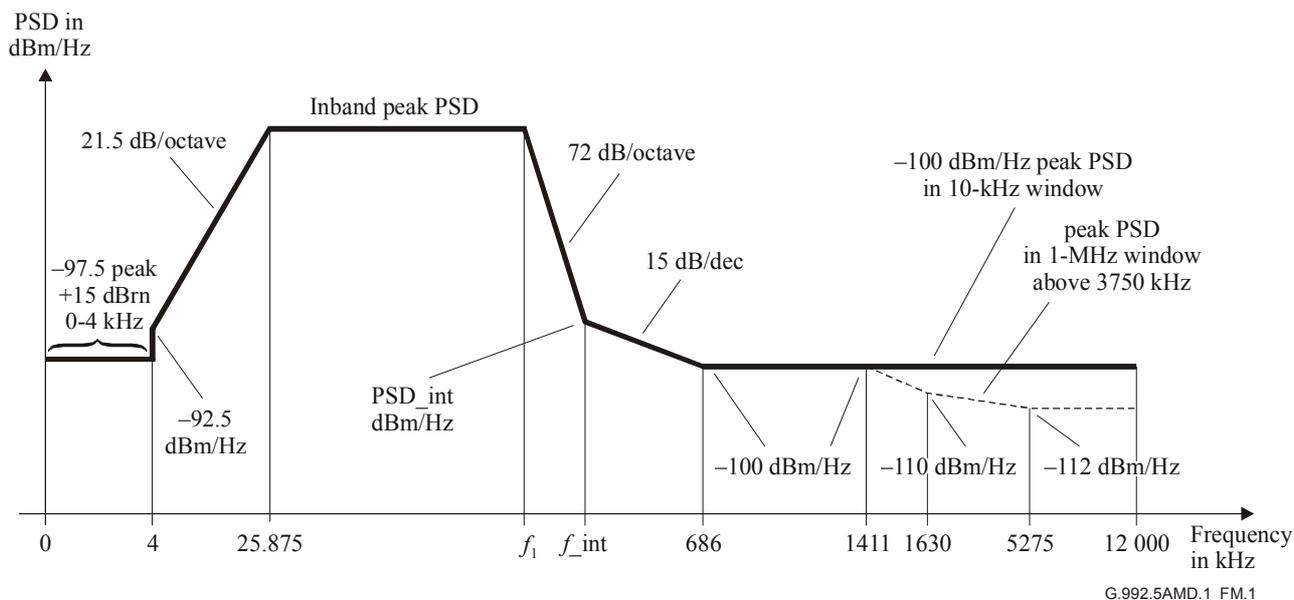
The ATU-R transmit PSD shall comply to one of the allowed family of spectral masks EU-32, EU-36, ... EU-64 (see Note 1). Each of the spectral masks shall be as defined in Figure M.1 and in Table M.3.

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.

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 the Annex M 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).



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 $f_i < f \leq f_j$, 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 $[f, f + 1 \text{ MHz}]$ 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.992.5 – ATU-R transmitter PSD mask

Table M.3/G.992.5 – 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	12.5	-35.0	155.25	274.00	-94.0
3	EU-40	-39.0	12.5	-35.5	172.50	305.16	-94.7
4	EU-44	-39.4	12.5	-35.9	189.75	336.40	-95.4
5	EU-48	-39.8	12.5	-36.3	207.00	367.69	-95.9
6	EU-52	-40.1	12.5	-36.6	224.25	399.04	-96.5
7	EU-56	-40.4	12.5	-36.9	241.50	430.45	-97.0
8	EU-60	-40.7	12.5	-37.2	258.75	461.90	-97.4
9	EU-64	-41.0	12.5	-37.5	276.00	493.41	-97.9

M.2.2.1 Passband PSD and response

See I.2.2.1.

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

Table M.4/G.992.5 – 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.992.5 – 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 dBm (see ITU-T Rec. G.996.1 [3] for the method of measurement);
- the aggregate transmit power across the whole passband, shall not exceed ($MAXNOMATP_{us} - PC_{Bus}$) 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 ($MAXNOMATP_{us} - PC_{Bus}$) 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.992.5 – ATU-C CL message additional Par(2) PMD bit definitions

Spar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	<p>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.</p> <p>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.</p>

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.992.5 – ATU-C MS message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	<p>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.</p> <p>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.</p> <p>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.</p>

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 MS message {Par(2)} fields are defined in Table M.8.

Table M.8/G.992.5 – ATU-R CLR message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	<p>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.</p> <p>As the ATU-R shall support all PSD mask configurations, it shall set all mask bits to ONE (1).</p>

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.992.5 – ATU-R MS message additional Par(2) PMD bit definitions

SPar(2) bit	Definition of related Npar(3) bits
Submode PSD masks	<p>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.</p> <p>Each of these bits may be set to ONE only if that bit was set to ONE in the last previous CL message and in the last previous CLR message.</p> <p>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.</p>

M.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.

M.4 Electrical characteristics

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

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