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G.992.3

Amendment 4

(06/2004)

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 4

ITU-T Recommendation G.992.3 (2002) – Amendment 4

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ITU-T Recommendation G.992.3

Asymmetric digital subscriber line transceivers 2 (ADSL2)

Amendment 4

Summary

This amendment contains changes and clarifications to ITU-T Rec. G.992.3. Changes mainly refer to clauses 7, 8, 9, Annexes J and K, and include two new Appendices V and VI.

Source

Amendment 4 to ITU-T Recommendation G.992.3 (2002) was approved on 13 June 2004 by ITU-T Study Group 15 (2001-2004) under the ITU-T Recommendation A.8 procedure. This publication includes also Appendices V and VI that were agreed by ITU-T Study Group 15 on 30 April 2004.

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.

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had 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.

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ITU-T Recommendation G.992.3

Asymmetric digital subscriber line transceivers 2 (ADSL2)

Amendment 4

1) Addition to 7.6.2, Valid framing configurations

Add Note 4 to Table 7-8 as follows:

NOTE 1 – This condition is a bound on the number of Mux Data Frames per symbol.

NOTE 2 – The 0.8 kbit/s overhead rate lowerbound corresponds to an $SEQ_p = 2$ (see Table 7-14) and an overhead channel period of 20 ms.

NOTE 3 – This condition puts bounds on the number of FEC codewords per symbol.

NOTE 4 – Setting MSGmin higher than 28 kbit/s may cause configuration errors and reduce the maximal achievable net data rate.

2) Clarification to 7.8.2.3, Overhead message format

Add text to last paragraph:

A maximum message length of 1024 octets ($P = 1024$ maximum) is defined. This message length refers to the length before HDLC encapsulation.

3) Amendment for 7.8.2.4, Overhead channel protocol

Add new subclause with following title and text:

7.8.2.4.3 Overhead message segmentation

An overhead message may be segmented at the transmitter's discretion as specified in 7.8.2.4.3/G.992.5, even if the message length P is less than the maximum of 1024 octets.

4) Clarification to 7.10.3, PMS-TC Exchange Phase

Change one but last paragraph as follows:

Within those constraints, the receiver shall select the values as to optimize in the priority listed:

1) Maximize net data rate for all bearer channels, per the allocation of the net data rate, in excess of the sum of the minimum net data rates over all bearer channels (see 7.10.2).
2) Minimize excess margin with respect to the maximum noise margin MAXSNRM through gain scalings (see 8.6.4). Other control parameters may be used to achieve this (e.g. PCB see 8.13.3).

5) Clarification to 8.13.2.4, Spectral bounds and shaping parameters

Add new paragraph with Figure at the end of the clause:

Figure 8-25a illustrates the flowchart for the implementation of the tss_i values.

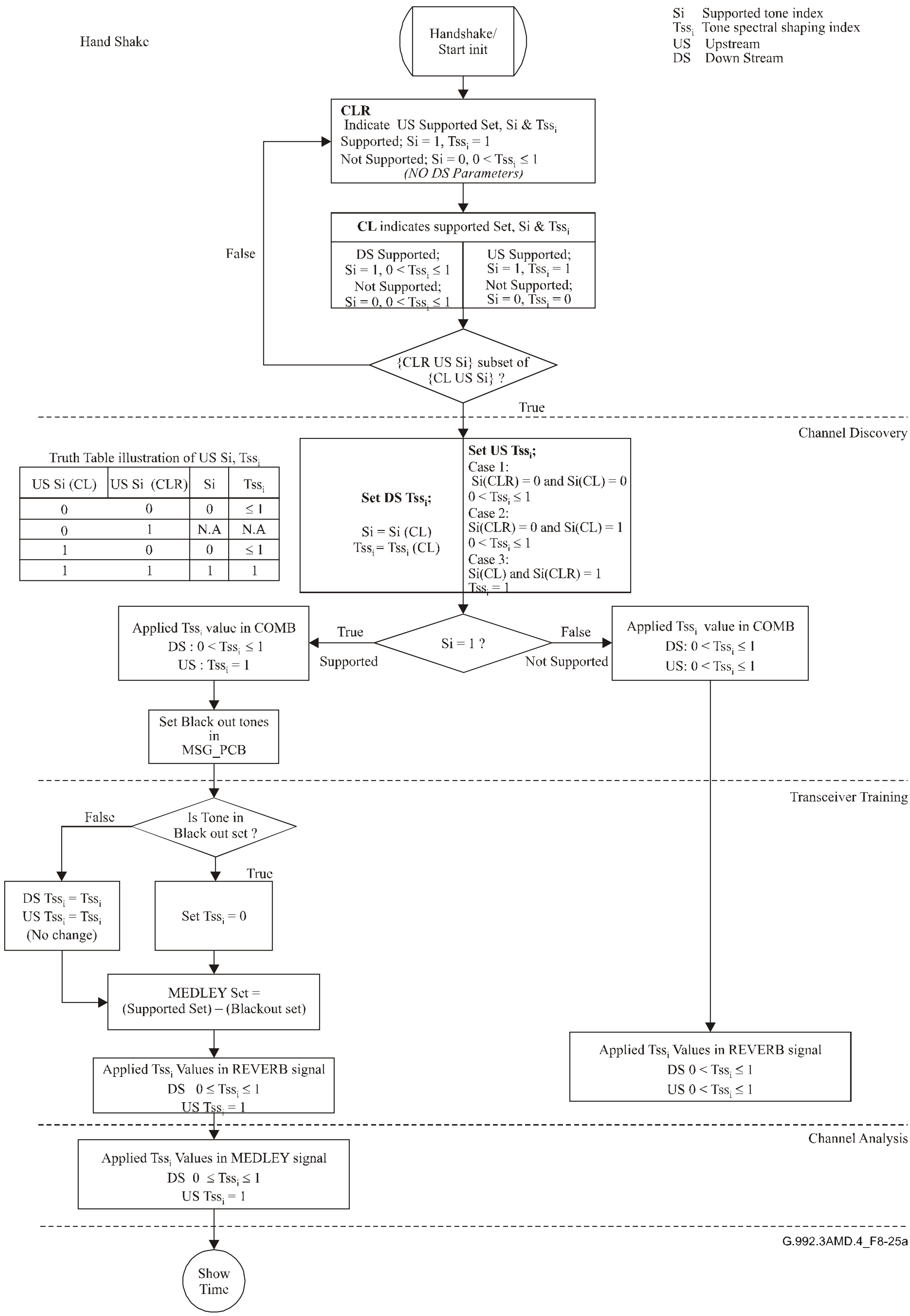


Figure 8-25a/G.992.3 – Flowchart for implementation of Tss_i values

6) Correction to 8.15, Loop Diagnostics state R-QUIET5

In Figure 8-35/G.992.3 – Loop diagnostics timing diagram (part 1), the duration of loop diagnostics state R-QUIET5 shall be shortened from 16 464 to 16 464 – 80 = 16 384 symbols (to match ATU-C state durations).

7) Clarification to 9.4.1.8, Clear eoc messages

Add sentence at end of first paragraph:

The Clear eoc message length shall be maximum 1024 octets.

8) Correction to 9.5.3, Link State Transitions and related clauses

Change Figure 9-5 as follows:

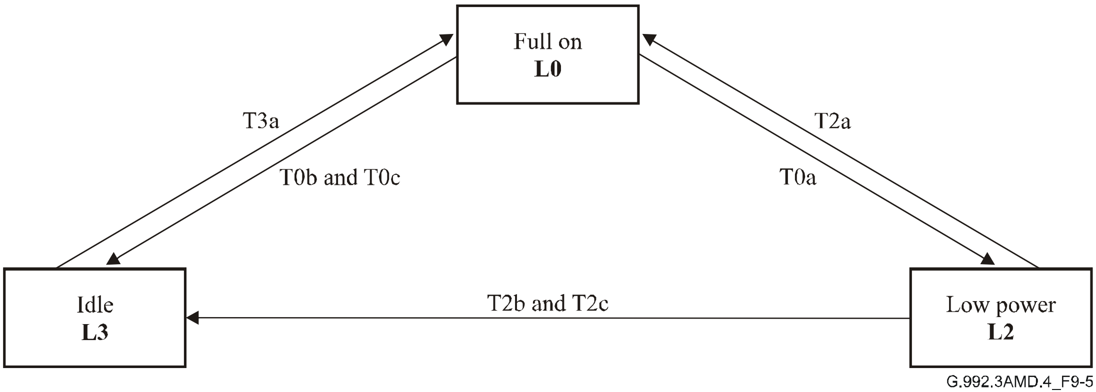


Figure 9-5/G.992.3 – ADSL link power management states and transitions

Change Table 9-32 as follows:

Table 9-32/G.992.3 – Power management states and transitions

Label	Starting state	Resulting state	Event	Procedure
T0a	L0	L2	Local command to ATU-C	Following this event, the ATUs shall use the procedure for entering low power state in 9.5.3.3.
T0b	L0	L3	Local command to either the ATU-C or ATU-R	Following this event, the ATUs shall use the orderly shutdown procedure in 9.5.3.1.
T0c	L0	L3	ATU-R PMD asserts lpr primitive	Following the lpr primitive at the ATU-R, the ATUs shall use the disorderly shutdown procedure in 9.5.3.2.
T2a	L2	L0	Local primitives at ATU-C or ATU-R	Following these local primitives, the ATUs shall use the low power exit procedure in 9.5.3.4.
T2b	L2	L3	ATU-R PMD asserts lpr primitive	Following the lpr primitive at the ATU-R, the ATUs shall use the disorderly shutdown procedure in 9.5.3.2.
T2c	L2	L3	Local command to the ATU-C	Following this event, the ATUs shall use the orderly shutdown procedure in 9.5.3.1.
T3a	L3	L0	Local ATU command	The ATUs shall use the initialization procedures as defined in clauses 6, 7 and 8.

Change related 6.8.2.2 as follows:

6.8.2.2 Transition to L3 link state operation

If operating in link state L2, the ATUs are intended to transition to link state L3~~0~~ ~~and make~~by making use of the orderly shutdown procedure. Alternatively, the ATUs can also transition to link state L0 and subsequently transition to link state L3 by making use of the orderly shutdown procedure. However, in the event of sudden power loss, the link may transition from link state L2 to state L3 directly. The transition should be as described in 9.5.3.2. Any specific TPS-TC tear-down procedure shall be as provided in Annex K.

Change related 9.5.3.1 first paragraph as follows:

9.5.3.1 Orderly shutdown procedure

A higher layer entity at the ATU-C or ATU-R may initiate the transition from L0 to L3 labeled T0b and the transition from L2 to L3 labeled T2c by providing a command to the MPS-TC function. This transition should be used for orderly power down procedure.

9) Correction to Annex J

Correct reference as follows:

J.1.3 ATU-C downstream transmit spectral mask for non-overlapped spectrum operation

J.1.3.2 Aggregate transmit power

Change "See B.1.2.2." to "See B.1.3.2."

Replace clause J.2 with the following:

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.992.3 – 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	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)

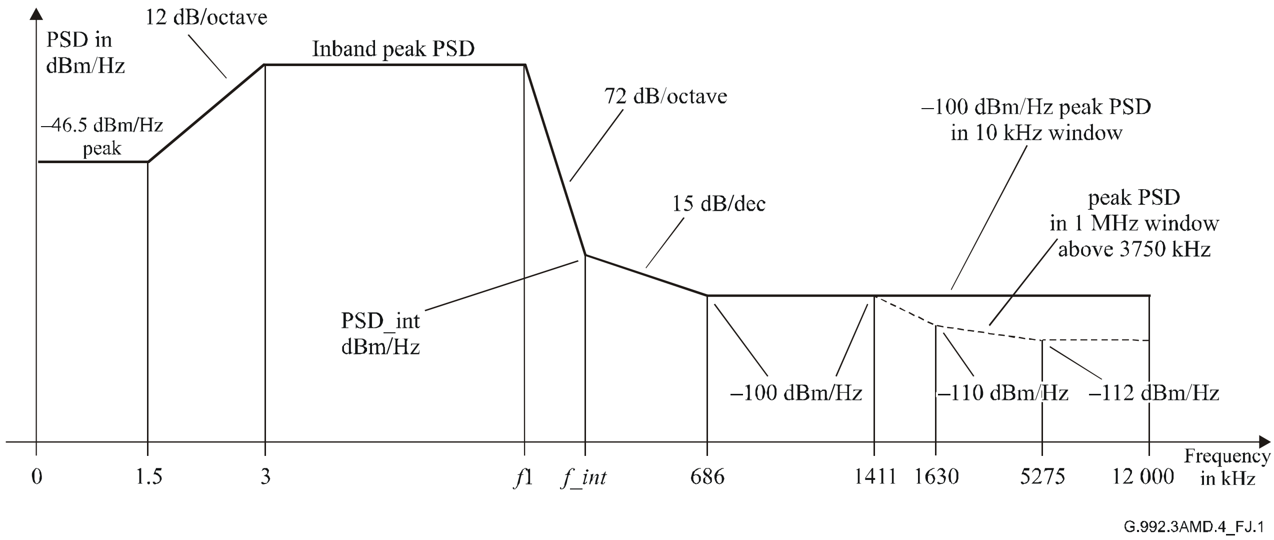
The ATU-R transmit PSD shall comply to one of the allowed family of spectral masks ADLU-32, ADLU-36,… ADLU-64 (see Note 1). Each of the spectral masks shall be as defined in Figure J.1 and Table J.3.

The passband is defined as the band from 3 kHz to an upperbound frequency $f1$, 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)	Measurement BW
0	–46.5	100 Hz
1.5	–46.5	100 Hz
3	Inband_peak_PSD	100 Hz
10	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)	Measurement BW
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 fi is applicable for all frequencies satisfying $fi < f \leq fj$, where fj 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 – All PSD and power measurements shall be made at the U-C interface.

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

Table J.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 *f1* (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.992.3 – 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
12000	–112

Table J.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	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 (MAXNOMATPus – PCBus) 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 (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 13.4 dBm.

10) Amendment to Annex K.1 STM-TC for Higher INP values

K.1.7.1 Valid configurations

The configurations listed in Table K.3 are valid for the STM-TC function.

Table K.3/G.992.3 – Valid configuration for STM-TC function

Parameter	Capability
INP_min_n	0, 1/2, 1, 2, 4, 8, 16

NOTE – Configuration of Minimum Net Data rates such that the sum of all Minimum Net Data rates over all bearer channels result in values higher than given in Table K.3a for downstream and Table K.3b for upstream, may lead to configuration errors by the ATU-C and/or initialization failures with "configuration error" failure caused by the ATU-R.

Table K.3a/G.992.3 – INP_min and delay_max related Downstream Net Data rates limits (in kbit/s)

		INP_min						
		0	**½**	**1**	**2**	**4**	**8**	**16**
delay_max [ms]	**1(Note)**	14656	0	0	0	0	0	0
	2	14656	7104	3008	960	0	0	0
	4	14656	13632	7104	3008	960	0	0
	8	14656	13632	13632	7104	3008	960	0
	16	14656	13632	13632	7552	3520	1472	448
	32	14656	13632	13632	7552	3712	1728	704
	63	14656	13632	13632	7552	3712	1728	704

NOTE – In ITU-T Rec. G.997.1, a 1 ms delay is reserved to mean that $S_p \leq 1$ and $D_p = 1$.

Table K.3b/G.992.3 – INP_min and delay_max related Upstream Net Data rates limits (in kbit/s)

		INP_min						
		0	**½**	**1**	**2**	**4**	**8**	**16**
delay_max [ms]	**1 (Note)**	3520	0	0	0	0	0	0
	2	3520	3072	1472	448	0	0	0
	4	3520	3264	1728	704	192	0	0
	8	3520	3264	1792	832	320	64	0
	16	3520	3264	1792	832	384	128	0
	32	3520	3264	1792	832	384	128	0
	63	3520	3264	1792	832	384	128	0

NOTE – In ITU-T Rec. G.997.1, a 1 ms delay is reserved to mean that $S_p \leq 1$ and $D_p = 1$.

K.1.7.2 Mandatory configurations

If implementing a STM-TC, an ATU shall support all combinations of the values of STM-TC control parameters for a STM-TC function displayed in Tables K.4 and K.5 in the downstream and upstream directions, respectively. The transmitter and receiver shall support mandatory features displayed in the tables.

Table K.4/G.992.3 – Mandatory downstream configuration for STM-TC function

Parameter	Capability
INP_min_n	~~All valid values shall be supported.~~0, 1/2, 1, 2

Table K.5/G.992.3 – Mandatory upstream control configuration for STM-TC function

Parameter	Capability
INP_min_n	~~All valid values shall be supported.~~0, 1/2, 1, 2

K.1.10.1 ITU-T Rec. G.994.1 capabilities list message

Table K.6/G.992.3 – Format for an STM-TC CL and CLR message

Spar(2) bit	Definition of related Npar(3) octets
	Definition of the parameter block of Npar(3) octets
	A parameter block of 8 octets containing: – the value of *net_max*; – the value of *net_min*; – the value of *net_reserve*; – the value of *delay_max*; – the value of *error_max*; and – the minimum Impulse Noise Protection *INP_min*. The unsigned 12-bit *net_max*, *net_min* and *net_reserve* values represent the data rate divided by 4000 bit/s. The *delay_max* is a 6-bit unsigned value expressed in ms. A value of 000000 indicates no delay bound is being imposed. The *error_max* is a 2-bit indication, defined as 00 for an error ratio of 1E-3, 01 for an error ratio of 1E-5, and 10 for an error ratio of 1E-7. The value 11 is reserved. The *INP_min* is a ~~2~~4 bits indication, defined as 0b0000 for *INP* = 0, 0b0001 for *INP* = 1/2, 0b0010 for *INP* = 1, ~~and~~ 0b0011 for *INP* = 2, 0b0111 for *INP* = 4, 0b1011 for *INP* = 8, and 0b1111 for *INP* = 16. *INP_min* = 0 is a special value indicating no impulse noise protection bound is being imposed. The optional *INP_min* values are indicated such that the 2 lsb correspond to the highest mandatory *INP* value and the 2 msb represent the higher optional values. A receiver not supporting the optional *INP_min* values may ignore the 2 msb and hence will fall back to the highest mandatory *INP_min* value.

11) Amendment to Annex K.2 ATM-TC for ATM bonding

K.2.7 Control parameters

Modify paragraph and insert subsequent paragraph as follows:

During activation and reconfiguration procedures, the actual net data rate net_act_n for stream #*n* shall always be set to the value of the derived parameter $net\_act_{p.n}$ of the underlying PMS-TC latency path function and shall be constrained such that $net\_min_n \leq net\_act_n \leq net\_max_n$. However, in case the $net\_min_n = net\_max_n$, the net_act_n may exceed the net_max_n by up to ~~4~~8 kbit/s, to allow for the PMS-TC net data rate granularity (see Table 7-7). The latency $delay\_act_n$ of transport of stream #*n* shall always be set to the value of the derived parameter $delay_p$ of the underlying PMS-TC path function and constrained such that $delay\_min_n \leq delay\_act_n \leq delay\_max_n$. The values net_act_n and $delay\_act_n$ are not control parameters; these values are the result of specific initialization and reconfiguration procedures.

If ATM bonding is not set in the G.994.1 bonding code tree, $delay\_min_n$ shall be set to 0 for both upstream and downstream directions and $delay\_max_n$ can be set to any valid value. If ATM bonding is set, then the G.994.1 bonding code tree includes the value of the *max_delay_variation* control parameter for downstream ATM bonding and the $delay\_min_n$ shall be set to $delay\_max_n$ – *max_delay_variation* for the downstream direction. If information related to $delay\_min_n$ is available through the ATU-R bonding management interface over the T-R reference point, it may take precedence over the value derived from the G.994.1 bonding code tree. For the upstream direction, the information related to $delay\_min_n$ is available through the ATU-C bonding management interface over the V-C reference point. For both upstream and downstream directions, if $delay\_min_n$ is greater than 0, there are combinations of $delay\_min_n$ and $delay\_max_n$ that may result in a failure to connect. Constraints on $delay\_max_n$ and $delay\_min_n$ designed to prevent this failure are described in Appendix VI.

12) Amendment to Annex K.2 ATM-TC for Higher INP values

K.2.7.1 Valid configurations

The configurations listed in Table K.10 are valid for the ATM-TC function.

Table K.10/G.992.3 – Valid configuration for ATM-TC function

Parameter	Capability
INP_min_n	0, 1/2, 1, 2, 4, 8, 16

NOTE – Configuration of Minimum Net Data rates such that the sum of all Minimum Net Data rates over all bearer channels result in values higher than given in Table K.3a for downstream and Table K.3b for upstream, may lead to configuration errors by the ATU-C and/or initialization failures with "configuration error" failure caused by the ATU-R.

K.2.7.2 Mandatory configurations

If implementing an ATM-TC, an ATU shall support all combinations of the values of ATM-TC control parameters for ATM-TC function #0 displayed in Tables K.11 and K.12 and in the downstream and upstream directions, respectively. The transmitter and receiver shall support mandatory features displayed in the tables.

Table K.11/G.992.3 – Mandatory downstream configuration for ATM-TC function #0

Parameter	Capability
INP_min_n	~~All valid values shall be supported.~~0, 1/2, 1, 2

Table K.12/G.992.3 – Mandatory upstream control configuration for ATM-TC function #0

Parameter	Capability
INP_min_n	~~All valid values shall be supported.~~0, 1/2, 1, 2

13) Amendment to Annex K.3 PTM-TC for Higher INP values

K.3.7.1 Valid configurations

The configurations listed in Table K.19 are valid for the PTM-TC function.

Table K.19/G.992.3 – Valid configuration for PTM-TC function

Parameter	Capability
INP_min_n	0, 1/2, 1, 2, 4, 8, 16

NOTE – Configuration of Minimum Net Data rates such that the sum of all Minimum Net Data rates over all bearer channels result in values higher than given in Table K.3a for downstream and Table K.3b for upstream, may lead to configuration errors by the ATU-C and/or initialization failures with "configuration error" failure caused by the ATU-R.

K.3.7.2 Mandatory configurations

If implementing a PTM-TC function, an ATU shall support all combinations of the values of PTM-TC control parameters for PTM-TC function #0 displayed in Tables K.20 and K.21 in the downstream and upstream directions, respectively. The transmitter and receiver shall support mandatory features displayed in the tables.

Table K.20/G.992.3 – Mandatory downstream configuration for PTM-TC function #0

Parameter	Capability
INP_min_n	~~All valid values shall be supported.~~0, 1/2, 1, 2

Table K.21/G.992.3 – Mandatory upstream control configuration for PTM-TC function #0

Parameter	Capability
INP_min_n	~~All valid values shall be supported.~~0, 1/2, 1, 2

14) Add the following new Appendix V

Appendix V

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.

V.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.

V.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 V.1 and shown plotted in Figure V.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 that the definitions given in Table V.1 and Figure V.1 are those of a PSD mask. The corresponding PSD template is 3.5 dB below the mask at all frequencies.

Table V.1/G.992.3 – 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 < *f* < 4	–97.5, with max power in the 0-4 kHz band of +15 dBrn
4 < *f* < 32	–94.5
32 < *f* < 109	–94.5 + 20.65 log2(*f*/32)
109 < *f* < 138	–58 + 58 log2(*f*/109)
138 < *f* < 200	–38.3 + 3.36 log2(*f*/138)
200 < *f* < 1104	–36.5
1104 < *f* < 3093	–36.5 – 36 log2(*f*/1104)
3093 < *f* < 4545	–90, peak with max power in the [*f*, *f* + 1 MHz] window of (–36.5 – 36 × log2(*f*/1104) + 60) dBm
4545 < *f* < 11 040	–90 peak, with max power in the [*f*, *f* + 1 MHz] window of –50 dBm

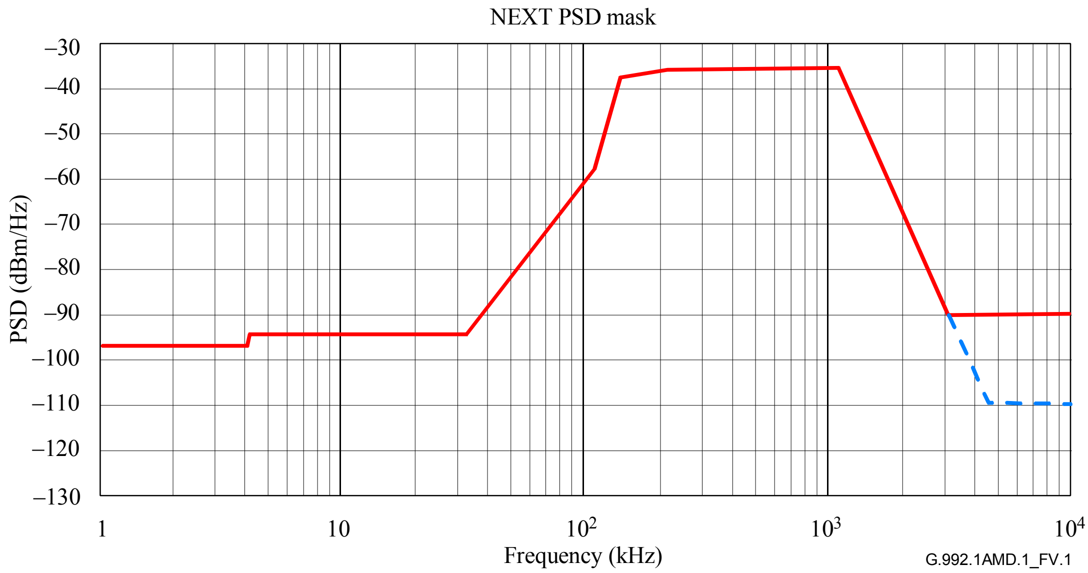


Figure V.1/G.992.3 – A shaped overlapped downstream PSD mask for use during NEXT periods of the TTR clock

V.1.2 Downstream shaped overlapped 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 V.2 and shown plotted in Figure V.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 that the definitions given in Table V.2 and Figure V.2 are those of a PSD mask. The corresponding PSD template is 3.5 dB below the mask at all frequencies.

Table V.2/G.992.3 – 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 < *f* < 4	–97.5, with max power in the 0-4 kHz band of +15 dBrn
4 < *f* < 4.8	–94.5
4.8 < *f* < 50	–94.5 + 11.0 log2(*f*/4.8)
50 < *f* < 126	–57.5 + 15.7 log2(*f*/50)
126 < *f* < 1104	–36.5
1104 < *f* < 3093	–36.5 – 36 log2(*f*/1104)
3093 < *f* < 4545	–90 peak, with max power in the [*f*, *f* + 1 MHz] window of (–36.5 – 36 × log2(*f*/1104) + 60) dBm
4545 < *f* < 11 040	–90 peak, with max power in the [*f*, *f* + 1 MHz] window of –50 dBm

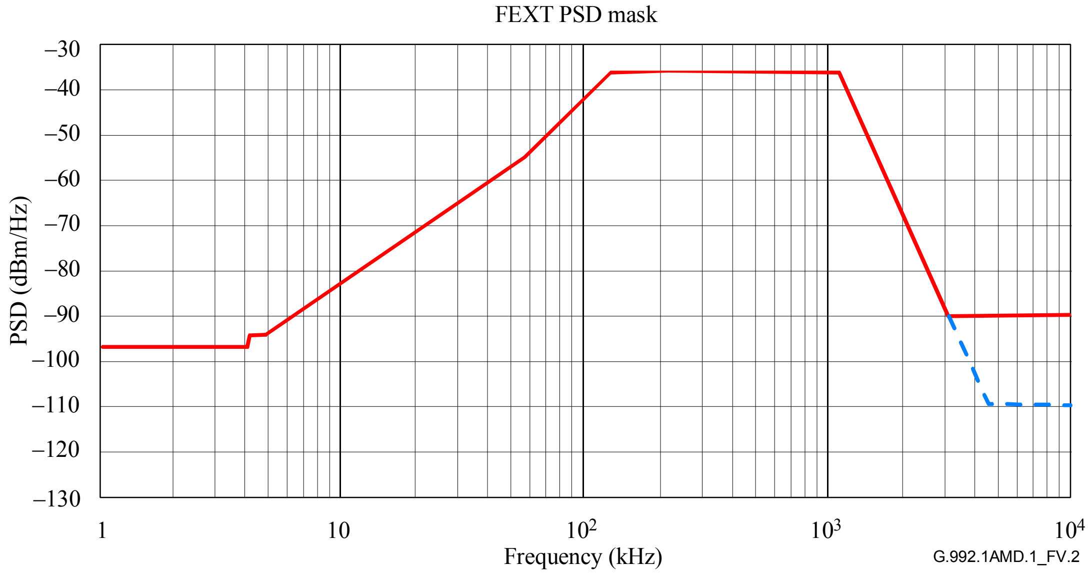


Figure V.2/G.992.3 – A shaped overlapped downstream PSD mask for use during FEXT periods of the TTR clock

V.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 V.3 and shown in Figure V.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 that the definitions given in Table V.3 and Figure V.3 are those of a PSD mask. The corresponding PSD template is 3.5 dB below the mask at all frequencies.

Table V.3/G.992.3 – Tabulation of a shaped downstream PSD mask for Profile 3

Frequency *f* (kHz)	**PSD (dBm/Hz) peak values**
0 < *f* < 4	–97.5, with max power in the in 0-4 kHz band of +15 dBrn
4 < *f* < 5	–92.5 + 18.64 log2(*f*/4)
5 < *f* < 5.25	–86.5
5.25 < *f* < 16	–86.5 + 15.25 log2(*f*/5.25)
16 < *f* < 32	–62 + 25.5 log2(*f*/16)
32 < *f* < 1104	–36.5
1104 < *f* < 3093	–36.5 – 36 log2(*f*/1104)
3093 < *f* < 4545	–90 peak, with max power in the [*f*, *f* + 1 MHz] window of (–36.5 – 36 × log2 (*f*/1104) + 60) dBm
4545 < *f* < 11 040	–90 peak, with max power in the [*f*, *f* + 1 MHz] window of –50 dBm

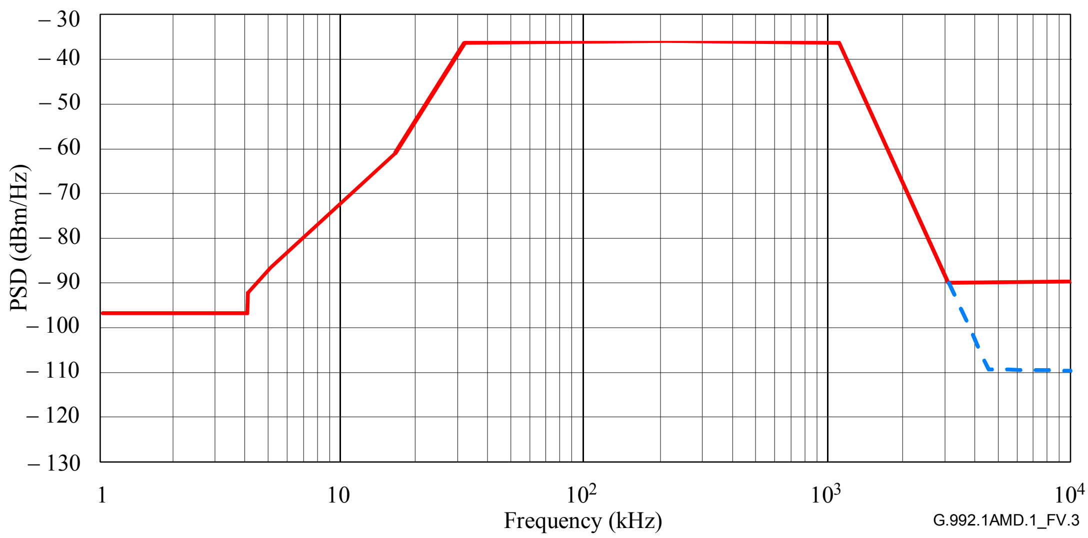


Figure V.3/G.992.3 – A shaped downstream PSD mask for Profile 3

15) Add the following new Appendix VI

Appendix VI

Constraints on delay, impulse noise protection, overhead rate, and net data rate when bonding

This appendix considers the case when multiple transceivers form a bonding group and the differential delay among members of the group is controlled through the *delay_min* parameter derived from ITU-T Rec. G.994.1. This appendix outlines a set of simple rules that allows the construction of a valid set of configuration parameters involving the minimum delay (*delay_min)*, the minimum impulse noise protection *(INP_min),* the minimum overhead message rate *(MSGmin)*, the minimum net data rate *(net_min)* and the data rate granularity. These rules restrict the framing parameters and may lead to a reduction in the attainable data rates.

The rules are as follows:

- Set *delay_min* = *delay_max*. In either the upstream or downstream direction, all transceivers in a bonding group should use the same delay. The value for *delay_min* and *delay_max* should be selected from Table VI.1 or VI.2.
- Set the minimum net data rate below the values shown in Tables VI.1 and VI.2 for downstream and upstream respectively. Depending on the downstream PSD mask and value of BIMAX, the actual maximum net data rate might be lower than those shown in these tables.
- The valid range of MSGmin and the corresponding data rate granularity (minimum value of *net_max – net_min)* are listed in Table VI.3.

Table VI.1/G.992.3 – Maximum downstream net data rate (kbit/s) for various values of *delay_min* = *delay_max* and *INP_min*

		INP_min[b)]						
		0	**½**	**1**	**2**	**4**	**8**	**16**
delay_min *delay_max* *(ms)*	**1**[a)]	14656	0	0	0	0	0	0
	2	14656	7104	3008	960	0	0	0
	4	14656	13632	7104	3008	960	0	0
	8	14656	13632	13632	7104	3008	960	0
	16	8064	7552	7552	7552	3520	1472	448
	32	3968	3712	3712	3712	3712	1728	704

a) In ITU-T Rec. G.997.1, a 1 ms delay is reserved to mean that $S_p \leq 1$ and $D_p = 1$.

b) Values of *INP_min* in gray are optional.

Table VI.2/G.992.3 – Maximum upstream net data rate (kbit/s) for various values of *delay_min* = *delay_max* and *INP_min*

		INP_min[b)]						
		0	**½**	**1**	**2**	**4**	**8**	**16**
delay_min *delay_max* *(ms)*	**1**[a)]	3520	0	0	0	0	0	0
	2	3520	3072	1472	448	0	0	0
	4	3520	3264	1728	704	192	0	0
	8	1920	1792	1792	832	320	64	0
	16	896	832	832	832	384	128	0
	32	0	0	0	0	0	0	0

a) In ITU-T Rec. G.997.1, a 1 ms delay is reserved to mean that $S_p \leq 1$ and $D_p = 1$.

b) Values of *INP_min* in gray are optional.

Table VI.3/G.992.3 – Range of MSGmin and minimum data rate granularity (*net_max – net_min)* when delay is selected from Tables VI.1 or VI.2

MSGmin (kbit/s)	Data rate granularity (kbit/s)
61-64	Not supported
29-60	64
14-28	32
6-13	16
4-5	8

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