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G.993.2

Amendment 1
(04/2007)

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

Digital sections and digital line system – Access networks

Very high speed digital subscriber line transceivers 2 (VDSL2)

Amendment 1

ITU-T Recommendation G.993.2 (2006) – Amendment 1

ITU-T

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ITU-T Recommendation G.993.2

Very high speed digital subscriber line transceivers 2 (VDSL2)

Amendment 1

Summary

This Amendment 1 to G.993.2 includes the following:

1) Added note to implementers, *issue 12.2.4.1.1*
2) Revision of Table 6-1, *issue 6.2*
3) To support PSD shaping in the US0 band, revise text in 7.2.1.1.1 and 7.2.1.1.2, and add new 7.2.1.1.3 based on "ProposalUS0shapingR1" rather than D0492R1, *issue 7.2.1.2*
4) Revise Table 7-2 (stopband PSDmax), *issue 7.2.4*
5) To support the new SRA, revise text in 9.4.1 based on "revise_9.4.1"
6) To support the optional OLR mechanisms (eoc messages), revise 11.2.3.3, 13.1, 13.2 and 13.3 based on CD-076R1 and CD-077R1, *issue 13.1.10*
7) To indicate optional vs mandatory support of eoc messages, revise Tables 11-2, 11-3, 11-4, 11-5, 11-25, 11-26, and 11-27 based on "eoc_mandatory_vs_optional"
8) Revise OLR text in 13.2 and 13.4 based on CD-072 and CD-074, *issues 13.1.2.6.5, 13.1.2.5.8*
9) To support the optional OLR mechanisms, revise 11.2.3.3, 13.1, 13.2, 13.3, 12.3.5.2.1.1, and 12.3.5.2.2.1 based on "fvdp-C-190", *issues 13.1.11, 13.1.13*
10) Revise 11.2.3.11 to define a Block Vector Read command based on CD-025R1, *issue 11.2.5.2*
11) Revise 11.2.3.11, 11.4.1 and add new 11.4.1.1.9 based on "Homework INP_act eoc message R1", *issue 11.2.6.1*
12) To support the revision of Annex C, revise Tables 12-5, 12-8, 12-11, and 12-14 based on C0100, *issue 12.2.3.1*
13) To support shaping of the US0 band, revise Tables 12-3, 12-5, 12-6, 12-9, 12-11, and 12-12 based on "HW US0 Shaping Codepoints VDSL2"
14) To support the new channel initialization policy, revise 12.3.5.2.1.2 (O-TPS), 12.3.5.2.2.1 (R-MSG 2), and Annex K based on "Geneva-R17A3R2", *issue 12.2.6.1.5.2*
15) To support the new Initialization success/failure code, revise 12.3.5.2.1.4 (O-PMD) and 12.3.5.2.2.4 (R-PMD) based on C0255R1, *issue 12.2.6.4.1*
16) To support the optional OLR mechanisms, revise initialization text in 12 based on GB-078R1, *issue 13.1.8.1*
17) To support SRA, revise initialization text in 12.3.5.2.1.1, 12.3.5.2.1.2, 13.4 and Annex K based on "Homework SRA init message R1"
18) Add new 14.3 "Input capacitance" based on D0670 and D0671, *issue 14.2*
19) Revise Annex A based on C0066, *issue A.0.1*
20) Replace Annex B based on C0068, further revised by correction in "BT-update-ref-table-b-5-corrigenda-G.993.2 Amendment 1 R1", *issue B.1.1*

21) Revision of Annex C and new Appendix based on CD-028 and CD-029, and Editorial update from "Draft_AnnexC", *issues B.3.2, C.2.3.3.2, C.2.3.3.3, C.2.5*

Source

Amendment 1 to ITU-T Recommendation G.993.2 (2006) was approved on 6 April 2007 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

This amendment includes the modifications introduced by Corrigendum 1 to Amendment 1, approved on 29 July 2007 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

This amendment also includes the modifications introduced by Corrigendum 2 approved on 29 July 2007 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

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ITU-T Recommendation G.993.2

Very high speed digital subscriber line transceivers 2 (VDSL2)

Amendment 1

1) Table 6-1

Revise Table 6-1 as follows:

Table 6-1 – VDSL2 profiles

Frequency plan	Parameter	Parameter value for profile							
		8a	**8b**	**8c**	**8d**	**12a**	**12b**	**17a**	**30a**
All	Maximum aggregate downstream transmit power (dBm)	+17.5	+20.5	+11.5	+14.5	+14.5	+14.5	+14.5	+14.5
All	Minimum aggregate downstream transmit power (dBm)	For further study	For further study	For further study	For further study	For further study	For further study	For further study	For further study
All	Maximum aggregate upstream transmit power (dBm)	+14.5	+14.5	+14.5	+14.5	+14.5	+14.5	+14.5	+14.5
All	Minimum aggregate upstream transmit power (dBm)	For further study	For further study	For further study	For further study	For further study	For further study	For further study	For further study
All	Sub-carrier spacing (kHz)	4.3125	4.3125	4.3125	4.3125	4.3125	4.3125	4.3125	8.625
All	Support of upstream band zero (US0)	Required	Required	Required	Required	Required	Not Required	Not Required	Not Supported~~Required~~
All	Minimum bidirectional net data rate capability (MBDC)	50 Mbit/s	50 Mbit/s	50 Mbit/s	50 Mbit/s	68 Mbit/s	68 Mbit/s	100 Mbit/s	200 Mbit/s
All	Aggregate interleaver and de-interleaver delay (octets)	65536	65536	65536	65536	65536	65536	98304	131072
All	Maximum interleaving depth (D_{max})	2048	2048	2048	2048	2048	2048	3072	4096
All	Parameter $(1/S)_{max}$ downstream	24	24	24	24	24	24	48	28
All	Parameter $(1/S)_{max}$ upstream	12	12	12	12	24	24	24	28

Table 6-1 – VDSL2 profiles

Frequency plan	Parameter	Parameter value for profile							
		8a	**8b**	**8c**	**8d**	**12a**	**12b**	**17a**	**30a**
Annex A~~, Annex B~~ (998)	Index of highest supported downstream data-bearing sub-carrier (upper band edge frequency in MHz (informative))	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	4095 (17.6604) ~~N/A~~	2666 (23)~~N/A~~
	Index of highest supported upstream data-bearing sub-carrier (upper band edge frequency in MHz (informative))	1205 (5.2)	1205 (5.2)	1205 (5.2)	1205 (5.2)	2782 (12)	2782 (12)	2782 (12)~~N/A~~	3478 (30)~~N/A~~
Annex B (998E)	Index of highest supported downstream data-bearing sub-carrier (upper band edge frequency in MHz (informative))	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	4095 (17.6604)	3478 (30)
	Index of highest supported upstream data-bearing sub-carrier (upper band edge frequency in MHz (informative))	1205 (5.2)	1205 (5.2)	1205 (5.2)	1205 (5.2)	2782 (12)	2782 (12)	3246 (14)	2885 (24.890)
Annex B (998ADE)	Index of highest supported downstream data-bearing sub-carrier (upper band edge frequency in MHz (informative))	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	4095 (17.6604)	2885 (24.890)
	Index of highest supported upstream data-bearing sub-carrier (upper band edge frequency in MHz (informative))	1205 (5.2)	1205 (5.2)	1205 (5.2)	1205 (5.2)	2782 (12)	2782 (12)	2782 (12)	3478 (30)
Annex B (997E)	Index of highest supported downstream sub-carrier (upper band edge frequency in MHz (informative))	1634 (7.05)	1634 (7.05)	1634 (7.05)	1634 (7.05)	1634 (7.05)	1634 (7.05)	3246 (14)~~N/A~~	3130 (27)~~N/A~~
	Index of highest supported upstream sub-carrier (upper band edge frequency in MHz (informative))	2047 (8.832)	2047 (8.832)	1182 (5.1)	2047 (8.832)	2782 (12)	2782 (12)	4095 (17.6604) ~~N/A~~	3478 (30)~~N/A~~

Table 6-1 – VDSL2 profiles

Frequency plan	Parameter	Parameter value for profile							
		8a	8b	8c	8d	12a	12b	17a	30a
Annex B (HPE)	Index of highest supported downstream sub-carrier (upper band edge frequency in MHz (informative))	N/A	N/A	N/A	N/A	N/A	N/A	4095 (17.6604)	3478 (30)
	Index of highest supported upstream sub-carrier (upper band edge frequency in MHz (informative))	N/A	N/A	N/A	N/A	N/A	N/A	3246 (14)	2885 (24.890)
Annex C	Index of highest supported downstream sub-carrier (upper band edge frequency in MHz (informative))	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	1971 (8.5)	4095 (17.6604)	2098 (18.1)
	Index of highest supported upstream sub-carrier (upper band edge frequency in MHz (informative))	1205 (5.2)	1205 (5.2)	1205 (5.2)	1205 (5.2)	2782 (12)	2782 (12)	2782 (12)	3478 (30)

2) Clause 7.2.1.1.1

Revise 7.2.1.1.1 as follows:

7.2.1.1.1 Overview

In some deployment scenarios, an operator may choose to force VDSL2 modems to transmit at levels lower than those specified by the Limit PSD masks. The MIB PSD mask is an additional tool that allows operators to shape the VTU-O and VTU-R transmit PSD masks. Power cut-back (see 12.3.3) and upstream power back-off (see 7.2.1.3) are tools that provide further reduction of the transmit PSD (below the transmit PSD mask).

The MIB PSD mask shall lie at or below the Limit PSD mask specified in the selected annex. Its definition shall be under the network management control (a MIB-controlled mechanism), as defined in ITU-T Rec. G.997.1 [4].

The MIB PSD mask shall be specified in the CO MIB by a set of breakpoints. Up to 16 breakpoints may be specified to construct the MIB PSD mask for all utilized upstream bands (including US0), and up to 32 breakpoints may be specified to construct the MIB PSD mask for all utilized downstream bands. It is not required to specify breakpoints for every band defined by a band plan. In frequency ranges in which the MIB PSD mask is not specified, the transmit PSD mask shall be equal to the Limit PSD mask.

~~NOTE – The MIB PSD mask requirements defined in this sub-clause do not apply to US0. The use of a MIB PSD mask in US0 is for further study.~~

Each breakpoint used to specify the MIB PSD mask shall consist of a sub-carrier index t_n and a PSD mask value PSD_n at that sub-carrier expressed in dBm/Hz. The sub-carrier indices shall always be calculated assuming 4.3125 kHz sub-carrier spacing (i.e., independent of the sub-carrier spacing actually used – see Table 6-1).

Breakpoints for each utilized band shall be represented by the set [(t_1, PSD_1), …, (t_n, PSD_n), …, (t_{NBP}, PSD_{NBP})]. The first breakpoint shall have the value t_1 = ceil(f_x/4.3125 kHz), where "ceil" denotes the ceiling function (rounding up to the nearest integer), and f_x is the frequency of the lower band edge (see Figure 7-1). The index t_1 corresponds to the lowest-frequency sub-carrier in the band, assuming that a profile with 4.3125 kHz sub-carrier spacing is used. Except for the US0 band, t~~T~~he last breakpoint in the band shall have the value t_{NBP} = floor(f_{x+1}/4.3125 kHz), where "floor" denotes the floor function (rounding down to the nearest integer), and f_{x+1} is the frequency of the upper band edge. For the US0 band, the last breakpoint is specified in 7.2.1.1.3. The index t_{NBP} corresponds to the highest-frequency sub-carrier in the band, assuming that a profile with 4.3125 kHz sub-carrier spacing is used. Additional breakpoints within a band, if needed, shall be specified so that $t_n < t_{n+1}$ for $n = 2$ to $NBP - 1$. The frequency f_n corresponding to the index t_n is $f_n = t_n \times 4.3125$ kHz.

All t_i in a particular frequency band shall be coded in the CO MIB as unsigned integers.

The value of the PSD at sub-carrier t_n, PSD_n, shall be coded in the CO MIB as an unsigned integer. The PSD values shall be coded from 0 dBm/Hz (coded as 0) to −127.5 dBm/Hz (coded as 255), in steps of 0.5 dBm/Hz. The valid range of PSD values is from 0 dBm/Hz to −95 dBm/Hz, although the values input via the MIB must be no higher than allowed by the Limit PSD mask.

In the case that a profile specifying 8.625 kHz sub-carrier spacing is used, the VTU shall subtract 1 from any odd values of t_i for $i = 2$ to $NBP - 1$. If t_1 is an odd number, the VTU shall add 1 to t_1 and use this value as the first breakpoint. If t_{NBP} is an odd number, the VTU shall subtract 1 from t_{NBP} and use this value as the last breakpoint.

The MIB PSD mask parameter in the CO MIB shall be a concatenation of the sets of breakpoints for all utilized bands.

3) Clause 7.2.1.1.2

Revise 7.2.1.1.2 as follows:

7.2.1.1.2 Definition of breakpoints above US0

Breakpoints specified in the CO MIB at frequencies above f_1 shall comply with the restrictions specified in this subclause.

4) New clause 7.2.1.1.3

Insert new clause 7.2.1.1.3 as follows:

7.2.1.1.3 Definition of breakpoints in US0

If US0 shaping is supported, breakpoints [(t_1, PSD_1), …, (t_n, PSD_n), …, (t_{NBPUS0}, PSD_{NBPUS0})] specified in the CO MIB at frequencies between f_{0L} and f_{0H} ($f_{0L} \le t_n \times 4.3125$ kHz $\le f_{0H}$) shall comply with the restrictions specified in the following subclauses.

7.2.1.1.3.1 Restriction on breakpoints in US0

The number of breakpoints in US0 (NBP_{US0}) shall be between 2 and 6. The first breakpoint t_1 shall be equal to ceil(f_{0L}/4.3125 kHz). The last breakpoint, t_{NBPUS0}, shall be smaller than or equal to floor(f_{0H}/4.3125 kHz). t_{NBPUS0} shall be between 32 and 128. If $32 \le t_{NBPUS0} \le 64$, t_{NBPUS0} shall be a multiple of 4. If $64 < t_{NBPUS0} \le 128$, t_{NBPUS0} shall be a multiple of 8.

The breakpoint PSD values PSD_n shall be specified according to the following constraints and requirements:

1) The range between the minimum and maximum PSD values over all breakpoints shall be no greater than 24 dB, i.e.,

$$\max\{PSD_n\} - \min\{PSD_n\} \le 24 \text{ dB},$$

where:

$$\max\{PSD_n\} = \max\left(PSD_1, PSD_2, ..., PSD_{NBP_{US0}}\right)$$

and:

$$\min\{PSD_n\} = \min\left(PSD_1, PSD_2, ..., PSD_{NBP_{US0}}\right)$$

2) The maximum slope between consecutive breakpoints shall be bound by at least one of the following two restrictions:

i) $\forall n : 1 < n < NBP_{US0}$:

$$\left|\frac{PSD_n - PSD_{n-1}}{t_n - t_{n-1}}\right| \le 0.75 \text{ dB/4.3125 kHz}$$

ii) $\forall n : 1 < n < NBP_{US0}$ and ($\max\{PSD_n\} - PSD_n \le 6$ dB or $\max\{PSD_n\} - PSD_{n-1} \le 6$ dB):

$$\left|\frac{PSD_n - PSD_{n-1}}{t_n - t_{n-1}}\right| \le 0.6 \text{ dB/4.3125 kHz}$$

7.2.1.1.3.2 Derivation of US0 PSD mask from defined breakpoints

The MIB PSD mask at an arbitrary frequency f between $t_1 \times 4.3125$ kHz and $t_{NBPUS0} \times 4.3125$ kHz shall be obtained by interpolation in dB on a linear frequency scale as follows:

$$\text{MIB PSD mask } (f) = \text{PSD}_n + (\text{PSD}_{n+1} - \text{PSD}_n) \times \frac{(f/4.3125 \text{ kHz}) - t_n}{t_{n+1} - t_n}, \quad t_n < (f/4.3125 \text{ kHz}) \le t_{n+1}$$

For frequencies below $t_1 \times 4.3125$ kHz, the MIB PSD mask shall be equal to PSD_1.

For $t_{NBPUS0} \times 4.3125$ kHz $< f <$ 989 kHz, the MIB_PSD_mask in dBm/Hz shall be the higher of:

$$MIB\_PSD\_Mask(f) = PSD_{NBPUS0-1} - 72 \times \log_2\left(\left(f/4.3125 \; kHz\right)/t_{NBPUS0-1}\right)$$

and:

$$MIB\_PSD\_Mask(f) = \max\left(-100 - 15 \times \log_{10}(f/686 \text{ kHz}) - 100\right)$$

5) Table 7-2

Revise the note in Table 7-2 as follows:

Table 7-2 – Stopband PSD requirements

Frequency (MHz)	**Limit PSD mask value (PSDmax dBm/Hz)**	**Maximum power in a 1-MHz sliding window (*Pmax* dBm)**
< 0.686	Subject to regional annexes	
0.686-4.0	−100	
4.0-5.0	−100	−50
5.0-30.0	−100	−52
≥ 30.0	−110~~NOTE~~	
Frequency (MHz)	**Limit PSD mask value at the transition frequency (dBm/Hz)**	
Transition frequency ($f = f_{tr1}$ and $f = f_{tr2}$)	−80	
~~NOTE – This Limit PSD mask value, PSDmax, shall be between −120 dBm/Hz and −110 dBm/Hz. The exact value is for further study.~~		

6) Clause 9.4.1

Revise the last paragraph of clause 9.4.1 as follows:

If a change of the interleaver depth is to be accompanied by a corresponding change of the data rate in the particular latency path (e.g., ~~DRR,~~ SRA – see 13.1), the change of D shall be coordinated with the corresponding change of parameter L_p (see Table 9-6) as described in 13.3~~in the following way. For an increase in depth, L_p shall be changed in the data frame immediately following the data frame that contains the first bit of byte *k*. For a decrease in depth, L_p shall be changed to the lower value in the data frame that contains the first bit of byte *k*. The restrictions on the maximum total delay of the interleaver/de-interleaver combination and *INP_min* shall be met before and after the change of *D*. No restrictions on the total delay apply during the procedure of changing *D*, i.e., between the first and last unspecified bytes.~~

7) New clause 9.9

Add the following new clause:

9.9 Delay variation

The delay variation occurring in an OLR on latency path p.

It is defined here as:

$$DV_p = \left| (delay_p\_H \times L_p\_H - delay_p\_L \times L_p\_L)/L_p\_H \right|$$

where:

L_p_L is the lower value of L_p in an OLR procedure

L_p_H is the higher value of L_p in an OLR procedure

$delay_p\_L$ = the actual delay in ms in the steady state corresponding with L_p_L

$delay_p\_H$ = the actual delay in ms in the steady state corresponding with L_p_H

The delay variation DV_n of bearer channel #n shall always be set to the value of DV_p of the underlying PMS-TC path function (see Annex K).

8) Table 11-1

Revise Table 11-1 as follows:

Table 11-1 – eoc message priority levels

Priority level	Associated time-out value	eoc command (response)
High	400 ms	Table 11-2, UTC (11.2.3.2)
Normal	800 ms	Table 11-3
Low	1 s	Table 11-4

9) Clause 11.2.3.2

Revise clause 11.2.3.2 as follows:

11.2.3.2 Command and response types

With the exception of Control Parameter Read, which is for further study, the VTU shall support all mandatory eoc command and response types specified in Table 11-2 (high priority commands), Table 11-3 (normal priority commands) and Table 11-4 (low priority commands), and their associated mandatory commands and responses specified in 11.2.3.3 to 11.2.3.11, inclusive. The VTU should reply with Unable-To-Comply (UTC) response on the optional commands that the VTU cannot recognize. The UTC response shall include two octets: the first octet of the UTC shall be the same as the first octet of the received command, and the second octet shall be FF_{16}. The UTC is a high priority response.

NOTE – If the UTC response is not supported, the command will time out. This would reduce the efficiency of the eoc.

Table 11-2 – High priority commands and responses

Command type and assigned value	Direction of command	Command content	Response content	Support
On-line Reconfiguration (OLR) 0000 0001_2	From the receiver of either VTU to the transmitter of the other	All the necessary PMD and PMS-TC control parameter values for the new configuration	Includes either a line signal marking the instant of re-configuration (Syncflag), or an OLR intermediate acknowledge (for segmented command), or an OLR command to defer or reject the proposed reconfiguration	See Table 11-5.

Table 11-3 – Normal priority commands and responses

Command type and assigned value	Direction of command	Command content	Response content	Support
Diagnostic $0100\ 0001_2$	From VTU-O to VTU-R	Request to run the self-test, or to update test parameters, or to start and stop transmission of corrupt CRC, or to start and stop reception of corrupt CRC	Acknowledgment	Mandatory
	From VTU-R to VTU-O	Request to update test parameters	Acknowledgment	Mandatory
Time $0100\ 0010_2$	From VTU-O to VTU-R	Set or readout the time	Acknowledgment of the set time command, or a response including the time value	Mandatory
Inventory $0100\ 0011_2$	From either VTU to the other	Identification request, auxiliary inventory information request, and Self-test Results request	Includes the VTU equipment ID auxiliary inventory information, and self-test results	Mandatory
Management Counter Read $0000\ 0101_2$	From either VTU to the other	Request to read the counters	Includes all counter values	Mandatory
Clear eoc $0000\ 1000_2$	From either VTU to the other	Clear eoc command as defined in ITU-T Rec. G.997.1 [4]	Acknowledgment	Mandatory
Power Management $0000\ 0111_b$	From either VTU to the other	Proposed new power state	An acknowledgement to either reject or grant the new power state	Mandatory
Non-standard Facility (NSF) $0011\ 1111_2$	From either VTU to the other	Non-standard identification field followed by vendor proprietary content	An acknowledgment or a negative acknowledgment indicating that the non-standard identification field is not recognized	Mandatory
Control Parameter Read $0000\ 0100_2$	From either VTU to the other	For further study	For further study	Mandatory

Table 11-4 – Low priority commands and responses

Command type and assigned value	Direction of command	Command content	Response content	Support
PMD Test Parameter Read 1000 0001_2	From either VTU to the other	The identification of test parameters for single read, or for multiple read, or for block read	Includes the requested test parameter values or a negative acknowledgment	See Tables 11-25 and 11-26.
Non-Standard Facility (NSF) Low Priority 1011 1111_2	From either VTU to the other	Non-standard identification field followed by vendor proprietary content	An acknowledgment or a negative acknowledgment indicating that the non-standard identification field is not recognized	Mandatory

10) Clause 11.2.3.3

Revise the tables in clause 11.2.3.3 as follows:

Table 11-5 – OLR commands sent by the initiating VTU

Name	Length (octets)	Octet number	Content	Support
Request Type 1	$5 + 4 \times N_f$ ($N_f \leq 128$)	2	04_{16} (Note 1)	Mandatory
		3 to 4	2 octets for the number of sub-carriers N_f to be modified	
		5 to $4 + 4 \times N_f$	$4 \times N_f$ octets describing the sub-carrier parameter field for each sub-carrier	
		$5 + 4 \times N_f$	1 octet for SC	
Request Type 2	For further study	2	05_{16} (Note 1)	For further study
		All others	Reserved by the ITU-T	
~~Request Type 3~~	~~For further study~~	~~2~~	~~06_{16} (Note)~~	

Table 11-5 – OLR commands sent by the initiating VTU

Name	Length (octets)	Octet number	Content	Support
		~~All others~~	~~Reserved by the ITU-T~~	
Request Type 3 (SRA) (Note 6)	$5 + 7\ N_{LP} + 4\ N_f$ ($N_f \le 128$)	2	06_{16} (Note 1)	Optional
		3 to $2 + 2\ N_{LP}$	$2 \times N_{LP}$ octets containing the new L_p values for each of the active latency paths (N_{LP} = number of active latency paths) (Notes 2 and 3)	
		$3 + 2\ N_{LP}$ to $2 + 4\ N_{LP}$	$2 \times N_{LP}$ octets containing the new D_p values for each of the active latency paths (N_{LP} = number of active latency paths) (Note 4)	
		$3 + 4\ N_{LP}$ to $2 + 5\ N_{LP}$	N_{LP} octets containing the new T_p values for each of the active latency paths (N_{LP} = number of active latency paths) (Notes 2, 3, 5)	
		$3 + 5\ N_{LP}$ to $2 + 6\ N_{LP}$	N_{LP} octets containing the new G_p values for each of the active latency paths (N_{LP} = number of active latency paths) (Notes 2, 3, 5)	
		$3 + 6\ N_{LP}$ to $2 + 7\ N_{LP}$	N_{LP} octets containing the new B_{p0} values for each of the active latency paths (N_{LP} = number of active latency paths) (Notes 2, 3, 5)	
		$3 + 7\ N_{LP}$ to $4 + 7\ N_{LP}$	2 octets for the number of sub-carriers N_f to be modified	
		$5 + 7\ N_{LP}$ to $4 + 7\ N_{LP} + 4\ N_f$	$4\ N_f$ octets describing the sub-carrier parameter field for each sub-carrier	
		$5 + 7\ N_{LP} + 4\ N_f$	1 octet for Segment Code (SC)	

NOTE 1 – All other values for octet number 2 are reserved by the ITU-T.

NOTE 2 – For this command, any change in L_p, T_p, G_p, and B_{p0} values shall be such that the length of the MDF (as defined in Table 9-6) remains unchanged for all active latency paths.

NOTE 3 – To keep the msg_p value within its valid range for relatively large changes of L_p, it may be necessary to change all of the T_p, G_p, and B_{p0} values.

NOTE 4 – If a change of D_p is not supported, the value of this parameter shall be identical to that currently used.

NOTE 5 – If a change of T_p, G_p and B_{p0} is not supported, the values of these parameters shall be identical to those currently used.

NOTE 6 – When N_{LP} = 2, the octets associated with latency path 0 are sent first.

Table 11-6 – OLR responses sent by the responding VTU

Name	Length (octets)	Octet number	Content	<u>Support</u>
Defer Type 1 Request	3	2	81_{16} (Note)	<u>Mandatory</u>
		3	1 octet for reason code (Table 11-7)	
Reject Type 2 Request	3	2	82_{16} (Note)	<u>For further study</u>
		3	1 octet for reason code (Table 11-7)	
Reject Type 3 Request	3	2	83_{16} (Note)	<u>Optional</u>
		3	1 octet for reason code (Table 11-7)	
IACK	3	2	$8B_{16}$ (Note)	<u>Mandatory</u>
		3	1 octet for SC	
NOTE – All other values for octet number 2 are reserved by the ITU-T.				

11) Clause 11.2.3.11

Revise clause 11.2.3.11 as follows:

11.2.3.11 PMD Test Parameter Read commands and responses

The PMD Test Parameter Read commands shall be used to retrieve the values of the PMD test parameters that are specified in 11.4.1 and maintained by the far-end VTU. The PMD Test Parameter Read commands are shown in Table 11-25, and may be initiated by either VTU. The responses shall be as shown in Table 11-26. The first octet of all PMD Test Parameter Read commands and responses shall be the assigned value for the PMD Test Parameter Read command type, as shown in Table 11-4. The subsequent octets of the commands shall be as shown in Table 11-25. The subsequent octets of the responses shall be as shown in Table 11-26. The octets shall be sent using the format described in 11.2.3.1.

Table 11-25 – PMD Test Parameter Read commands sent by the requesting VTU

Name	Length (octets)	Octet number	Content	<u>Support</u>
Single Read	2	2	01_{16} (Note <u>1</u>)	<u>Mandatory</u>
Next Multiple Read	2	2	03_{16} (Note <u>1</u>)	<u>Mandatory</u>
Multiple Read	4	2	04_{16} (Note <u>1</u>)	<u>Mandatory</u>
		3 to 4	2 octets describing the sub-carrier group index	
Block Read	6	2	05_{16} (Note <u>1</u>)	<u>Mandatory</u>
		3 to 4	2 octets describing the start sub-carrier group index	
		5 to 6	2 octets describing the stop sub-carrier group index	

Table 11-25 – PMD Test Parameter Read commands sent by the requesting VTU

Name	Length (octets)	Octet number	Content	Support
Vector Block Read	7	2	06_{16} (Note 1)	Optional
		3	1 octet describing the type of test parameter to read (Note 2) 01_{16}: Channel transfer function Hlog(*f*) per sub-carrier group 03_{16}: Quiet Line Noise PSD QLN(*f*) per sub-carrier group 04_{16}: Signal to noise ratio SNR(*f*) per sub-carrier group.	
		4 to 5	2 octets describing the start sub-carrier group index	
		6 to 7	2 octets describing the stop sub-carrier group index	
Scalar Read	3	2	07_{16} (Note 1)	Optional
		3	1 octet describing the type of scalar test parameters to be read (Note 2) 21_{16} to 27_{16}: the parameter index to read according to the ID of Table 11-27.	
NOTE 1 – All other values for octet number 2 are reserved by the ITU-T. NOTE 2 – All other values for octet number 3 are reserved by the ITU-T.				

Table 11-26 – PMD Test Parameter Read responses sent by the responding VTU

Name	Length (octets)	Octet number	Content	Support
Single Read ACK	~~Parameter-dependent~~ 42 (see Note 1)	2	81_{16} (Note 2)	Mandatory
		3 ~~+~~to 42	Octets for the test parameters arranged for the single read format	
Multiple Read ACK	12	2	82_{16} (Note 2)	Mandatory
		3 to 12	Octets for the test parameters arranged for the multiple read format	
NACK	2	2	80_{16} (Note 2)	Mandatory
Block Read ACK	Parameter-dependent (see Note 1)	2	84_{16} (Note 2)	Mandatory
		3 +	Octets for the test parameters arranged for the block read format	
Vector Block Read ACK	Parameter-dependent (see Note 1)	2	86_{16} (Note 2)	Optional
		3 +	Octets for the test parameters arranged for the block read format	
Scalar Read ACK	Parameter-dependent (see Note 1)	2	87_{16} (Note 2)	Optional
		3 +	Octets for the test parameters arranged for the scalar read format	
NOTE 1 – Message length equals 2 octets plus the length shown in Table 11-27. NOTE 2 – All other values for octet number 2 are reserved by the ITU-T.				

Table 11-27 – PMD test parameter ID values and length of responses

Test parameter ID (Note)	Test parameter name	Length for Single Read (octets)	Length for Multiple Read (octets)	Length for Block Read or Vector Block Read (octets)	Length for Scalar Read (octets)	Support
01_{16}	Channel transfer function Hlog(*f*) per sub-carrier group	N/A	4	2 + (stop sub-carrier group index − start sub-carrier group index + 1) × 2	N/A	Mandatory
~~02_{16}~~	~~Reserved by the ITU-T~~					
03_{16}	Quiet line noise PSD QLN(*f*) per sub-carrier group	N/A	3	2 + (stop sub-carrier group index − start sub-carrier group index + 1)	N/A	Mandatory
04_{16}	Signal-to-noise ratio SNR(*f*) per sub-carrier group	N/A	3	2 + (stop sub-carrier group index − start sub-carrier group index + 1)	N/A	Mandatory
~~05_{16}~~	~~Reserved by the ITU-T~~					
21_{16}	Loop attenuation LATN	2 × 5	N/A	N/A	~~2 +~~ 2 × 5	Mandatory
22_{16}	Signal attenuation SATN	2 × 5	N/A	N/A	~~2 +~~ 2 × 5	Mandatory
23_{16}	Signal-to-noise ratio margin SNRM & SNRM-pb	2 × 6	N/A	N/A	~~2 +~~ 2 × 6	Mandatory
24_{16}	Attainable net data rate ATTNDR	4	N/A	N/A	~~2 +~~ 4	Mandatory
25_{16}	Near-end actual aggregate transmit power ACTATP	2	N/A	N/A	~~2 +~~ 2	Mandatory
26_{16}	Far-end actual aggregate transmit power ACTATP	2	N/A	N/A	~~2 +~~ 2	Mandatory
27_{16}	Far-end actual impulse noise protection INP_act	N/A	N/A	N/A	~~2 +~~ 2	Optional
NOTE – All other Test parameter ID values are reserved by the ITU-T.						

NOTE – Since the number of sub-carriers, *G*, in the sub-carrier group (see 11.4.1) may be different for QLN, Hlog, and SNR, the values of QLN, Hlog and SNR communicated by Multiple Read, Block Read, or Vector Block Read for the same sub-carrier group index may correspond to different sub-carrier indices. The sub-carrier index for each parameter equals *G* × sub-carrier group_index, where the value of *G* is as defined in Table 11-30 (for showtime) and sub-carrier group index = 0 to 511.

Upon reception of a PMD Test Parameter Read command, the responding VTU shall send the corresponding response. If the format of the Test Parameter Read command is incorrect, the VTU shall respond with the negative acknowledge (NACK). Any function of either the requesting or the responding VTU shall not be affected.

The Single Read command shall be used to retrieve all test parameters with ID values from 21_{16} to 26_{16} inclusive. In response to a Single Read command, the values for the test parameters (one value per parameter) shall be transferred in numerically increasing order of the parameter ID shown in Table 11-27. The format of the octets for each parameter shall be as specified in 11.4.1. Values formatted as multiple octets shall be mapped to the response in order of most significant to least significant octet. The LATN, SATN and SNRM format shall include five 2-octet values intended for 5 potentially available frequency bands for each transmission direction. The 2-octet values shall be sent in the order shown in Table 11-28. The value 00_{16} shall be used to indicate the disabled bands. Octets indicated as reserved shall be set to ZERO in the transmitter and ignored by the receiver. The SNRM test parameter shall, in addition to all SNRM-pb values (11.4.1.1.6.3), include the overall SNRM value (11.4.1.1.6.2). The first 2-octet value is the overall SNRM, followed by the five 2-octet values of the SNRM-pb as specified in Table 11-28.

Table 11-28 – Order for sending LATN, SATN and SNRM-pb parameters

Octet number	Upstream direction	Downstream direction
1	US0	DS1
2		
3	US1	DS2
4		
5	US2	DS3
6		
7	US3	~~Reserved~~DS4
8		
9	~~Reserved~~US4	Reserved
10		

A Scalar Read command shall be used to retrieve a single test parameter. Support of this read command is optional. The ID of the test parameter to retrieve shall be indicated in the third octet of the read command as specified in Table 11-25. In response to a Scalar Read command, the VTU shall send the value of the test parameter if this command and the test parameter are supported by the VTU; otherwise the VTU shall send a NACK. The format of the octets for each parameter value shall be as described in 11.4.1. Values formatted as multiple octets shall be mapped to the response in order of most significant to least significant octet. The format of the LATN, SATN and SNRM shall be identical to the format used in Single Read Command. The Far-end actual impulse noise protection (ID=27_{16}) shall include two 1-octet values and be sent in the order shown in Table 11-28.1. For a disabled bearer (see Table 12-45, Mapped configurations of downstream bearer channels and TPS-TC types field), the VTU-R shall set the corresponding octet to ZERO. The VTU-O shall ignore this octet. ~~The value FF_{16} shall be used to indicate the disabled bearers.~~

Table 11-28.1 – Order for sending far-end actual impulse noise protection parameters

Octet number	Parameter
1	INP_act for bearer channel 0
2	INP_act for bearer channel 1

Multiple Read and Next Multiple Read commands shall be used to retrieve test parameters of one sub-carrier group. In response to a Multiple Read or Next Multiple Read command, the VTU shall send information for ~~all~~ test parameters with ID 01_{16}, 03_{16}, and 04_{16} associated with the indicated sub-carrier group~~ (the test parameters with ID values from 21_{16} to 26_{16} are not transferred)~~. The Multiple Read command contains the index of the requested sub-carrier group (see Table 11-25). If a Next Multiple Read command is to be sent, it shall only be sent after a Multiple Read command. In response to each subsequent Next Multiple Read command, the sub-carrier group index shall be incremented by one. If the sub-carrier group index exceeds 511 (see 11.4.1), the response shall be a NACK. The values of the PMD parameters per sub-carrier group shall be inserted into the message in numerical order of the parameter ID shown in Table 11-27. The format of the octets for each parameter shall be as described in 11.4.1. Values that are formatted as multiple octets shall be mapped to the response in order of most significant to least significant octet.

A Block Read command shall be used to retrieve test parameters over a range of sub-carrier groups. In response to a Block Read command, the VTU shall send information for ~~all~~ test parameters <u>with ID 01_{16}, 03_{16}, and 04_{16}</u> associated with the specified block of sub-carrier groups~~ (test parameters with a Test parameter ID = 21 or higher are not transferred)~~. For test parameters specified per sub-carrier group, all values for sub-carrier groups with indices from #start to #stop are transferred in a single response. If the sub-carrier group index exceeds 511, the response shall be a NACK. The values of the PMD parameters per sub-carrier group shall be inserted into the message in increasing order of the parameter ID shown in Table 11-27. The format of the octets for each parameter value shall be as described in 11.4.1. Values formatted as multiple octets shall be mapped to the response in order of most significant to least significant octet. The number of octets in a Block Read command shall not exceed the maximum length *P* of the eoc message specified in 11.2.3.1.

<u>A Vector Block Read command shall be used to retrieve a single test parameter over a range of sub-carrier groups. Support of this read command is optional. The ID of the test parameter to retrieve shall be indicated in the third octet of the read command as specified in Table 11-25. In response to a Vector Block Read command, the VTU shall send information for the test parameter associated with the specified block of sub-carrier groups if this command is supported by the VTU; otherwise the VTU shall send a NACK. All values for sub-carrier groups with indices from #start to #stop are transferred in a single response. If the sub-carrier group index exceeds 511, the response shall be a NACK. The format of the octets for each parameter value shall be as described in 11.4.1. Values formatted as multiple octets shall be mapped to the response in order of most significant to least significant octet.</u>

When transferring values of the channel transfer function Hlog(*f*), the quiet line noise QLN(*f*), and the signal-to-noise ratio SNR(*f*), the measurement time shall be included in the response (the first two octets after the ACK), followed by the value *m* (see 11.4.1.1.1), value *n* (see 11.4.1.1.2), and value SNR (see 11.4.1.1.3), respectively. The measurement time shall be included only once in a response to a Block Read<u> or Vector Block Read</u> command, and shall be included in each response to a Multiple Read or Next Multiple Read command.

The values of some test parameters are represented using fewer bits than contained in the corresponding field defined for the response in Table 11-27. In the case that the field has more than one octet, the bits shall be mapped to the LSBs of the multi-octet field in the response. Unused MSBs in the multi-octet field shall be set to ZERO for unsigned quantities and to the value of the sign bit for signed quantities.

12) Clause 11.4.1

Revise clause 11.4.1 as follows:

11.4.1 Test parameters

The test parameters are measured by the PMD transmit or receive function and shall be reported on request to the near-end VME. Test parameters can be used to identify possible issues with the physical loop and to check for adequate physical media performance margin at acceptance and after repair verification, or at any other time following the initialization of the VDSL2 system.

The following test parameters shall be passed on request from the receive PMD transmit function to the near-end VME:

- Channel characteristics function H(*f*) per sub-carrier (CCF-ps);
- Quiet line noise PSD QLN(*f*) per sub-carrier (QLN-ps);
- Signal-to-noise Ratio SNR(*f*) per sub-carrier (SNR-ps);
- Loop attenuation per band (LATN-pb);
- Signal attenuation per band (SATN-pb);
- Signal-to-noise ratio margin per band (SNRM-pb);
- Attainable net data rate (ATTNDR);~~ and~~
- Far-end actual aggregate transmit power (ACTATP)<u>; and</u>
- <u>Far-end actual impulse noise protection (INP_act)</u>.

The following test parameter shall be passed on request from the transmit PMD transmit function to the near-end VME:

- Near-end actual aggregate transmit power (ACTATP).

The purposes of making the above information available are:

- H(*f*) can be used to analyse the physical copper loop condition;
- QLN(*f*) can be used to analyse the crosstalk;
- SNR(*f*) can be used to analyse time-dependent changes in crosstalk levels and loop attenuation (such as due to moisture and temperature variations); and
- The combination of H(*f*), QLN(*f*) and SNR(*f*) can be used to help determine why the data rate is not equal to the maximum data rate for a given loop.

The detailed diagnostic information H(*f*) and QLN(*f*) would be most useful during showtime. However, requesting this would place an undue computational burden on the VDSL2 modems. Thus, the combination of complete information on the channel (H(*f*) and QLN(*f*)) during initialization combined with initialization and showtime SNR(*f*) is provided as a reasonable compromise. This combination of data will allow greater analysis of the loop conditions than traditional methods and will reduce interruptions to both VDSL2 and the underlying service that traditional diagnostic methods require.

The quiet line noise (QLN), signal-to-noise Ratio (SNR), and channel characteristics in format (Hlin, Hlog) shall be represented by sub-carrier group. The number of sub-carriers, G, in one sub-carrier group shall be equal to:

$$G = pow2(\Theta / 512)$$

where the function $pow2$(x) takes the nearest power of 2 greater than or equal to x and Θ is the highest sub-carrier index of the transmitter SUPPORTEDCARRIERS set if the parameter is measured during the Channel Discovery phase; or the last sub-carrier index of the transmitter MEDLEY set in other cases.

<u>Specific carrier sets to be used during showtime and loop diagnostic mode are summarized in Table 11-30 (N/A indicates that a parameter is not applicable).</u>

Table 11-30 – Value of *G* for various phases of operation

Test parameter	Normal operation	Loop Diagnostic mode	
	Showtime	Channel discovery	Channel analysis and exchange
QLN	SUPPORTEDCARRIERS	SUPPORTEDCARRIERS	N/A
HLOG	SUPPORTEDCARRIERS	SUPPORTEDCARRIERS	N/A
HLIN	N/A	N/A	MEDLEY
SNR	MEDLEY	N/A	MEDLEY

Valid values of *G* are 1, 2, 4 and 8.

13) New clause 11.4.1.1.9

Add new clause 11.4.1.1.9 as follows:

11.4.1.1.9 Actual Impulse Noise Protection (INP_act)

The actual impulse noise protection INP_act_n of bearer channel #n is defined in 9.6. The value is coded in fraction of DMT symbols by steps of 0.1. The range is from 0 (coded as 0) to 25.4 (coded as 254). The value 255 is a special value indicating an INP_act higher than 25.4.

14) Tables 12-3, 12-5, 12-6, 12-8, 12-9, 12-11, 12-12 and 12-14

Revise Tables 12-3 and 12-5 (in clause 12.3.2.1.1), Tables 12-6 and 12-8 (in clause 12.3.2.1.2), Tables 12-9 and 12-11 (in clause 12.3.2.2.1), and Tables 12-12 and 12-14 (in clause 12.3.2.2.2) as follows:

Table 12-3 – VTU-O CL message NPar(2) bit definitions

G.994.1 NPar(2) Bit	Definition of NPar(2) bit
All-digital mode	If set to ONE, signifies that the VTU-O supports all-digital mode.
Support of downstream virtual noise	If set to ONE, signifies that the VTU-O supports the use of the downstream virtual noise mechanism.
Lineprobe	Always set to ONE in a VTU-O CL message.
Loop Diagnostic mode	Set to ONE if the VTU-O requests Loop Diagnostic mode.
Support of PSD shaping in US0	Always set to ONE in a VTU-O CL message.

Table 12-5 – VTU-O CL message NPar(3) bit definitions

G.994.1 SPar(2) Bit	Definition of NPar(3) bits
Profiles	Each valid profile is represented by one bit in a field of 8 bits. The valid profiles are: 8a, 8b, 8c, 8d, 12a, 12b, 17a and 30a. Each profile supported by the VTU-O is indicated by setting its corresponding bit to ONE.
Bands Upstream	For a given band plan as defined in the regional annexes, this NPar(3) field shall include all of the upstream bands in ascending order starting at f_2 (as shown in Figure A.1, Table B.1, Figure C.1~~7-1~~) and ending at the highest band required for the highest frequency profile for which support is indicated. Up to four upstream bands may be defined. Each band shall be defined by a start sub-carrier index and stop sub-carrier index using 13 bits per index value. The sub-carrier indices shall represent 4.3125 kHz sub-carrier spacing. Adjacent upstream bands shall be coded as separate bands.
Bands Downstream	For a given band plan as defined in the regional annexes, this NPar(3) field shall include all of the downstream bands in ascending order starting at f_1 (as shown in Figure A.1, Table B.1, Figure C.1~~7-1~~) and ending at the highest band required for the highest frequency profile for which support is indicated. Up to four downstream bands may be defined. Each band shall be defined by a start sub-carrier index and stop sub-carrier index using 13 bits per index value. The sub-carrier indices shall represent 4.3125 kHz sub-carrier spacing. Adjacent downstream bands shall be coded as separate bands.
RFI Bands	This NPar(3) shall indicate in ascending order the start sub-carrier index and stop sub-carrier index for each RFI band in which the transmit PSD is to be reduced below −80 dBm/Hz. Each index is represented by 13 bits. Up to 16 RFI bands may be defined. The sub-carrier indices shall represent 4.3125 kHz sub-carrier spacing.
Initial IDFT Size (2N)	This NPar(3) indicates the initial downstream IDFT size that the VTU-O shall use at the beginning of the Channel Discovery phase, encoded as a number from 7 to 13 representing n, where IDFTsize $2N = 2^n$.
CE Lengths	This NPar(3) is a field of 15 bits representing the valid CE lengths: $2N/32$, $3N/32$, $4N/32$, …, $16N/32$ inclusive. For each CE length that the VTU-O can support, the corresponding bit shall be set to ONE. The bit corresponding to $5N/32$ shall always be set to ONE.
Annex A US0	A parameter block of 5 octets encoding the Annex A US0 capabilities. This block shall be coded as follows: – Bits 1-6 of octet 1 and bits 1-4~~3~~ of octet 2 shall be individually set to ONE to indicate support by a VTU-O of the corresponding Annex A US0~~-EU~~ masks EU-32 through EU-128~~ by the VTU-O~~. – Bits 1-6 of octet 3 and bits 1-4~~3~~ of octet 4 shall be individually set to ONE to indicate support by the VTU-O of the corresponding Annex A US0 ~~ADLU~~ masks ADLU-32 through ADLU-128~~by the VTU-O~~. – Bit 1 of octet 5 shall be set to ONE to indicate that all supported Annex A US0 masks are also supported by the VTU-O for profile 12b. This bit may be set to ONE if profile 12b is supported. – Bit 2 of octet 5 shall be set to ONE to indicate that all supported Annex A US0 masks are also supported by the VTU-O for profile 17a. This bit may be set to ONE if profile 17a is supported.

Table 12-5 – VTU-O CL message NPar(3) bit definitions

G.994.1 SPar(2) Bit	Definition of NPar(3) bits
Annex B US0	A parameter block of 2 octets encoding the Annex B US0 capabilities. This block shall be coded as follows: – Bits 1-3 of octet 1 shall be individually set to ONE to indicate support of the corresponding Annex B US0 masks by the VTU-O. – Bit 1 of octet 2 shall be set to ONE to indicate that all supported Annex B US0 masks are also supported by the VTU-O for profile 12b. This bit may be set to ONE if profile 12b is supported. – Bit 2 of octet 2 shall be set to ONE to indicate that all supported Annex B US0 masks are also supported by the VTU-O for profile 17a. This bit may be set to ONE if profile 17a is supported.
Annex C US0	~~A parameter block of 1 octet. Annex C US0 PSD masks are for further study~~A parameter block of 3 octets encoding the Annex C US0 capabilities. This block shall be coded as follows: – Bits 1-2 of octet 1 shall be individually set to ONE to indicate the support of the corresponding Annex C US0 Type(b) masks by the VTU-O. – Bits 1-2 of octet 2 shall be individually set to ONE to indicate the support of the corresponding Annex C US0 Type(co) masks by the VTU-O. – Bit 1 of octet 3 shall be set to ONE to indicate that all supported Annex C US0 masks are also supported by the VTU-O in the profile 12b. This bit may be set to ONE if profile 12b is supported. – Bit 2 of octet 3 shall be set to ONE to indicate that all supported Annex C US0 masks are also supported by the VTU-O in the profile 17a. This bit may be set to ONE if profile 17a is supported.

Table 12-6 – VTU-O MS message NPar(2) bit definitions

G.994.1 NPar(2) Bit	Definition of NPar(2) bit
All-digital mode	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. If set to ONE, indicates that both the VTU-O and the VTU-R shall be configured for operation in all-digital mode.
Support of downstream virtual noise	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the downstream virtual noise mechanism may be used.
Lineprobe	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the channel discovery phase of initialization shall include a lineprobe stage.
Loop Diagnostic mode	Set to ONE if either the last previous CLR or the last previous CL message has set this bit to ONE. Indicates that both VTUs shall enter Loop Diagnostic mode.
Support of PSD shaping in US0	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the VTU-R supports PSD shaping in the US0 band.

Table 12-8 – VTU-O MS message NPar(3) bit definitions

G.994.1 SPar(2) Bit	Definition of NPar(3) bits
Profiles	Each valid profile is represented by one bit in a field of 8 bits. The valid profiles are: 8a, 8b, 8c, 8d, 12a, 12b, 17a and 30a. The profile selected by the VTU-O is indicated by setting its corresponding bit to ONE.
CE Lengths	This NPar(3) is a field of 15 bits representing the valid CE lengths 2*N*/32, 3*N*/32, 4*N*/32, …, 16*N*/32 inclusive. The VTU-O shall indicate by setting to ONE the bit corresponding to the selected initial CE length. All other bits shall be set to ZERO. The selected CE length shall be one whose bit was set to ONE in both the last previous CLR and the last previous CL messages.
Annex A US0 (Note)	A parameter block of 5 octets encoding the Annex A US0 selection. The VTU-O shall indicate its selection of the Annex A US0 mask by setting to ONE the bit corresponding to that PSD mask. No more than one bit in this NPar(3) shall be set to ONE. The selected bit shall be set to ONE if and only if it was set to ONE in both the last previous CLR and the last previous CL messages and the selected profile supports US0 either explicitly or implicitly by its definition in Table 6-1. Bits 1-2 of octet 5 shall always be set to ZERO. If all bits are set to ZERO, the US0 band shall not be enabled.
Annex B US0 (Note)	A parameter block of 2 octets encoding the Annex B US0 selection. The VTU-O shall indicate its selection of the Annex B US0 PSD mask by setting to ONE the bit corresponding to that PSD mask. No more than one bit in this NPar(3) shall be set to ONE. The selected bit shall be set to ONE if and only if it was set to ONE in both the last previous CLR and the last previous CL messages, and the selected profile supports US0 either explicitly or implicitly by its definition in Table 6-1. Bits 1-2 of octet 2 shall always be set to ZERO. If all bits are set to ZERO, the US0 band shall not be enabled.
Annex C US0 (Note)	~~A parameter block of 1 octet. The Annex C US0 PSD masks are for further study~~ A parameter block of 3 octets encoding the Annex C US0 selection. The VTU-O shall indicate its selection of the Annex C US0 PSD mask by setting to ONE the bit corresponding to that PSD mask. No more than one bit in this NPar(3) shall be set to ONE. The selected bit shall be set to ONE if and only if it was set to ONE in both the last previous CLR and the last previous CL messages, and the selected profile supports US0 either explicitly or implicitly by its definition in Table 6-1. Bits 1-2 of octet 3 shall always be set to ZERO. If all bits are set to ZERO, the US0 band shall not be enabled.
NOTE – Support of US0 means the capability of the VTU-R to transmit US0 and the capability of the VTU-O to receive it.	

Table 12-9 – VTU-R CLR message NPar(2) bit definitions

G.994.1 NPar(2) Bit	Definition of NPar(2) bit
All-digital mode	If set to ONE, signifies that the VTU-R supports all-digital mode.
Support of downstream virtual noise	If set to ONE, signifies that the VTU-R supports the use of the downstream virtual noise mechanism.
Lineprobe	Set to ONE if the VTU-R requests the inclusion of a Lineprobe stage in initialization.
Loop Diagnostic mode	Set to ONE if the VTU-R requests Loop Diagnostic mode.
Support of PSD shaping in US0	If set to ONE, signifies that the VTU-R supports PSD shaping in the US0 band.

Table 12-11 – VTU-R CLR message NPar(3) bit definitions

G.994.1 SPar(2) Bit	Definition of NPar(3) bits
Profiles	Each valid profile is represented by one bit in a field of 8 bits. The valid profiles are: 8a, 8b, 8c, 8d, 12a, 12b, 17a and 30a. Each profile supported by the VTU-R is indicated by setting its corresponding bit to ONE.
Initial IDFT Size (2*N*)	This NPar(3) indicates the initial upstream IDFT size that the VTU-R shall use at the beginning of the Channel Discovery phase, encoded as a number from 6 to 13 representing *n*, where IDFTsize $2N = 2^n$.
CE Lengths	This NPar(3) is a field of 15 bits representing the valid CE lengths 2*N*/32, 3*N*/32, 4*N*/32, …, 16*N*/32, inclusive. For each supported CE length, the corresponding bit shall be set to ONE. The bit corresponding to 5*N*/32 shall always be set to ONE.
Annex A US0	A parameter block of 5 octets encoding the Annex A US0 capabilities. This block shall be coded as follows: – Bits 1-6 of octet 1 and bits 1-4~~3~~ of octet 2 shall be individually set to ONE to indicate support by a VTU-R of the corresponding Annex A US0 ~~EU~~ masks EU-32 through EU-128~~by the VTU-R~~. If bit 4 of octet 2 is set to ONE, the VTU-R shall also set the "Support of PSD shaping in US0" NPar(2) bit to ONE (see Table 12-9). – Bits 1-6 of octet 3 and bits 1-4~~3~~ of octet 4 shall be individually set to ONE to indicate support by the VTU-R of the corresponding Annex A US0 ~~ADLU~~ masks ADLU-32 through ADLU-128~~by the VTU-R~~. If bit 4 of octet 4 is set to ONE, the VTU-R shall also set the "Support of PSD shaping in US0" NPar(2) bit to ONE (see Table 12-9). – Bit 1 of octet 5 shall be set to ONE to indicate that all supported Annex A US0 masks are also supported by the VTU-R in the profile 12b. This bit may be set to ONE if profile 12b is supported. – Bit 2 of octet 5 shall be set to ONE to indicate that all supported Annex A US0 masks are also supported by the VTU-R in the profile 17a. This bit may be set to ONE if profile 17a is supported.
Annex B US0	A parameter block of 2 octets encoding the Annex B US0 capabilities. This block shall be coded as follows: – Bits 1-3 of octet 1 shall be individually set to ONE to indicate support of the corresponding Annex B US0 masks by the VTU-R. – Bit 1 of octet 2 shall be set to ONE to indicate that all supported Annex B US0 masks are also supported by the VTU-R for profile 12b. This bit may be set to ONE if profile 12b is supported. – Bit 2 of octet 2 shall be set to ONE to indicate that all supported Annex B US0 masks are also supported by the VTU-R for profile 17a. This bit may be set to ONE if profile 17a is supported.
Annex C US0	~~A parameter block of 1 octet. Annex C US0 PSD masks are for further study~~ A parameter block of 3 octets encoding the Annex C US0 capabilities. This block shall be coded as follows: – Bits 1-2 of octet 1 shall be individually set to ONE to indicate the support of the corresponding Annex C US0 Type(b) masks by the VTU-R. – Bits 1-2 of octet 2 shall be individually set to ONE to indicate the support of the corresponding Annex C US0 Type(co) masks by the VTU-R. – Bit 1 of octet 3 shall be set to ONE to indicate that all supported Annex C US0 masks are also supported by the VTU-R in the profile 12b. This bit may be set to ONE if profile 12b is supported. – Bit 2 of octet 3 shall be set to ONE to indicate that all supported Annex C US0 masks are also supported by the VTU-R in the profile 17a. This bit may be set to ONE if profile 17a is supported.

Table 12-12 – VTU-R MS message NPar(2) bit definitions

G.994.1 NPar(2) Bit	Definition of NPar(2) bit
All-digital mode	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. If set to ONE, indicates that both the VTU-O and the VTU-R shall be configured for operation in all-digital mode.
Support of downstream virtual noise	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the downstream virtual noise mechanism may be used.
Lineprobe	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the Channel Discovery phase of initialization shall include a Lineprobe stage.
Loop Diagnostic mode	Set to ONE if either the last previous CLR or the last previous CL message has set this bit to ONE. Indicates that both VTUs shall enter Loop Diagnostic mode.
Support of PSD shaping in US0	Set to ONE if and only if both the last previous CLR and the last previous CL messages have set this bit to ONE. Indicates that the VTU-R shall support PSD shaping in the US0 band.

Table 12-14 – VTU-R MS message NPar(3) bit definitions

G.994.1 SPar(2) Bit	Definition of NPar(3) bits
Profiles	Each valid profile is represented by one bit in a field of 8 bits. The valid profiles are: 8a, 8b, 8c, 8d, 12a, 12b, 17a and 30a. The profile selected by the VTU-R is indicated by setting its corresponding bit to ONE.
CE Lengths	This NPar(3) is a field of 15 bits representing the valid CE lengths 2*N*/32, 3*N*/32, 4*N*/32, …, 16*N*/32, inclusive. The VTU-R shall indicate by setting to ONE the bit corresponding to the selected initial CE length. All other bits shall be set to ZERO. The selected CE length shall be one whose bit was set to ONE in both the last previous CLR and the last previous CL messages.
Annex A US0 (Note)	A parameter block of 5 octets encoding the Annex A US0 selection. The VTU-R shall indicate its selection of the Annex A US0 mask by setting to ONE the bit corresponding to that PSD mask. No more than one bit in this NPar(3) shall be set to ONE. The selected bit shall be set to ONE if and only if it was set to ONE in both the last previous CLR and the last previous CL messages and the selected profile supports US0 either explicitly or implicitly by its definition in Table 6-1. Bits 1-2 of octet 5 shall always be set to ZERO. If all bits are set to ZERO, the US0 band shall not be enabled.
Annex B US0 (Note)	A parameter block of 2 octets encoding the Annex B US0 selection. The VTU-R shall indicate its selection of the Annex B US0 mask by setting to ONE the bit corresponding to that PSD mask. No more than one bit in this NPar(3) shall be set to ONE. The selected bit shall be set to ONE if and only if it was set to ONE in both the last previous CLR and the last previous CL messages and the selected profile supports US0 either explicitly or implicitly by its definition in Table 6-1. Bits 1-2 of octet 2 shall always be set to ZERO. If all bits are set to ZERO, the US0 band shall not be enabled.

Table 12-14 – VTU-R MS message NPar(3) bit definitions

G.994.1 SPar(2) Bit	Definition of NPar(3) bits
Annex C US0 (Note)	~~A parameter block of 1 octet. The Annex C US0 PSD masks are for further study~~ A parameter block of 3 octets encoding the Annex C US0 selection. The VTU-R shall indicate its selection of the Annex C US0 mask by setting to ONE the bit corresponding to that PSD mask. No more than one bit in this NPar(3) shall be set to ONE. The selected bit shall be set to ONE if and only if it was set to ONE in both the last previous CLR and the last previous CL messages and the selected profile supports US0 either explicitly or implicitly by its definition in Table 6-1. Bits 1-2 of octet 3 shall always be set to ZERO. If all bits are set to ZERO, the US0 band shall not be enabled.
NOTE – Support of US0 means the capability of the VTU-R to transmit US0 and the capability of the VTU-O to receive it.	

15) Clause 12.3.3.1

Add the following note after the second paragraph in clause 12.3.3.1 as follows:

…

During the Channel Discovery phase, the VTU-R shall determine the required UPBO based on the estimation of the electrical length of the loop and on the values of parameters for the UPBO reference PSD (UPBOPSD) it receives from the VTU-O. Both VTUs may perform additional PSD cut-back.

NOTE 1 – In regions of the spectrum not expected to be useable in showtime, the transceiver may reduce the value of the PSD from the beginning of Channel Discovery to prevent unnecessary crosstalk into other systems. A VTU may, for example, determine the tones where CDPSD can be reduced based on the received signal level and known transmit level of the G.994.1 [2] tones. A specific mechanism is vendor discretionary.

…

16) Clause 12.3.5.2.1.1

Revise clause 12.3.5.2.1.1 (O-MSG 1) as follows:

12.3.5.2.1.1 O-MSG 1

The O-MSG 1 message contains the capabilities of the VTU-O and the requirements for downstream transmission (such as margin). The full list of parameters carried by the O-MSG 1 message is shown in Table 12-40.

Table 12-40 – Description of message O-MSG 1

	Field name	Format
1	Message descriptor	Message code
2	Downstream target SNR margin (TARSNRMds)	2 bytes
3	Downstream minimum SNR margin (MINSNRMds)	2 bytes
4	Downstream maximum SNR margin for (MAXSNRMds)	2 bytes
5	RA-MODE	1 byte
6	NTR	1 byte
7	TPS-TC capabilities	see Table 12-41
8	PMS-TC capabilities	see Table 12-43
9	Downstream Rate adaptation downshift SNR margin (RA-DSNRMds)	2 bytes
10	Downstream Rate adaptation downshift time interval (RA-DTIMEds)	2 bytes
11	Downstream Rate adaptation upshift SNR margin (RA-USNRMds)	2 bytes
12	Downstream Rate adaptation upshift time interval (RA-UTIMEds)	2 bytes

Field #1 "Message descriptor" is a unique one-byte code that identifies the message. See Table 12-2 for a complete list of codes.

Field #2 "Downstream target SNR margin (TARSNRMds)" indicates the target SNR margin of the VTU-R receiver. The definition and use of this parameter shall be the same as for the parameter "Downstream Target Noise Margin (TARSNRMds)" specified in ITU-T Rec. G.997.1 [4]. The value and format of this parameter shall be the same as that in Field #12 of O-SIGNATURE (see 12.3.3.2.1.1).

Field #3 "Downstream minimum SNR margin for (MINSNRMds)" is the minimum SNR margin the VTU-R shall tolerate. The definition and use of this parameter shall be the same as for the parameter "Downstream Minimum Noise Margin (MINSNRMds)" specified in ITU-T Rec. G.997.1 [4]. The field shall be formatted as a 16-bit unsigned integer with LSB weight of 0.1 dB and a valid range between 0 and 31 dB.

Field #4 "Downstream maximum SNR margin (MAXSNRMds)." The value and format for this parameter shall be the same as in Field #11 of O-SIGNATURE (see 12.3.3.2.1.1).

NOTE – Improper setting of one or more of the following parameters – maximum net data rate, downstream maximum SNR margin, impulse noise protection, maximum interleaving delay (in SNRM_MODE=1), and TXREFVN (in SNRM_MODE=2) – can result in high levels of transmit power that can lead to high crosstalk experienced by DSLs on other pairs in the same binder. Specifically, high values of maximum net data rate, downstream maximum SNR margin, impulse noise protection, low values of maximum interleaving delay (in SNRM_MODE=1), and high values of TXREFVN (in SNRM_MODE=2) are of concern.

Field #5 "RA-MODE" specifies the mode of operation of a rate-adaptive VTU-O in the downstream direction as defined in ITU-T Rec. G.997.1 [4]. This field shall be coded as an 8-bit integer with valid values 01_{16}, 02_{16} and 03_{16} for RA-MODE 1, 2, and 3, respectively.

Field #6 "NTR" shall be set to 01_{16} if the VTU-O is transporting the NTR signal in the downstream direction, otherwise it shall be set to 00_{16}.

Field #7 "TPS-TC capabilities" indicates the TPS-TC capabilities of the VTU-O as shown in Table 12-41.

Field #8 "PMS-TC capabilities" indicates the PMS-TC capabilities of the VTU-O. This includes the supported latency paths at the VTU-O (DS and US) and the capabilities per path (such as supported coding and interleaver parameters), as shown in Table 12-43.

Field #9 "Downstream Rate adaptation downshift SNR margin (RA-DSNRMds)": The definition and use of this parameter is specified in 13.4. The field shall be formatted as a 16-bit unsigned integer with LSB weight of 0.1 dB and has a valid range between 0 and 31.0 dB.

Field #10 "Downstream Rate adaptation downshift time interval (RA-DTIMEds)": The definition and use of this parameter is specified in 13.4. The field shall be formatted as a 16-bit unsigned integer with LSB weight of 1 s and has a valid range between 0 to 16383 s.

Field #11 "Downstream Rate adaptation upshift SNR margin (RA-USNRMds)": The definition and use of this parameter is specified in 13.4. The field shall be formatted as a 16-bit unsigned integer with LSB weight of 0.1 dB and has a valid range between 0 and 31.0 dB.

Field #12 "Downstream Rate adaptation upshift time interval (RA-UTIMEds)": The definition and use of this parameter is specified in 13.4. The field shall be formatted as a 16-bit unsigned integer with LSB weight of 1 s and has a valid range between 0 to 16383 s.

Table 12-41 – TPS-TC capabilities of the VTU-O

Field name	Format	Description
Maximum number of downstream TPS-TCs of each type	1 byte: [ssaapp00]	Indicates the maximum number of TPS-TCs of each type that the VTU-O supports in the downstream direction: • ss=max number of downstream STM TPS-TCs (0,1,2); • aa=max number of downstream ATM TPS-TCs (0,1,2); and • pp=max number of downstream PTM TPS-TCs (0,1,2)
Maximum number of upstream TPS-TCs of each type	1 byte: [ssaapp00]	Indicates the maximum number of TPS-TCs of each type that the VTU-O supports in the upstream direction: • ss=max number of upstream STM TPS-TCs (0,1,2); • aa=max number of upstream ATM TPS-TCs (0,1,2); and • pp=max number of upstream PTM TPS-TCs (0,1,2)
Supported combinations of downstream bearer channels and TPS-TCs	1 byte: [$s_0a_0p_0$ 0 $s_1a_1p_1$ 0]	s_0: equal to 1 if STM can be supported on bearer channel 0 a_0: equal to 1 if ATM can be supported on bearer channel 0 p_0: equal to 1 if PTM can be supported on bearer channel 0 s_1: equal to 1 if STM can be supported on bearer channel 1 a_1: equal to 1 if ATM can be supported on bearer channel 1 p_1: equal to 1 if PTM can be supported on bearer channel 1
Supported combinations of upstream bearer channels and TPS-TCs	1 byte: [$s_0a_0p_0$ 0 $s_1a_1p_1$ 0]	s_0: equal to 1 if STM can be supported on bearer channel 0 a_0: equal to 1 if ATM can be supported on bearer channel 0 p_0: equal to 1 if PTM can be supported on bearer channel 0 s_1: equal to 1 if STM can be supported on bearer channel 1 a_1: equal to 1 if ATM can be supported on bearer channel 1 p_1: equal to 1 if PTM can be supported on bearer channel 1
For each supported TPS-TC, a Bearer channel descriptor (see Table 12-42) shall be appended to the message.		
Downstream STM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported downstream STM TPS-TCs.

Table 12-41 – TPS-TC capabilities of the VTU-O

Field name	Format	Description
Downstream ATM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported downstream ATM TPS-TCs.
Downstream PTM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported downstream PTM TPS-TCs.
Upstream STM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported upstream STM TPS-TCs.
Upstream ATM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported upstream ATM TPS-TCs.
Upstream PTM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported upstream PTM TPS-TCs.
NOTE – The number of bearer channel descriptors for the TPS-TC capabilities depends on the fields "Maximum number of downstream/upstream TPS-TCs".		

Table 12-42 – Bearer channel descriptor

Octet	Content of field
1-2	Minimum net data rate (net_min_n)
3-4	Maximum net data rate (net_max_n)
5-6	Reserved net data rate ($net\_reserve_n$) (Note)
7	Maximum interleaving delay
8	Impulse noise protection and dynamic interleaver reconfiguration
9	TPS-TC options
NOTE – This parameter is not used in this version of this Recommendation and shall be set to the value of the minimum net data rate in octets 1 and 2. The OLR procedures that utilize this parameter will be defined in a future revision of this Recommendation.	

In the fields "Minimum net data rate", "Maximum net data rate" and "Reserved net data rate", the parameter values for net_min_n, net_max_n and $net\_reserve_n$, respectively, shall be coded as unsigned integers representing the data rate as a multiple of 8 kbit/s.

The fields "Maximum interleaving delay" and "Impulse noise protection" are not applicable in O-MSG 1 (which communicates capabilities), and the values of octets 7 and 8 in each Bearer channel descriptor shall be ignored by the VTU-R receiver.

The field "TPS-TC options" shall contain one octet to negotiate and select the options for this bearer. The content depends on the type of TPS-TC mapped on this bearer.

For a bearer mapped to a PTM TPS-TC, the octet shall be coded as follows:

- Bit 0: If the VTU-O supports pre-emption in this bearer (Annex N.3.1.2/G.992.3 [10]), the bit shall be set to ONE.
- Bit 1: If the VTU-O supports short packets in this bearer (Annex N.3.1.3/G.992.3 [10]), the bit shall be set to ONE.
- Bits 2-7 are reserved by the ITU-T and set to ZERO.

For a bearer mapped to an ATM or STM TPS-TC, the TPS-TC options field is reserved by the ITU-T and shall be set to 00_{16}.

Table 12-43 – PMS-TC capabilities of the VTU-O

Field name	Format	Description
Downstream ~~dynamic interleaver~~OLR capabilities	1 byte [000fdsii]	Indicates the support of optional OLR mechanisms in the downstream direction. f = 0 if downstream framing reconfiguration (change of T_p, G_p and B_{p0}) is not supported, f = 1 otherwise. d is reserved by ITU-T for future use and shall be set to ZERO. s = 0 if downstream SRA (change of L_p, b_i, g_i) is not supported, s = 1 otherwise. ii = 00 if interleaver reconfiguration (change of D_p) is not supported, ii = 01 if interleaver reconfiguration is supported on one downstream latency path, ii = 11 if interleaver reconfiguration is supported on both downstream latency paths~~Support of dynamic change of interleaver depth in the downstream direction (see 9.4.1). A value of 00~~$_{16}$~~ indicates not supported. All other values are for further study~~. ii = 10 is reserved by the ITU-T.
Upstream OLR capabilities~~dynamic interleaver~~	1 byte [000fdsii]	Indicates the support of optional OLR mechanisms in the upstream direction. f = 0 if upstream framing reconfiguration (change in T_p, G_p and B_{p0}) is not supported, f = 1 otherwise. d is reserved by ITU-T for future use and shall be set to ZERO. s = 0 if upstream SRA (change of L_p, b_i, g_i) is not supported, s = 1 otherwise. ii = 00 if interleaver reconfiguration (change of D_p) is not supported, ii = 01 if interleaver reconfiguration is supported on one upstream latency path, ii = 11 if interleaver reconfiguration is supported on both upstream latency paths (Note)~~Support of dynamic change of interleaver depth in the upstream direction (see 9.4.1). A value of 00~~$_{16}$~~ indicates not supported. All other values are for further study~~. ii = 10 is reserved by the ITU-T.
Downstream message overhead data rate	1 byte	Minimum message overhead data rate that is needed by the VTU-O in the downstream direction. The unsigned 8-bit value is the message overhead data rate divided by 1000 bits per second minus 1 (covering the range 1 to 256 kbit/s).
Upstream message overhead data rate	1 byte	Minimum message overhead data rate that is needed by the VTU-O in the upstream direction. The unsigned 8-bit value is the message overhead data rate divided by 1000 bits per second minus 1 (covering the range 1 to 256 kbit/s).
Max DS net data rate for latency path 0	2 bytes	Parameter block of 2 octets that describes the maximum downstream net data rate supported in latency path #0. The unsigned 16-bit value is the net data rate divided by 8000 bits per second.
Max US net data rate for latency path 0	2 bytes	Parameter block of 2 octets that describes the maximum upstream net data rate supported in latency path #0. The unsigned 16-bit value is the net data rate divided by 8000 bits per second.
Max DS net data rate for latency path 1	2 bytes	Parameter block of 2 octets that describes the maximum downstream net data rate supported in latency path #1. The unsigned 16-bit value is the net data rate divided by 8000 bits per second.

Table 12-43 – PMS-TC capabilities of the VTU-O

Field name	Format	Description
Max US net data rate for latency path 1	2 bytes	Parameter block of 2 octets that describes the maximum upstream net data rate supported in latency path #1. The unsigned 16-bit value is the net data rate divided by 8000 bits per second.
DS $(1/S)_{max}$	1 byte	Parameter block of 1 octet that describes the maximum value of $1/S$ supported by the VTU-O in the downstream direction as defined in 9.5.5. The unsigned 8-bit value is coded as 1 to 64 in steps of 1.
US $(1/S)_{max}$	1 byte	Parameter block of 1 octet that describes the maximum value of $1/S$ supported by the VTU-O in the upstream direction as defined in 9.5.5. The unsigned 8-bit value is coded as 1 to 64 in steps of 1.
NOTE – If only one latency path is supported, the values for latency path 1 shall be set to ZERO.		

17) Clause 12.3.5.2.1.2

Revise clause 12.3.5.2.1.2 (O-TPS) as follows:

12.3.5.2.1.2 O-TPS

The O-TPS message conveys the TPS-TC configuration for both the upstream and the downstream directions. It is based on the capabilities that were indicated in O-MSG 1 and R-MSG 2. The full list of parameters carried by the O-TPS message is shown in Table 12-44.

Table 12-44 – Description of message O-TPS

	Field name	Format
1	Message descriptor	Message code
2	TPS-TC configuration	See Table 12-45
3	Maximum delay variation	See Table 12-45.1

Field #1 "Message descriptor" is a unique one-byte code that identifies the message. See Table 12-2 for a complete list of codes.

Field #2 "TPS-TC configuration" specifies the TPS-TC configuration in the upstream and downstream directions, and is structured as shown in Table 12-45.

Field #3 "Maximum delay variation" specifies the maximum delay variation for each active bearer channel in the downstream direction, and is structured as shown in Table 12-45.1.

Table 12-45 – TPS-TC configuration

Field name	Format	Description
Mapped configurations of downstream bearer channels and TPS-TC types (Note 1)	1 byte: [aaaa bbbb]	aaaa = TPS-TC type that is mapped to DS bearer channel 0 • aaaa=1000: STM-TC • aaaa=0100: ATM-TC • aaaa=0010: PTM-TC • aaaa =0000: inactive bearer channel bbbb = TPS-TC type that is mapped to DS bearer channel 1 • bbbb =1000: STM-TC • bbbb =0100: ATM-TC • bbbb =0010: PTM-TC • bbbb =0000: inactive bearer channel
Mapped configurations of upstream bearer channels and TPS-TC types (Note 1)	1 byte: [cccc dddd]	cccc = TPS-TC type that is mapped to US bearer channel 0 • cccc =1000: STM-TC • cccc =0100: ATM-TC • cccc =0010: PTM-TC • cccc =0000: inactive bearer channel dddd = TPS-TC type that is mapped to US bearer channel 1 • dddd =1000: STM-TC • dddd =0100: ATM-TC • dddd =0010: PTM-TC • dddd =0000: inactive bearer channel
Downstream rate adaptation ratio	1 byte	This field contains the rate adaptation ratio of downstream bearer channel 0 as specified in ITU-T Rec. G.997.1 [4]. This field shall be coded as an unsigned integer in the range from 0 to 100. A value of 100 means that the whole excess capacity is allocated to bearer channel 0.
For each active bearer channel in each direction, a Bearer channel descriptor (see Table 12-42) shall be appended to the message:		
Downstream bearer channel 0 configuration	0, or 1 bearer channel descriptor	Contains the required configuration of the downstream bearer 0
Downstream bearer channel 1 configuration	0, or 1 bearer channel descriptor	Contains the required configuration of the downstream bearer 1
Upstream bearer channel 0 configuration	0, or 1 bearer channel descriptor	Contains the required configuration of the upstream bearer 0
Upstream bearer channel 1 configuration	0 or 1 bearer channel descriptor	Contains the required configuration of the upstream bearer 1
NOTE 1 – Some simultaneous mappings of TPS-TCs are invalid (see 8.1.3.1). NOTE 2 – The number of bearer channel descriptors for the bearer channel configurations depends on the number of active bearer channels in each direction.		

In each Bearer channel descriptor, the fields "Minimum net data rate", "Maximum net data rate" and "Reserved net data rate" shall contain the values for *net_min_n*, *net_max_n* and *$net\_reserve_n$*, respectively, selected by the VTU-O. Each shall be coded as an unsigned integer representing the data rate as a multiple of 8 kbit/s.

In the field "Maximum interleaving delay," the parameter $delay\_max_n$ shall be coded as an unsigned integer expressing delay in ms as follows:

- The valid values are $0 \le delay\_max_n \le 63$, and $delay\_max_n = 255$.
- The value $delay\_max_n = 1$ is a special value indicating that the interleaver depth D_p shall be set to D_p=1, corresponding to the lowest possible delay.
- The value $delay\_max_n = 0$ is a special value indicating that no bound on the maximum delay is being imposed.
- The value $delay\_max_n = 255$ is a special value indicating an interleaving delay of 1 ms.

The field "Impulse noise protection<u> and dynamic interleaver reconfiguration</u>" shall be coded as follows:

- Bits 0-5 shall contain the required INP_min_n value expressed in DMT symbols.
- The valid values are $0 \le INP\_min_n \le 16$.
- The value $INP\_min_n = 0$ is a special value indicating that no minimum level of impulse noise protection is required.
- Bit 6 <u>shall be set to 1 to indicate that the bearer should be mapped in a latency path that supports dynamic interleaver reconfiguration. When no latency paths support dynamic interleaver reconfiguration or when the bearer chooses not to use it, the value of this bit shall be ZERO.</u>

  <u>NOTE 1 – For both upstream and downstream transmission, the number of bearer channels that set the value of bit 6 to ONE cannot be higher than the number of latency paths that support interleaver reconfiguration.</u>~~is reserved and shall be set to ZERO.~~
- Bit 7: INP_no_erasure_required (see 9.6)
  - When set to ONE, it indicates that the VTU-R receiver shall set $INP_p = INP\_no\_erasure_p$.
  - When set to ZERO, it indicates that the VTU-R receiver is not required to set $INP_p = INP\_no\_erasure_p$.

NOTE 2 – Improper setting of one or more of the following parameters – maximum net data rate, downstream maximum SNR margin, impulse noise protection, maximum interleaving delay (in SNRM_MODE=1), and TXREFVN (in SNRM_MODE=2) – can result in high levels of transmit power that can lead to high crosstalk experienced by DSLs on other pairs in the same binder. Specifically, high values of maximum net data rate, downstream maximum SNR margin, impulse noise protection, low values of maximum interleaving delay (in SNRM_MODE=1), and high values of TXREFVN (in SNRM_MODE=2) are of concern.

The field "TPS-TC options" shall be coded as follows:

- Bit 0: The bit shall be set to ONE to enable pre-emption in this bearer, if and only if the bit was set to ONE for this bearer in both O-MSG 1 and R-MSG 2.
- Bit 1: The bit shall be set to ONE to enable short packets in this bearer, if and only if the bit was set to ONE for this bearer in both O-MSG 1 and R-MSG 2.
- ~~Bits 2-7 are reserved by the ITU-T and set to ZERO.~~

For a bearer mapped to an ATM or STM TPS-TC, <u>bits 0 and 1 of </u>the TPS-TC options field ~~is~~ <u>are</u> reserved by the ITU-T and shall be set to ~~00_{16}~~<u>ZERO</u>.

<u>For the upstream bearer channel(s), bits 2-7 shall be set to ZERO.</u>

For the downstream bearer channel(s), bit 2 contains the selection of the CIpolicy that shall be used in the downstream direction. A value of ZERO indicates that the mandatory CIpolicy shall be used. A value of ONE indicates that the optional CIpolicy 1 (see 12.3.7) shall be used. The CO shall only select optional CIpolicies for which the VTU-R has indicated support (see 12.3.5.2.2.1). A value of ONE can only be selected if no more than one bearer channel is active.

Bits 3-7 are reserved by the ITU-T and shall be set to ZERO.

Table 12-45.1 – Maximum delay variation

Field name	Format	Description
For each active bearer channel in downstream direction, a maximum delay variation field shall be present in this message:		
Downstream bearer channel 0 DV_max	0, or 1 byte (Note)	Contains the required DV_max of the downstream bearer 0
Downstream bearer channel 1 DV_max	0, or 1 byte (Note)	Contains the required DV_max of the downstream bearer 1
NOTE – The number of bytes is 0 if the bearer is disabled and is 1 if the bearer is enabled.		

The fields "Downstream bearer channel 0 DV_max" and "Downstream bearer channel 1 DV_max" describe the maximum allowed value for the delay variation, and shall be coded as an unsigned integer equal to the DV_max divided by 0.1 ms.

- The valid values are $0 \le DV\_max_n \le 25.4$;
- The value FF_{16} is a special value indicating that no delay variation bound is imposed.

18) Clause 12.3.5.2.1.3

Revise Table 12-46 and the subsequent text below the table in clause 12.3.5.2.1.3 (O-PMS) as follows:

Table 12-46 – Description of message O-PMS

	Field name	Format
1	Message descriptor	Message code
2	MSGLP	1 byte
3	Mapping of bearer channels to latency paths	1 byte
4	B_{x0}	1 byte
5	B_{x1}	1 byte
6	LP_0	Latency Path descriptor
7	LP_1	Latency Path descriptor
8	$max\_delay\_octet_{DS,0}$ ~~$MaxD_0$~~	3 bytes
9	$max\_delay\_octet_{DS,1}$ ~~$MaxD_1$~~	3 bytes
10	$max\_delay\_octet_{US,0}$	3 bytes
11	$max\_delay\_octet_{US,1}$	3 bytes

• • •

Field #8 "max_delay_octet$_{DS,0}$~~MaxD$_0$~~" is a 3-byte field that specifies the maximum interleaver delay that the VTU-R shall be allowed to use to de-interleave the data stream in downstream latency path #0. The maximum interleaver delay shall be specified in bytes as an unsigned integer.

Field #9 "max_delay_octet$_{DS,1}$~~MaxD$_1$~~" is a 3-byte field that specifies the maximum interleaver delay that the VTU-R shall be allowed to use to de-interleave the data stream in downstream latency path #1. The maximum interleaver delay shall be specified in bytes as an unsigned integer. If the value of this field is $FFFFFF_{16}$, the VTU-R shall autonomously partition the interleaver delay specified in Field #8 (max_delay_octet$_{DS,0}$~~MaxD$_0$~~) between both downstream latency paths. The value $FFFFFF_{16}$ is not allowed if the modem intends to use interleaver reconfiguration in the downstream direction.

Field #10 "max_delay_octet$_{US,0}$" is a 3-byte field that specifies the maximum interleaver delay that the VTU-O will use to de-interleave the data stream in upstream latency path #0. The maximum interleaver delay shall be specified in bytes as an unsigned integer.

Field #11 "max_delay_octet$_{US,1}$" is a 3-byte field that specifies the maximum interleaver delay that the VTU-O will use to de-interleave the data stream in upstream latency path #1. The maximum interleaver delay shall be specified in bytes as an unsigned integer.

The values exchanged in Fields #8 to #11 shall be valid during initialization and showtime. In particular, interleaver reconfiguration in a given latency path shall not lead to an interleaver delay that exceeds the values exchanged in O-PMS for that latency path. Any OLR command that results in a delay value that is higher than the one exchange during initialization shall be rejected.

The latency path descriptor is described in Table 12-47. It contains the primary parameters of the framer, as specified in Table 9-6, and the interleaver settings for one latency path. All values are unsigned integers.

19) Clause 12.3.5.2.1.4

Revise clause 12.3.5.2.1.4 (O-PMD) as follows:

12.3.5.2.1.4 O-PMD

The O-PMD message conveys the initial PMD parameter settings that shall be used in the upstream direction during showtime. The full list of parameters carried by the O-PMD message is shown in Table 12-48.

Table 12-48 – Description of message O-PMD

	Field name	Format
1	Message descriptor	Message code
2	Trellis	1 byte
3	Bits and gains table	$2 \times NSC_{us}$ bytes
4	Tone ordering table	$3 \times \lceil NSC_{US}/2 \rceil$ bytes coded as follows: • Bits 0-11: t_{2n-1} • Bits 12-23: t_{2n}
5	Initialization status	1 byte
NOTE – The $\lceil x \rceil$ notation represents rounding to the nearest greater integer.		

Field #1 "Message descriptor" is a unique one-byte code that identifies the message. See Table 12-2 for a complete list of codes.

Field #2 "Trellis" indicates whether trellis coding shall be used in the upstream direction (00_{16} = trellis disabled, 01_{16} = trellis enabled).

Field #3 "Bits and gains table" contains the b_i and g_i values for every sub-carrier in MEDLEYus. The b_i shall indicate the number of bits to be mapped by the VTU-R to the sub-carrier i; the g_i shall indicate the scale factor that shall be applied to sub-carrier i, relative to the gain that was used for that sub-carrier during the transmission of R-P-MEDLEY.

The b_i's and g_i's shall only be defined for sub-carriers from the MEDLEYus set (as indicated in R-PRM), and shall be sent in ascending order of sub-carrier indices i.

Each b_i value shall be represented as an unsigned 4-bit integer. Each g_i value shall be represented as an unsigned 12-bit fixed-point quantity, with the binary point assumed just to the right of the third most significant bit. For example, a g_i with binary representation (MSB listed first) 001.010000000_2 would instruct the VTU-R to scale the constellation for sub-carrier i by a gain of 1.25, so that the power of that sub-carrier would be 1.94 dB higher than it was during R-P-MEDLEY.

Each pair of b_i and g_i values shall be mapped on a 16-bit field as follows: [$b_M$bbb $g_M$ggg gggg gggg], where b_M and g_M are the MSBs of the b_i and g_i binary representations, respectively.

Field #4 "Tone ordering table" contains the tone ordering table t for the upstream direction. The tone ordering table contains the order in which the sub-carriers shall be assigned bits in the upstream direction. The table shall include all sub-carriers of the MEDLEYus set and only these sub-carriers. Each sub-carrier index shall be represented as a 12-bit value. Pairs of sub-carrier indices shall be mapped to a field of 3 bytes as shown in Table 12-48. For example, if the value of the n^{th} field is 400200_{16}, $t_{2n-1} = 200_{16} = 512$ and $t_{2n} = 400_{16} = 1024$. If the number of sub-carriers in the MEDLEYus set is odd, the last 12 bits of the field shall be set to ZERO (and ignored by the receiver). The value of the first index sent shall be equal to the index of the first entry in the tone ordering table (t_1, see 10.3.1). The remaining indices shall be sent in increasing order of the tone ordering table t entries (t_2, t_3, … t_{NSCus}).

Field #5: indicates the "Initialization status".

If, within the constraints of the channel initialization policies defined in 12.3.7, the receiver is unable to select a set of configuration parameters, the "Initialization success/failure code" indicates the initialization failure cause as defined in ITU-T Rec. G.997.1 [4]. If, within the constraints of the channel initialization policies defined in 12.3.7, the receiver is able to select a set of configuration parameters, the "Initialization success/failure code" indicates the initialization success. Valid Initialization success/failure codes are as follows:

- 80_{16}: Initialization success;
- 81_{16}: Configuration error;
- 82_{16}: Configuration not feasible on line;
- 00_{16}: Feature not supported.

Other values are reserved by the ITU-T.

If an initialization success/failure code 81_{16} or 82_{16} is set:

- all values in Field #2 to 4 shall be set to 0; and
- the VTU-O shall return to L3 link state instead of L0 link state at the completion of the initialization procedures.

20) Clause 12.3.5.2.2.1

Revise clause 12.3.5.2.2.1 (R-MSG 2) as follows:

12.3.5.2.2.1 R-MSG 2

The R-MSG 2 message conveys VTU-R information to the VTU-O. The full list of parameters carried by the R-MSG 2 message is shown in Table 12-49.

Table 12-49 – Description of message R-MSG 2

	Field name	Format
1	Message descriptor	Message code
2	TPS-TC capabilities	See Table 12-50
3	PMS-TC capabilities	See Table 12-51

Field #1 "Message descriptor" is a unique one-byte code that identifies the message. See Table 12-2 for a complete list of codes.

Field #2 "TPS-TC capabilities" indicates the TPS-TC capabilities of the VTU-R, as shown in Table 12-50.

Field #3 "PMS-TC capabilities" indicates the PMS-TC capabilities of the VTU-R. This includes the supported latency paths at the VTU-R (DS and US) and the capabilities per path (such as supported coding and interleaver parameters), as shown in Table 12-51.

Table 12-50 – TPS-TC capabilities of VTU-R

Field name	Format	Description
Maximum number of downstream TPS-TCs of each type	1 byte: [ssaapp00]	Indicates the maximum number of TPS-TCs of each type that the VTU-R supports in the downstream direction: • ss=max number of downstream STM TPS-TCs (0,1,2); • aa=max number of downstream ATM TPS-TCs (0,1,2); and • pp=max number of downstream PTM TPS-TCs (0,1,2).
Maximum number of upstream TPS-TCs of each type	1 byte: [ssaapp00]	Indicates the maximum number of TPS-TCs of each type that the VTU-R supports in the upstream direction: • ss=max number of downstream STM TPS-TCs (0,1,2); • aa=max number of downstream ATM TPS-TCs (0,1,2); and • pp=max number of downstream PTM TPS-TCs (0,1,2).
Supported combinations of downstream bearer channels and TPS-TCs	1 byte: [$s_0a_0p_0$ 0 $s_1a_1p_1$ 0]	s_0: equal to 1 if STM can be supported on bearer channel 0 a_0: equal to 1 if ATM can be supported on bearer channel 0 p_0: equal to 1 if PTM can be supported on bearer channel 0 s_1: equal to 1 if STM can be supported on bearer channel 1 a_1: equal to 1 if ATM can be supported on bearer channel 1 p_1: equal to 1 if PTM can be supported on bearer channel 1

Table 12-50 – TPS-TC capabilities of VTU-R

Field name	Format	Description
Supported combinations of upstream bearer channels and TPS-TCs	1 byte: [$s_0 a_0 p_0$ 0 $s_1 a_1 p_1$ 0]	s_0: equal to 1 if STM can be supported on bearer channel 0 a_0: equal to 1 if ATM can be supported on bearer channel 0 p_0: equal to 1 if PTM can be supported on bearer channel 0 s_1: equal to 1 if STM can be supported on bearer channel 1 a_1: equal to 1 if ATM can be supported on bearer channel 1 p_1: equal to 1 if PTM can be supported on bearer channel 1
For each supported TPS-TC, a Bearer channel descriptor (see Table 12-42) shall be appended to the message.		
Downstream STM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported downstream STM TPS-TCs.
Downstream ATM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported downstream ATM TPS-TCs.
Downstream PTM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported downstream PTM TPS-TCs.
Upstream STM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported upstream STM TPS-TCs.
Upstream ATM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported upstream ATM TPS-TCs.
Upstream PTM TPS-TC capabilities	0, 1, or 2 bearer channel descriptors	Contains the capabilities of the supported upstream PTM TPS-TCs.
NOTE – The number of bearer channel descriptors for the TPS-TC capabilities depends on the fields "Maximum number of downstream/upstream TPS-TCs".		

Each bearer channel descriptor (see Table 12-42) shall be coded as follows.

In the fields "Minimum net data rate", "Maximum net data rate" and "Reserved net data rate", the parameter values for net_min_n, net_max_n and $net\_reserve_n$, respectively, shall be coded as unsigned integers representing the data rate as a multiple of 8 kbit/s.

The fields "Maximum interleaving delay" and "Impulse noise protection" are not applicable in R-MSG 2 (which communicates capabilities), and the values of octets 7 and 8 in each bearer channel descriptor shall be ignored by the VTU-O receiver.

The field "TPS-TC options" shall be coded as follows:

- Bit 0: If the VTU-R supports pre-emption in this bearer (N.3.1.2/G.992.3 [10]), the bit shall be set to ONE.
- Bit 1: If the VTU-R supports short packets in this bearer (N.3.1.3/G.992.3 [10]), the bit shall be set to ONE.
- ~~Bits 2-7 are reserved by the ITU-T and set to ZERO.~~

For a bearer mapped to an ATM or STM TPS-TC, bits 0 and 1 shall be set to ZERO at the transmitter and ignored by the receiver~~the TPS-TC options field is reserved by the ITU-T and shall be set to 00_{16}~~.

Bit 2 indicates whether the optional channel initialization policy is supported for that bearer channel. This bit shall be set to ONE to indicate support for this policy.

Bits 3-7 are reserved by ITU-T and shall be set to ZERO.

Table 12-51 – PMS-TC capabilities of VTU-R

Field name	Format	Description
Downstream OLR capabilities~~dynamic interleaver~~	1 byte [000fdsii]	Indicates the support of optional OLR mechanisms in the downstream direction. f = 0 if downstream framing reconfiguration (change of T_p, G_p and B_{p0}) is not supported, f = 1 otherwise. d is reserved by ITU-T for future use and shall be set to zero. s = 0 if downstream SRA (change of L_p, b_i, g_i) is not supported, s = 1 otherwise. ii = 00 if interleaver reconfiguration (change of D_p) is not supported, ii = 01 if interleaver reconfiguration is supported on one downstream latency path, ii = 11 if interleaver reconfiguration is supported on both downstream latency paths~~Support of dynamic change of interleaver depth in the downstream direction (see 9.4.1). A value of 0016 indicates not supported. All other values are for further study~~. ii = 10 is reserved by the ITU-T.
Upstream OLR capabilities~~dynamic interleaver~~	1 byte [000fdsii]	Indicates the support of optional OLR mechanisms in the upstream direction. f = 0 if upstream framing reconfiguration (change of T_p, G_p and B_{p0}) is not supported, f = 1 otherwise. d is reserved by ITU-T for future use and shall be set to zero. s = 0 if upstream SRA (change of L_p, b_i, g_i) is not supported, s = 1 otherwise. ii = 00 if interleaver reconfiguration (change of D_p) is not supported, ii = 01 if interleaver reconfiguration is supported on one upstream latency path, ii = 11 if interleaver reconfiguration is supported on both upstream latency paths~~Support of dynamic change of interleaver depth in the upstream direction (see 9.4.1). A value of 0016 indicates not supported. All other values are for further study~~. ii = 10 is reserved by the ITU-T.
Downstream message overhead data rate	1 byte	Minimum message overhead data rate that is needed by the VTU-R in the downstream direction. The unsigned 8-bit value is the message overhead data rate divided by 1000 bits per second minus 1 (covering the range 1 to 256 kbit/s).
Upstream message overhead data rate	1 byte	Minimum message overhead data rate that is needed by the VTU-R in the upstream direction. The unsigned 8-bit value is the message overhead data rate divided by 1000 bits per second minus 1 (covering the range 1 to 256 kbit/s).
Max DS net data rate for latency path 0	1 byte	The maximum downstream net data rate supported in latency path #0. The unsigned 16-bit value is the net data rate divided by 8000 bits per second.
Max US net data rate for latency path 0	1 byte	The maximum upstream net data rate supported in latency path #0. The unsigned 16-bit value is the net data rate divided by 8000 bits per second.
Max DS net data rate for latency path 1	2 bytes	Parameter block of 2 octets that describes the maximum downstream net data rate supported in latency path #1. The unsigned 16-bit value is the net data rate divided by 8000 bits per second.

Table 12-51 – PMS-TC capabilities of VTU-R

Field name	Format	Description
Max US net data rate for latency path 1	2 bytes	Parameter block of 2 octets that describes the maximum upstream net data rate supported in latency path #1. The unsigned 16-bit value is the net data rate divided by 8000 bits per second.
DS $(1/S)_{max}$	1 byte	Parameter block of 1 octet that describes the maximum value of $1/S$ supported by the VTU-R in the downstream direction as defined in 9.5.5. The unsigned 8-bit value is coded as 1 to 64 in steps of 1.
US $(1/S)_{max}$	1 byte	Parameter block of 1 octet that describes the maximum value of $1/S$ supported by the VTU-R in the upstream direction as defined in 9.5.5. The unsigned 8-bit value is coded as 1 to 64 in steps of 1.
NOTE – If only one latency path is supported, the values for latency path 1 shall be set to ZERO.		

21) Clause 12.3.5.2.2.4

Revise clause 12.3.5.2.2.4 (R-PMD) as follows:

12.3.5.2.2.4 R-PMD

The R-PMD message conveys the initial PMD parameter settings that shall be used in the downstream direction during showtime. The content of R-PMD is shown in Table 12-54.

Table 12-54 – Description of message R-PMD

	Field name	Format
1	Message descriptor	Message code
2	Trellis	1 byte
3	Bits and gains table	$2 \times NSC_{ds}$ bytes
4	Tone ordering table	$3 \times \lceil NSC_{ds} / 2 \rceil$ bytes coded as follows: • Bits 0-11: t_{2n-1} • Bits 12-23: t_{2n}
5	Showtime pilot tones	Tone descriptor
6	Initialization status	1 byte
NOTE – The $\lceil x \rceil$ notation represents rounding to the nearest greater integer.		

Field #1 "Message descriptor" is a unique one-byte code that identifies the message. See Table 12-2 for a complete list of codes.

Field #2 "Trellis" indicates whether trellis coding shall be used in the downstream direction (00_{16} = trellis disabled, 01_{16} = trellis enabled).

Field #3 "Bits and gains table" contains the b_i and g_i values for every sub-carrier in MEDLEYds. The b_i shall indicate the number of bits to be mapped by the VTU-O to the sub-carrier i; the g_i shall indicate the scale factor that shall be applied to sub-carrier i, relative to the gain that was used for that sub-carrier during the transmission of O-P-MEDLEY.

The b_i's and g_i's shall only be defined for sub-carriers from the MEDLEYds set (as indicated in O-PRM), and shall be sent in ascending order of the sub-carrier indices i.

Each b_i value shall be represented as an unsigned 4-bit integer. Each g_i value shall be represented as an unsigned 12-bit fixed-point quantity, with the binary point assumed just to the right of the third most significant bit. For example, a g_i with binary representation (MSB listed first) 001.010000000_2 would instruct the VTU-O to scale the constellation for sub-carrier i by a gain of 1.25, so that the power of that sub-carrier would be 1.94 dB higher than it was during O-P-MEDLEY.

Each pair of b_i and g_i values shall be mapped on a 16-bit field as follows: [$b_M$bbb $g_M$ggg gggg gggg], where b_M and g_M are the MSBs of the b_i and g_i binary representations, respectively.

Field #4 "Tone ordering table" contains the tone ordering table t for the downstream direction. The tone ordering table contains the order in which the sub-carriers shall be assigned bits in the downstream direction. The table shall include all sub-carriers of the MEDLEYds set and only these sub-carriers. Each sub-carrier index shall be represented as a 12-bit value. Pairs of sub-carrier indices shall be mapped to a field of 3 bytes as shown in Table 12-54. For example, if the value of the n^{th} field is 400200_{16}, $t_{2n-1} = 200_{16} = 512$ and $t_{2n} = 400_{16} = 1024$. If the number of sub-carriers in the MEDLEYds set is odd, the last 12 bits of the field shall be set to ZERO (and ignored by the receiver). The value of the first index sent shall be equal to the index of the first entry in the tone ordering table (t_1, see 10.3.1). The remaining indices shall be sent in increasing order of the tone ordering table t entries (t_2, t_3, … t_{NSCds}).

Field #5 "Showtime pilot tones" indicates the selection of pilot tones that the VTU-R intends to use during showtime. The field shall be formatted as a Tone descriptor, as shown in Table 12-25. The first octet of the tone descriptor shall contain the number of pilot tones selected by the VTU-R. If this number is zero, there shall be no further octets in the descriptor. If the number of tones is not equal to zero, each group of three consecutive octets in the descriptor shall describe the location (i.e., the sub-carrier index) of two pilot tones. If the number of pilot tones is odd, the last 12 bits shall be ignored.

The VTU-R shall only select a tone as a pilot tone if the bit loading for that tone, as given in the bits and gains table (Field #3), is equal to zero. The showtime pilot tones shall be modulated as specified in 10.4.5.1. The total number of showtime pilot tones shall not exceed 16.

Field #6: indicates the "Initialization status".

If, within the constraints of the channel initialization policies defined in 12.3.7, the receiver is unable to select a set of configuration parameters, the "Initialization success/failure code" indicates the initialization failure cause as defined in ITU-T Rec. G.997.1 [4]. If, within the constraints of the channel initialization policies defined in 12.3.7, the receiver is able to select a set of configuration parameters, the "Initialization success/failure code" indicates the initialization success. Valid Initialization success/failure codes are as follows:

- 80_{16}: Initialization success;
- 81_{16}: Configuration error;
- 82_{16}: Configuration not feasible on line;
- 00_{16}: Feature not supported.

Other values are reserved by the ITU-T.

If an initialization success/failure code 81_{16} or 82_{16} is set:

- all values in Field #2 to 4 shall be set to 0; and
- the VTU-R shall return to L3 link state instead of L0 link state at the completion of the initialization procedures.

22) Clause 12.3.7

Revise clause 12.3.7 (Service priorities) as follows:

12.3.7 ~~Service priorities~~Channel initialization policies

The method used by the receiver to select the values of transceiver parameters described in this sub-clause is implementation dependent. However, within the limit of the total data rate provided by the local PMD, the selected values shall meet all of the constraints communicated by the transmitter prior to the Channel Analysis & Exchange phase, including:

- Message overhead data rate ≥ Minimum message overhead data rate;
- Net data rate ≥ Minimum net data rate for all bearer channels;
- Impulse noise protection ≥ Minimum impulse noise protection for all bearer channels;
- Delay ≤ Maximum delay for all bearer channels.

Within those constraints, the receiver shall select the values as to optimize in the priority configured through the CO-MIB channel initialization policy parameter (CIPOLICY, see 7.3.2.10/G.997.1).~~listed~~: The channel initialization policy applies only for the selection of the values exchanged during initialization, and does not apply during showtime.

The following channel initialization policies are defined:

- Policy ZERO if $CIpolicy_n$=0, then:
  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 12.3.5).
  2) Minimize excess margin with respect to the maximum SNR margin MAXSNRM through gain adjustments (see 10.3.4.2). Other control parameters may be used to achieve this (e.g., MAXMASK, see 7.2.3).
- Policy ONE if $CIpolicy_n$=1, then:

  Maximize INP_act_n for the bearer channel.

If the CO-MIB sets the CIPOLICY to ONE for a bearer channel, it shall have the minimum net data rate set equal to the maximum net data rate and shall have the MAXSNRM set to infinity.

If only a single bearer channel is configured through the CO-MIB, then the CIPOLICY shall be set to ZERO or ONE. If multiple bearer channels are configured through the CO-MIB, then the CIPOLICY shall be set to ZERO for each of the bearer channels. The use of the channel initialization policy ONE with multiple bearer channels is for further study.

Support of channel initialization policy ZERO is mandatory. Support of channel initialization policy ONE is optional. Additional channel initialization policies are for further study. The $CIpolicy_n$ parameter values other than 0 and 1 are reserved for use by the ITU-T.

23) Clause 13.1

Revise clause 13.1 (Types of on-line reconfiguration) as follows:

Types of OLR include bit swapping~~, dynamic rate repartitioning (DRR)~~ and seamless rate adaptation (SRA).

Bit swapping reallocates bits and power (i.e., margin) among the allowed sub-carriers without modification of the higher layer features of the physical layer. Bit swapping reconfigures the bit and gain (b_i, g_i) parameters without changing any other PMD or PMS-TC control parameters. After a bit swapping reconfiguration, the total data rate $(\Sigma L_p) \times f_s$ is unchanged, and the total data rate on each latency path $(L_p \times f_s)$ is unchanged.

~~Dynamic rate repartitioning (DRR) is for further study.~~

~~Seamless rate adaptation (SRA) is for further study.~~

~~In this version of the Recommendation, only bit swapping is defined.~~ Because bit swapping is used autonomously to maintain the operating conditions of the modem during changing environment conditions, bit swapping is a mandatory capability. The procedure for bit swapping is defined in 11.2.3.3 (OLR commands) and shall be implemented using Type 1 OLR messages as shown in Tables 11-5 and 11-6.

Seamless rate adaptation (SRA) is used to reconfigure the total data rate (ΣL_p) by modifying the framing parameters (L_p) and modifications to the bits and fine gains (b_i, g_i) parameters. Since the total data rate is modified, at least one latency path (or more) will have a new data rate (L_p) after the SRA. Since SRA is optional, the ability to support it is identified during the initialization procedure. The procedure for SRA is defined in 11.2.3.3 (OLR commands) and shall be implemented using Type 3 OLR messages as shown in Tables 11-5 and 11-6.

Interleaver reconfiguration (within SRA) allows to dynamically change the interleaver depth D_p on one or more latency paths. SRA may be accompanied by a change of the framing parameters T_p, G_p and B_{p0}. Interleaver reconfiguration and modification of framing parameters T_p, G_p and B_{p0} are optional.

The procedure for interleaver reconfiguration is defined in 9.4.1 and 11.2.3.3 (OLR commands) and shall be implemented using Type 3 OLR messages as shown in Tables 11-5 and 11-6.

24) Clause 13.2

Revise clause 13.2 (Control parameters) as follows:

13.2 Control parameters

13.2.1 Control parameters controlled by the OLR procedures

On-line reconfiguration of the PMD is accomplished by a coordinated change to the bits and gain values on two or more sub-carriers. The bit and gain parameters described in Table 13-1 may be changed through on-line reconfiguration within the limits described.

Table 13-1 – Reconfigurable control parameters of the PMD function

Parameter	Definition
b_i	The number of bits per sub-carrier may be increased or decreased in the [0 … 15] range. A change of the b_i values ~~shall~~ may be performed without modifying the L value (~~i.e.~~e.g., bit swap) or with a change of the L value (e.g., seamless rate adaptation).
g_i	The sub-carrier gain adjustments may be increased or decreased in the [−14.5 … +2.5] range.

The updated bits and gains table shall comply with the bits and gains table requirements listed in 10.3.1 and 10.3.4.

On-line reconfiguration of the PMS-TC is accomplished by a coordinated change to the value of one or more of the framing parameters shown in Table 13-2. The framing parameters displayed in Table 13-2 may be changed through on-line reconfiguration within the limits described.

Table 13-2 – Reconfigurable framing parameters of the PMS-TC function

Parameter	Definition
L_p	If latency path #p is used, the number of bits from latency path #*p* transmitted in each DMT symbol may be increased or decreased; the value of L_p is determined by the total data rate assigned for the latency path.
D_p	The interleaver depth on latency path *p* may be increased or decreased, as long as the resulting interleaver delay on that latency path does not exceed the bounds determined during initialization.
T_p	The number of MDFs in an overhead sub-frame: This value can be increased or decreased within the set of valid values (see Table 9-6).
G_p	The total number of overhead octets in an OH sub-frame: This value can be increased or decreased within the set of valid values (see Table 9-6).
B_{p0}	The total number of octets from bearer channel #0 in a mux data frame: This value can be increased or decreased within the set of valid values (see Table 9-6).
NOTE – Any change in L_p, T_p, G_p, and B_{p0} values shall be such that the length of the MDF (as defined in Table 9-6) remains unchanged for all active latency paths.	

13.2.2 Parameters controlling the OLR procedures

The list of parameters controlling OLR procedure Type 3 is presented in Table 13-3.

Table 13-3 – Control parameters controlling the OLR procedures

Parameter	Definition
RA-USNRM *RA-UTIME*	The rate adaptation upshift noise margin and time interval (defined in ITU-T Rec. G.997.1 [4]). The parameter can be different for the VTU-O (*RA-USNRMus* and *RA-UTIMEus*) and the VTU-R (*RA-UTIMEds*, *RA-USNRMds*). VTU-O: Configured through CO-MIB. VTU-R: Configured through CO-MIB and communicated to the VTU-R during initialization (O-MSG 1). The valid values for *RA-USNRMus* and *RA-USNRMds* are values between 0 and 31.0 dB in steps of 0.1 dB. The valid values for *RA-UTIMEus* and *RA-UTIMEds* are values between 0 to 16383 s in steps of 1 s.
RA-DSNRM *RA-DTIME*	The rate adaptation downshift noise margin and time interval (defined in ITU-T Rec. G.997.1 [4]). The parameter can be different for the VTU-O (*RA-DSNRMus* and *RA-DTIMEus*) and the VTU-R (*RA-DTIMEds*, *RA-DSNRMds*). VTU-O: Configured through the CO-MIB. VTU-R: Configured through the CO-MIB and communicated to the VTU-R during initialization (O-MSG 1). The valid values for *RA-DSNRMus* and *RA-DSNRMds* are values between 0 and 31.0 dB in steps of 0.1 dB. The valid values for *RA-DTIMEus* and *RA-DTIMEds* are values between 0 to 16383 s in steps of 1 s.

Table 13-3 – Control parameters controlling the OLR procedures

Parameter	Definition
~~DV_p~~	~~The delay variation occurring in an OLR on latency path p.~~ ~~It is defined here as:~~ ~~$DV_p = \lvert (delay_p\_H * L_p\_H - delay_p\_L * L_p\_L) / L_p\_H \rvert$~~ ~~where:~~ ~~$L_p\_L$ is the lower value of L_p in an OLR procedure~~ ~~L_p_H is the higher value of L_p in an OLR procedure~~ ~~$delay_p\_L$ = the actual delay in ms in the steady state corresponding with L_p_L~~ ~~$delay_p\_H$ = the actual delay in ms in the steady state corresponding with L_p_H~~ ~~The delay variation DV_n of bearer channel #n shall always be set to the value of DV_p of the underlying PMS-TC path function (see Annex K).~~
$DVmax_n$	The maximum allowed value for the delay variation DV_n of bearer channel #n. It ranges from 0.1 to 25.4 in steps of 0.1 ms. The value 25.5 indicates that no delay variation bound is imposed. The parameter can be different for the VTU-O and the VTU-R. VTU-O: Configured through the CO-MIB. VTU-R: Configured through the CO-MIB and communicated to the VTU-R during initialization (O-TPS).

25) Clause 13.3

Revise clause 13.3 (Timing of changes in sub-carrier configuration) as follows:

In both the upstream and the downstream directions, the reconfiguration of the PMD~~ and PMS-TC~~ functions shall take effect starting with the tenth symbol that follows transport of the Syncflag for OLR type 1. As defined in 10.2, the sync symbol is transmitted after every 256 data symbols. The reconfiguration of the PMD function shall take effect starting with the symbol at symbol count 9 in the next DMT superframe, where the first symbol in each DMT superframe is the symbol at symbol count 0.

For OLR Type 3, when performed in the latency path p, the change in L_p values and b_i, g_i values shall take effect starting from the 66th symbol that follows the Syncflag, i.e., the symbol with symbol count 65 in the DMT superframe following the Syncflag, where the first symbol in the DMT superframe is the symbol at symbol count 0.

The change of framing parameters T_p, G_p and B_{p0} shall take effect on the first OH frame of the first OH superframe that follows the 66th DMT symbol after the Syncflag.

The change in D_p shall take effect on the first byte of an interleaved RS codeword (byte k as defined in 9.4.1). This codeword shall be determined as follows:

- For a decrease in interleaver depth, this shall be the first RS codeword that starts at or after the beginning of the 66th DMT symbol.
- For an increase in interleaver depth, this shall be the last RS codeword that starts at or before the beginning of the 66th DMT symbol.

The location of the RS codeword relative to the 66th DMT symbol is illustrated in Figure 13-1.

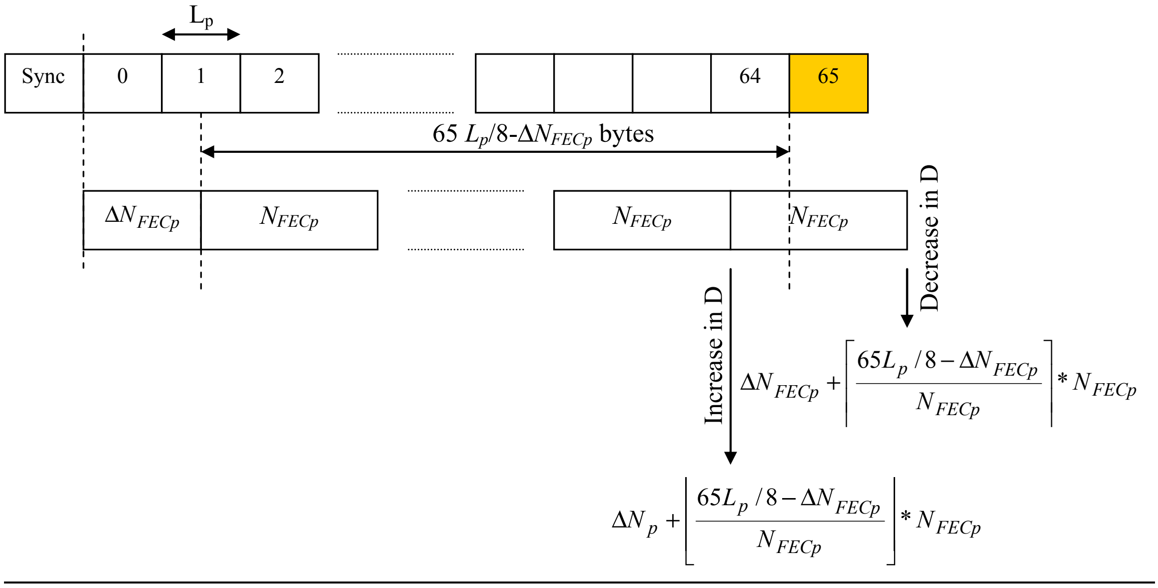

Figure 13-1 – Finding the byte where the change in D_p is activated

Figure 13-1 shows the DMT symbol counter and the byte counter at which the interleaver depth change is activated, relative to the Syncflag. For an increase in depth, the change in D_p will always happen at the same time or before the change in L_p, but as close to it as possible (i.e., the change in D_p happens during the DMT symbol with count 64 or sooner). Likewise, for a decrease in depth, the change in D_p will always happen at the same time or after the change in L_p, but as close to it as possible (i.e., the change in D_p happens during the DMT symbol with count 65 or later).

26) Clause 13.4

Revise clause 13.4 as follows:

13.4 Receiver initiated procedure

A VTU receiver may initiate a reconfiguration. If it is going to do so, it computes the necessary change in the bits and gains table and requests this change in the transmit PMD function of the VTU at the other end of the line. After it receives a positive acknowledgment, as specified in 11.2.3.3, the VTU shall change the relevant control parameters~~bits and gains table~~ of its own receive PMD function and the PMS-TC function at the time specified in 13.3. A bit swap request shall change only the bits and gains table. It shall not modify the *L* value. Bit swapping reconfigurations involve changes of only the PMD sub-layer configuration parameters. They do not change the TPS-TC and PMS-TC sub-layer configuration parameters.

The transmit PMD function shall support bit swaps requested by the receive PMD function.

A VTU receiver shall only send OLR request commands that meet all of following constraints:

- Message overhead data rate ≥ Minimum message overhead data rate;
- Net data rate ≥ Minimum net data rate for all bearer channels;
- Impulse noise protection ≥ Minimum impulse noise protection for all bearer channels;
- Delay ≤ Maximum delay for all bearer channels;
- $DV_n \le DVmax_n$ for all bearer channels.

13.4.1 Receiver Initiated SRA downshift procedure

If the noise margin is below the downshift noise margin (*RA-DSNRM*) and stays below that for more than the time specified by the minimum downshift rate adaptation interval (*RA-DTIME*), the VTU shall attempt to decrease the net data rate, such that the noise margin is increased to a level higher than or equal to the Downshift Noise Margin + 1 dB (see Figure 13-2).

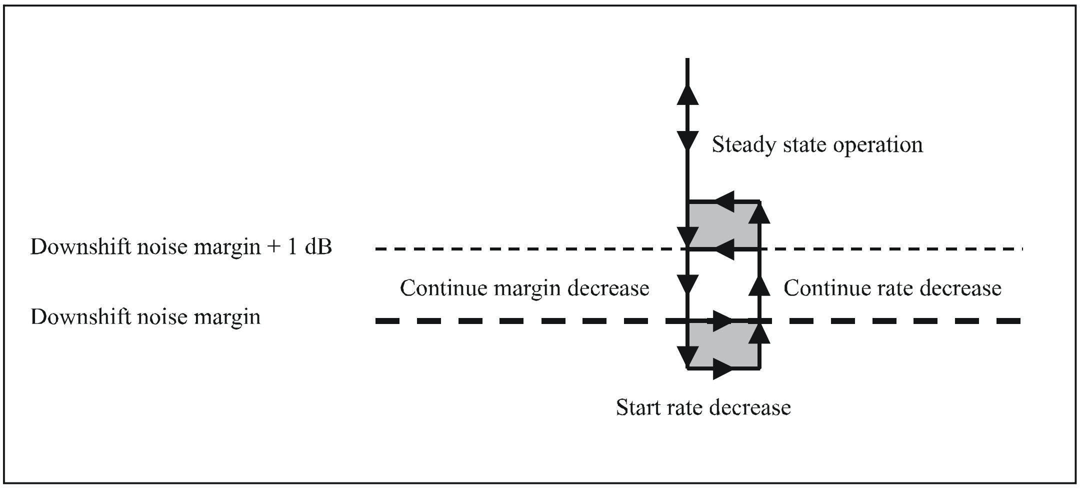

Figure 13-2 – SRA downshift procedure

If a $DVmax_p$ parameter specifies a bound on delay variation, it is possible that the rate decrease allowed by this maximum delay variation in a single SRA request is not sufficient to re-establish the margin to downshift noise margin + 1 dB. In this case, a number of consecutive SRA requests shall be executed until the margin is higher than or equal to the downshift noise margin + 1 dB.

13.4.2 Receiver initiated SRA upshift procedure

If the noise margin is above the upshift noise margin (*RA-USNRM*) and stays above that for more than the time specified by the minimum upshift rate adaptation interval (*RA-UTIME*), the VTU shall attempt to increase the net data rate, such that the noise margin is decreased to a level lower than or equal to the upshift noise margin – 1 dB (see Figure 13-3).

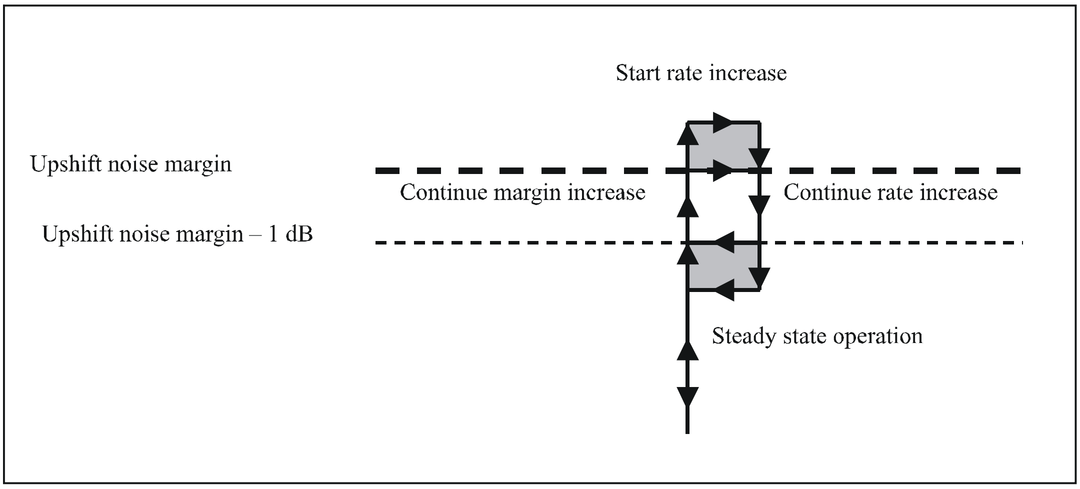

Figure 13-3 – SRA upshift procedure

If a *DVmax*$_p$ parameter specifies a bound on delay variation, it is possible that the rate increase allowed by this maximum delay variation in a single SRA request, is not sufficient to re-establish the margin to upshift noise margin – 1 dB. In this case, a number of consecutive SRA requests shall be executed until the margin is lower than or equal to the upshift noise margin – 1 dB.

27) New clause 14.3

Add new clause 14.3 as follows:

14.3 Input capacitance

Input capacitance requirements are shown in Table 14-1.

Table 14-1 – Input capacitance requirements

Underlying service			Min capacitance (nF)	Max capacitance (nF)
POTS	Integrated HPF	With US0	20	34
		Without US0	For further study	34
	External HPF	With US0	30	78
		Without US0	For further study	78
ISDN	Integrated HPF	With US0	6	11
		Without US0	For further study	11
	External HPF	With US0	10.8	59
		Without US0	For further study	59
No underlying service	N/A	N/A	No requirement	No requirement
NOTE – Capacitance shall be measured at a single frequency ≤ 4 kHz for over POTS and ≤ 30 kHz for over ISDN.				

28) Annex A

Revise Annex A as follows:

Annex A

Region A (North America)

A.1 Band plan

The band plan for North America is shown in Figure A.1. The US0 band, if present, has a lower frequency, f_{0L}, which can vary from 4 kHz (without POTS) to 25 kHz (with POTS), and an upper frequency, f_{0H}, which can vary from 138 to 276 kHz.

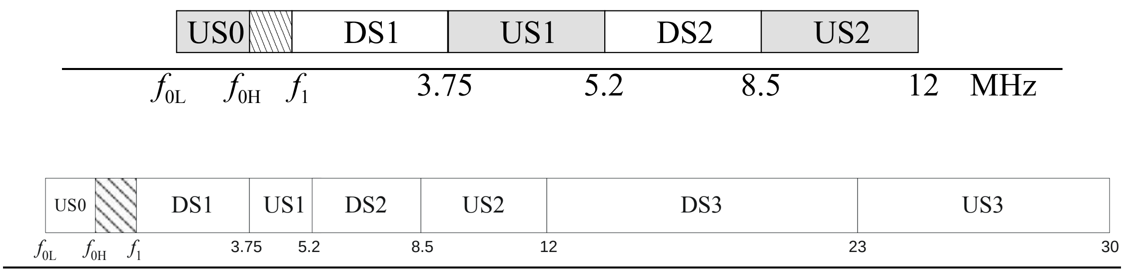

Figure A.1 – Band plan for North America

A.2 Limit PSD ~~specifications~~masks

The breakpoint frequencies and PSD values in Tables A.1 through A.8~~6~~ are exact. The indicated slopes shown in corresponding Figures A.2 through A.6~~4~~ are approximate.

NOTE – The out-of-band specification above 1.1 MHz is governed by the stopband specification in Table 7-2.

NOTE – It is expected that methods to verify compliance to the ~~transmit~~ Limit PSD mask will be defined by the regional bodies.

A.2.1 VTU-R Limit PSD ~~specification~~masks

The Limit PSD mask between the breakpoints is determined using the following interpolation rules:

- For frequencies less than (3750-175) kHz, the breakpoints in Tables A.1 through A.8~~6~~ shall be connected linearly on a plot with the abscissa $\log_{10}(f)$ and the ordinate the Limit PSD mask in dBm/Hz.
- For frequencies above (3750-175) kHz, the breakpoints in Tables A.1 through A.8~~6~~ shall be connected linearly on a plot with the abscissa f and the ordinate the Limit PSD mask in dBm/Hz.

A.2.1.1 VTU-R operation over POTS

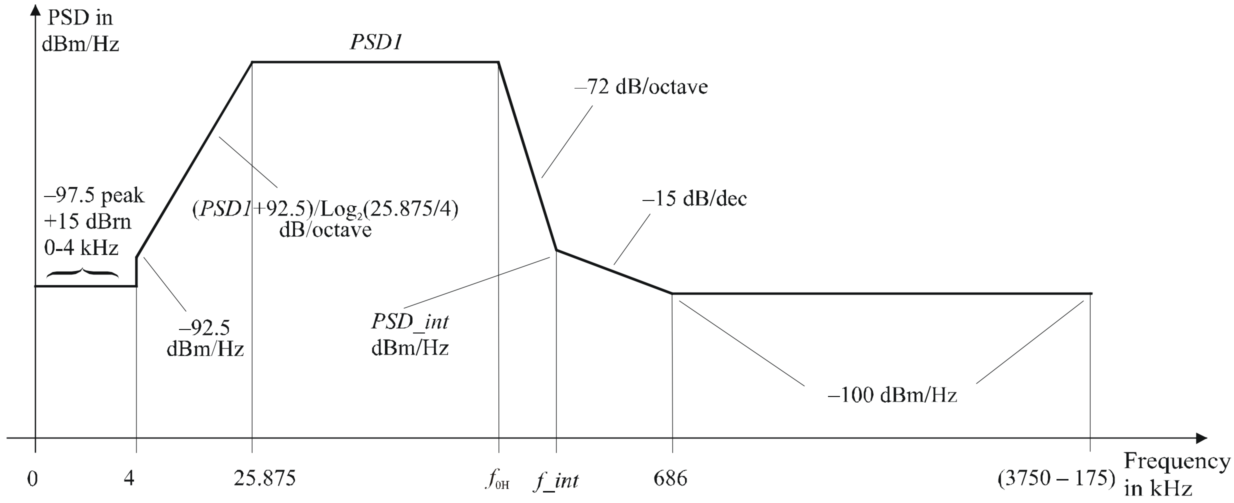

Figure A.2 – VTU-R US0 ~~transmitter~~ Limit PSD mask for operation over POTS

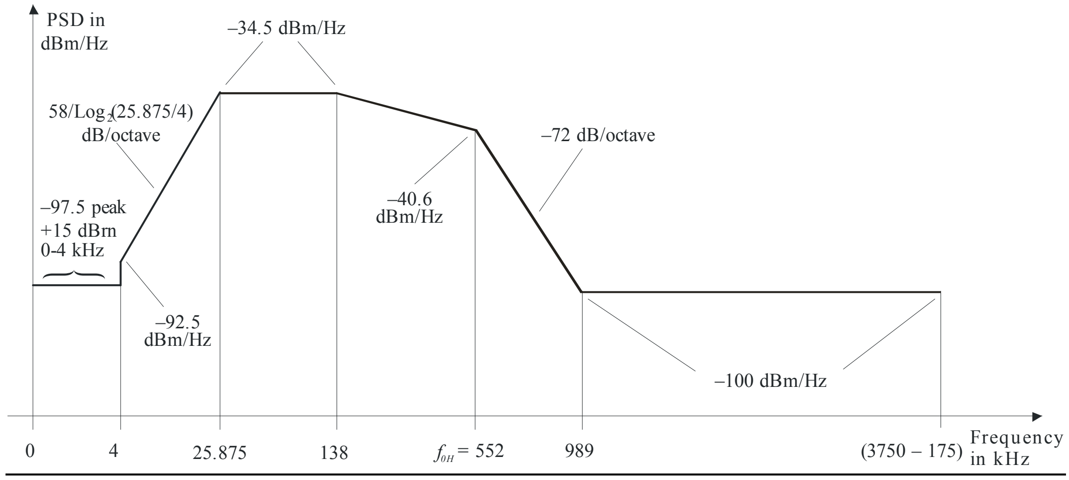

Figure A.3 – VTU-R EU-128 ~~transmitter~~Limit PSD mask for operation over POTS

Table A.1 – VTU-R ~~transmitter~~ Limit PSD mask for operation over POTS as a function of profile

Frequency (kHz)	Limit PSD Mask level (dBm/Hz) for profiles 8a, 8b, 8c, 8d	Limit PSD Mask level (dBm/Hz) for profiles 12a, 12b, 17a	Limit PSD Mask level (dBm/Hz) for profile 30a
0	−97.5	−97.5	−97.5
4	−97.5	−97.5	−97.5
4	−92.5	−92.5	−92.5
25.875	*PSD1* (see Table A.2)	*PSD1* (see Table A.2)	*PSD1* (see Table A.2)
f_{0H}	*PSD1* (see Table A.2)	*PSD1* (see Table A.2)	*PSD1* (see Table A.2)
f_int	*PSD_int* (see Table A.2)	*PSD_int* (see Table A.2)	*PSD_int* (see Table A.2)
686	−100	−100	−100
1104	−100	−100	−100

Table A.1 – VTU-R ~~transmitter~~ Limit PSD mask for operation over POTS as a function of profile

Frequency (kHz)	Limit PSD Mask level (dBm/Hz) for profiles 8a, 8b, 8c, 8d	Limit PSD Mask level (dBm/Hz) for profiles 12a, 12b, 17a	Limit PSD Mask level (dBm/Hz) for profile 30a
3750 – 175	−100	−100	−100
3750	−80	−80	−80
3750	−53 + 3.5	−53 + 3.5	−53 + 3.5
5200	−53 + 3.5	−53 + 3.5	−53 + 3.5
5200	−80	−80	−80
5200 + 175	−100	−100	−100
8500 − 175	−100	−100	−100
8500	−100	−80	−80
8500	−100	−54 + 3.5	−54 + 3.5
12000	−100	−54 + 3.5	−54 + 3.5
12000	−100	−80	−80
12000 + 175	−100	−100	−100
23000 − 175	−100	−100	−100
23000	−100	−100	−80
23000	−100	−100	−60 + 3.5
30000	−100	−100	−60 + 3.5
30000	−110	−11~~0~~0	−80
30175 ~~+ 175~~	−110	−110	−110
≥30175	−110	−110	−110

Table A.2 – *PSD1*, *PSD_int* and the frequencies f_{0H} and *f_int*

Upstream mask-number	Designator	*PSD1* (dBm/Hz)	Frequency f_{0H} (kHz)	Intercept frequency *f_int* (kHz)	Intercept PSD level *PSD_int* (dBm/Hz)
1	EU-32	−34.5	138.00	242.92	−93.2
2	EU-36	−35.0	155.25	274.00	−94.0
3	EU-40	−35.5	172.50	305.16	−94.7
4	EU-44	−35.9	189.75	336.40	−95.4
5	EU-48	−36.3	207.00	367.69	−95.9
6	EU-52	−36.6	224.25	399.04	−96.5
7	EU-56	−36.9	241.50	430.45	−97.0
8	EU-60	−37.2	258.75	461.90	−97.4
9	EU-64	−37.5	276.00	493.41	−97.9
NOTE – EU-32 through EU-64 shall not be used in conjunction with D-128.					

Table A.3 – VTU-R EU-128 Limit PSD mask for operation over POTS as a function of profile

Frequency (kHz)	**Limit PSD Mask level (dBm/Hz) for profiles 8a, 8b, 8c, 8d**	**Limit PSD Mask level (dBm/Hz) for profiles 12a, 12b, 17a**	**Limit PSD Mask level (dBm/Hz) for profile 30a**
0	−97.5	−97.5	−97.5
4	−97.5	−97.5	−97.5
4	−92.5	−92.5	−92.5
25.875	−34.5	−34.5	−34.5
138	−34.5	−34.5	−34.5
f_{0H} = 552	–34.5 – 10*log$_{10}$(f_{0H} – 3)/ (138 – 3)	–34.5 – 10*log$_{10}$(f_{0H} – 3)/ (138 – 3)	–34.5 – 10*log$_{10}$(f_{0H} – 3)/ (138 – 3)
989	−100	−100	−100
1104	−100	−100	−100
3750 − 175	−100	−100	−100
3750	−80	−80	−80
3750	−53 + 3.5	−53 + 3.5	−53 + 3.5
5200	−53 + 3.5	−53 + 3.5	−53 + 3.5
5200	−80	−80	−80
5200 + 175	−100	−100	−100
8500 − 175	−100	−100	−100
8500	−100	−80	−80
8500	−100	−54 + 3.5	−54 + 3.5
12000	−100	−54 + 3.5	−54 + 3.5
12000	−100	−80	−80
12000 + 175	−100	−100	−100
23000 − 175	−100	−100	−100
23000	−100	−100	−80
23000	−100	−100	−60 + 3.5
30000	−100	−100	−60 + 3.5
30000	−110	−110	−80
30175	−110	−110	−110
≥30175	−110	−110	−110

A.2.1.2 VTU-R All-digital mode operation

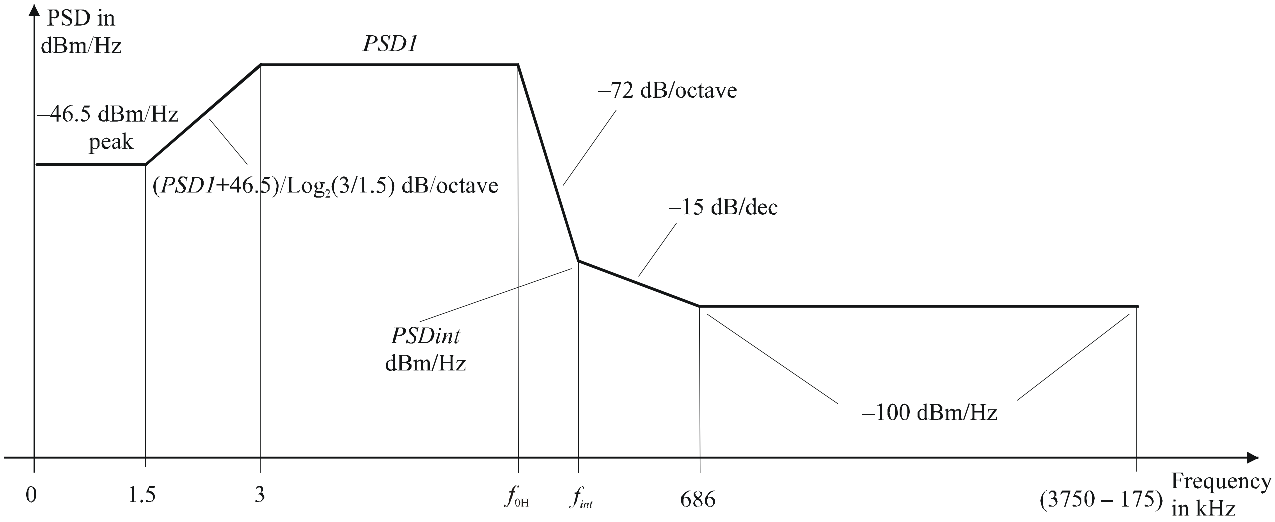

Figure A.4~~3~~ – VTU-R US0 ~~transmitter~~ Limit PSD mask for all-digital mode operation

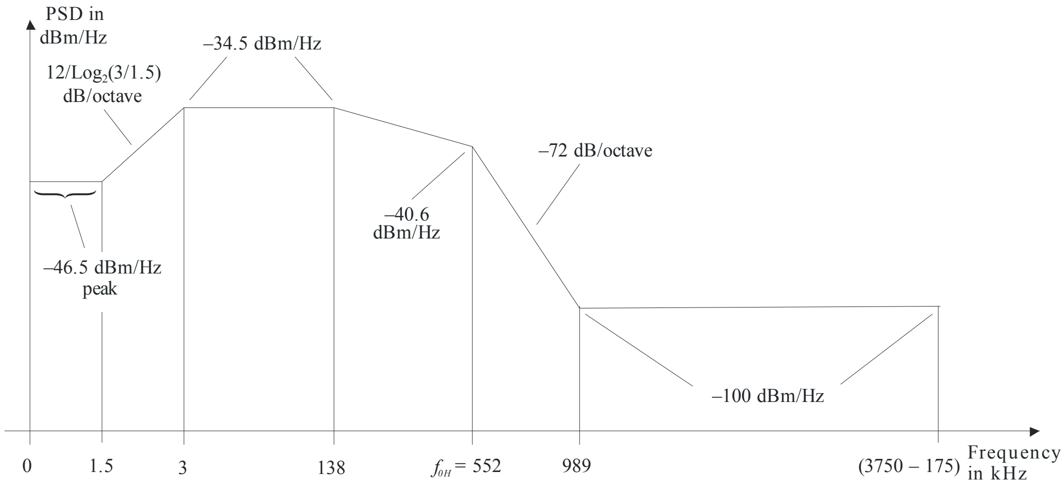

Figure A.5 – VTU-R ADLU-128 ~~transmitter~~Limit PSD mask for all-digital mode operation

Table A.4~~3~~ – VTU-R ~~transmitter~~ Limit PSD mask for all-digital mode operation as a function of profile

Frequency (kHz)	Limit PSD Mask level (dBm/Hz) for profiles 8a, 8b, 8c, 8d	Limit PSD Mask level ~~*PSD1*~~ (dBm/Hz) for profiles 12a, 12b, 17a	Limit PSD Mask level (dBm/Hz) for profile 30a
0	−46.5	−46.5	−46.5
1.5	−46.5	−46.5	−46.5
3	*PSD1* (see Table A.5)	*PSD1* (see Table A.5)	*PSD1* (see Table A.5)
f_{0H}	*PSD1* (see Table A.5)	*PSD1* (see Table A.5)	*PSD1* (see Table A.5)
f_{int}	*PSDint* (see Table A.5)	*PSDint* (see Table A.5)	*PSDint* (see Table A.5)
686	−100	−100	−100
1104	−100	−100	−100
3750 − 175	−100	−100	−100
3750	−80	−80	−80
3750	−53 + 3.5	−53 + 3.5	−53 + 3.5
5200	−53 + 3.5	−53 + 3.5	−53 + 3.5
5200	−80	−80	−80
5200 + 175	−100	−100	−100
8500 − 175	−100	−100	−100
8500	−100	−80	−80
8500	−100	−54 + 3.5	−54 + 3.5
12000	−100	−54 + 3.5	−54 + 3.5
12000	−100	−80	−80
12000 + 175	−100	−100	−100
23000 − 175	−100	−100	−100
23000	−100	−100	−80
23000	−100	−100	−60 + 3.5
30000	−100	−100	−60 + 3.5
30000	−110	−110	−80
30175	−110	−110	−110
≥30175	−110	−110	−110

Table A.54 – *PSD1*, *PSDint* and the frequencies f_{0H} and f_{int}

Upstream mask-number	Designator	*PSD1* (dBm/Hz)	Frequency f_{0H} (kHz)	Intercept Frequency f_{int} (kHz)	Intercept PSD level *PSDint* (dBm/Hz)
1	ADLU-32	−34.5	138.00	242.92	−93.2
2	ADLU-36	−35.0	155.25	274.00	−94.0
3	ADLU-40	−35.5	172.50	305.16	−94.7
4	ADLU-44	−35.9	189.75	336.40	−95.4
5	ADLU-48	−36.3	207.00	367.69	−95.9
6	ADLU-52	−36.6	224.25	399.04	−96.5
7	ADLU-56	−36.9	241.50	430.45	−97.0
8	ADLU-60	−37.2	258.75	461.90	−97.4
9	ADLU-64	−37.5	276.00	493.41	−97.9
NOTE – ADLU-32 through ADLU-64 shall not be used in conjunction with D-128.					

Table A.6 – VTU-R ADLU-128 ~~transmitter~~Limit PSD mask for all-digital mode operation as a function of profile

Frequency (kHz)	Limit PSD Mask level (dBm/Hz) for profiles 8a, 8b, 8c, 8d	Limit PSD Mask level (dBm/Hz) for profiles 12a, 12b, 17a	Limit PSD Mask level (dBm/Hz) for profile 30a
0	−46.5	−46.5	−46.5
1.5	−46.5	−46.5	−46.5
3	−34.5	−34.5	−34.5
138	−34.5	−34.5	−34.5
f_{0H} = 552	$-34.5 - 10*\log_{10}(f_{0H} - 3)/(138 - 3)$	$-34.5 - 10*\log_{10}(f_{0H} - 3)/(138 - 3)$	$-34.5 - 10*\log_{10}(f_{0H} - 3)/(138 - 3)$
989	−100	−100	−100
1104	−100	−100	−100
3750 − 175	−100	−100	−100
3750	−80	−80	−80
3750	−53 + 3.5	−53 + 3.5	−53 + 3.5
5200	−53 + 3.5	−53 + 3.5	−53 + 3.5
5200	−80	−80	−80
5200 + 175	−100	−100	−100
8500 − 175	−100	−100	−100
8500	−100	−80	−80
8500	−100	−54 + 3.5	−54 + 3.5
12000	−100	−54 + 3.5	−54 + 3.5
12000	−100	−80	−80
12000 + 175	−100	−100	−100

Table A.6 – VTU-R ADLU-128 ~~transmitter~~Limit PSD mask for all-digital mode operation as a function of profile

Frequency (kHz)	Limit PSD Mask level (dBm/Hz) for profiles 8a, 8b, 8c, 8d	Limit PSD Mask level (dBm/Hz) for profiles 12a, 12b, 17a	Limit PSD Mask level (dBm/Hz) for profile 30a
23000 − 175	−100	−100	−100
23000	−100	−100	−80
23000	−100	−100	−60 + 3.5
30000	−100	−100	−60 + 3.5
30000	−110	−110	−80
30175	−110	−110	−110
≥30175	−110	−110	−110

NOTE – The actual transmit PSD shape is further constrained by the total power limit of 14.5 dBm as well as additional spectral compatibility rules imposed by regional authorities.

A.2.2 VTU-O Limit PSD ~~specification~~masks

The Limit PSD mask between the breakpoints is determined using the following interpolation rules:

- For frequencies less than f_1, the breakpoints in Tables A.1 through A.8~~6~~ shall be connected linearly on a plot with the abscissa $\log_{10}(f)$ and the ordinate the Limit PSD mask in dBm/Hz.
- For frequencies above f_1, the breakpoints in Tables A.1 through A.8~~6~~ shall be connected linearly a plot with the abscissa f and the ordinate the Limit PSD mask in dBm/Hz.

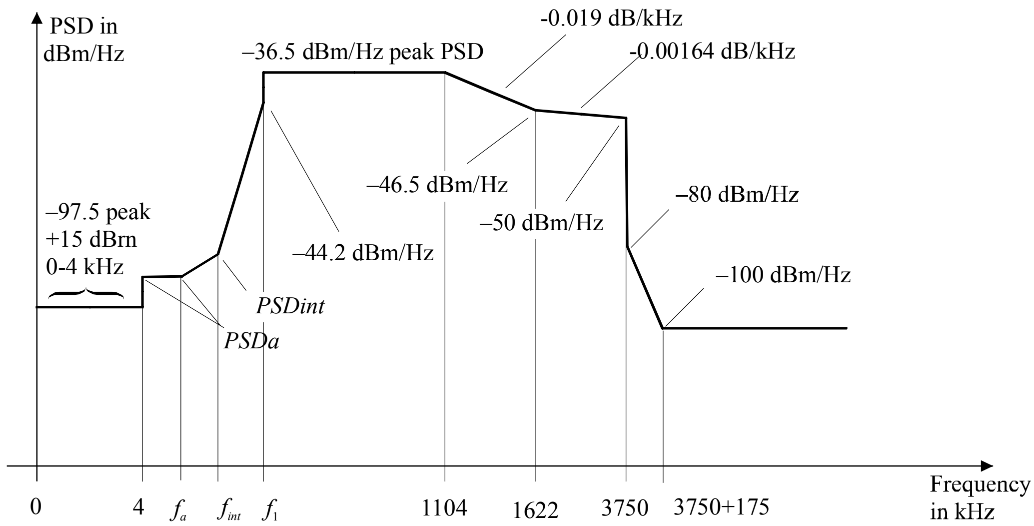

Figure A.6~~4~~ – VTU-O DS1 ~~transmitter~~ Limit PSD mask

Table A.7~~5~~ – VTU-O ~~transmitter~~ Limit PSD mask as a function of profile

Frequency (kHz)	Limit PSD Mask level (dBm/Hz) for profiles 8a, 8b, 8c, 8d, 12a and 12b	Limit PSD Mask level (dBm/Hz) for profile 17a	Limit PSD Mask level (dBm/Hz) for profile 30a
0	−97.5	−97.5	−97.5
4	−97.5	−97.5	−97.5
4	*PSDa* (see Table A.8)	*PSDa* (see Table A.8)	*PSDa* (see Table A.8)
f_a	*PSDa* (see Table A.8)	*PSDa* (see Table A.8)	*PSDa* (see Table A.8)
f_{int}	*PSDint* (see Table A.8)	*PSDint* (see Table A.8)	*PSDint* (see Table A.8)
f_1	−44.2	−44.2	−44.2
f_1	−36.5	−36.5	−36.5
1104	−36.5	−36.5	−36.5
1622	−50 + 3.5	−50 + 3.5	−50 + 3.5
3750	−53.5 + 3.5	−53.5 + 3.5	−53.5 + 3.5
3750	−80	−80	−80
3750 + 175	−100	−100	−100
5200 − 175	−100	−100	−100
5200	−80	−80	−80
5200	−55 + 3.5	−55 + 3.5	−55 + 3.5
8500	−55 + 3.5	−55 + 3.5	−55 + 3.5
8500	−80	−80	−80
8500 + 175	−100	−100	−100
12000 − 175	−100	−100	−100
12000	−100	−80	−80
12000	−100	−60 + 3.5	−60 + 3.5
17664	−100	−60 + 3.5	−60 + 3.5
21000	−100	−80	−60 + 3.5
21450	−100	−100	−60 + 3.5
23000	−100	−100	−60 + 3.5
23000	−100	−100	−80
23000 + 175	−100	−100	−100
30000	−100	−100	−100
≥30000	−110	−110	−110

Table A.~~6~~8 – *PSD_int* and *PSDa* and the frequencies f_1, f_int, and f_a

~~Downstream Mask- Number~~	Designator	f_1 (kHz)	f_{int} (kHz)	*PSDint* (dBm/Hz)	f_a (kHz)	*PSDa* (dBm/Hz)
~~1~~	D-32	138.00	80	−72.5	4	−92.5
	D-48	207.00	155	−62	53	−90
~~9~~	D-64	276.00	227.1	−62	101.2	−90
	D-128 (Note)	552.00	440	-68	240	–90
NOTE – D-128 shall only be used in conjunction with EU-128 or ADLU-128.						

A.~~2.~~3 UPBO reference PSDs

Specification of parameters '*a*' and '*b*' is for further study.

29) Annex B

Replace Annex B with the following:

Annex B

Region B (Europe)

B.1 Band plans

This annex defines the various band plans required for European deployment of VDSL2 systems operating at a maximum frequency of 30 MHz. These are based on ITU-T Rec. G.993.1 [1] band plans A and B (also referred to as plan 998 and plan 997, respectively). The various band plans are defined in Table B.1 below and can be summarized as follows:

Plan 997	The original plan 997 (f_{max} = 12 MHz).
Plan 997E17	Plan 997 directly extended to f_{max} = 17.664 MHz.
Plan 997E30	Plan 997 directly extended to f_{max} = 30 MHz.
	NOTE – Plan 997E17 and plan 997 are truncated versions of plan 997E30.
Plan 998	The original plan 998 (f_{max} = 12 MHz).
Plan 998E17	Plan 998 directly extended to f_{max} = 17.664 MHz.
Plan 998E30	Plan 998 directly extended to f_{max} = 30 MHz.
	NOTE – Plan 998E17 and plan 998 are truncated versions of plan 998E30.
Plan 998ADE17	Plan 998 extended to f_{max} = 17.664 MHz (downstream transmission only above 12 MHz)
Plan 998ADE30	Plan 998 extended to f_{max} = 30 MHz.
	NOTE – Plan 998ADE17 and plan 998 are truncated versions of plan 998ADE30.
Plan HPE17	Band plan for operation between 7.05 MHz and 17.664 MHz.
Plan HPE30	Band plan for operation between 7.05 MHz and 30 MHz.
	NOTE – Plan HPE17 is a truncated version of plan HPE30.

Different variants are defined for band plans 997, 998, 998E17, 998E30, 998ADE17 and 998ADE30 to accommodate different underlying services (POTS and ISDN), and different US0 bandwidths.

Table B.1 – Band-edge frequencies for European VDSL2 band plans

Band plan	Band-edge frequencies (as defined in the generic band plan in 7.1.2)										
	f_{0L} kHz	f_{0H} kHz	f_1 kHz	f_2 kHz	f_3 kHz	f_4 kHz	f_5 kHz	f_6 kHz	f_7 kHz	f_8 kHz	f_9 kHz
	US0		DS1	US1	DS2	US2	DS3	US3	DS4	US4	
997	25	138	138	3000	5100	7050	12000	N/A	N/A	N/A	N/A
	25	276	276								
997E17	25	138	138	3000	5100	7050	12000	14000	17664	N/A	N/A
997E30	N/A	N/A	138	3000	5100	7050	12000	14000	19500	27000	30000
	US0		DS1	US1	DS2	US2	US3	DS3	US4	DS4	
998	25	138	138	3750	5200	8500	12000	N/A	N/A	N/A	N/A
	25	276	276								
	120	276	276								
	N/A	N/A	138								
998E17	N/A	N/A	138	3750	5200	8500	12000	14000	17664	N/A	N/A
	N/A	N/A	276	3750	5200	8500	12000	14000	17664	N/A	N/A
998E30	N/A	N/A	138	3750	5200	8500	12000	14000	21450	24890	30000
	N/A	N/A	276	3750	5200	8500	12000	14000	21450	24890	30000
	US0		DS1	US1	DS2	US2	DS3	US3			
998ADE17	25	138	138	3750	5200	8500	12000	17664	N/A		
	120	276	276								
	N/A	N/A	276								

Table B.1 – Band-edge frequencies for European VDSL2 band plans

Band plan	Band-edge frequencies (as defined in the generic band plan in 7.1.2)										
	f_{0L} kHz	f_{0H} kHz	f_1 kHz	f_2 kHz	f_3 kHz	f_4 kHz	f_5 kHz	f_6 kHz	f_7 kHz	f_8 kHz	f_9 kHz
998ADE30	N/A	N/A	138	3750	5200	8500	12000	24890	30000		
	N/A	N/A	276								
						DS2	US2	US3	DS3	US4	DS4
HPE17	N/A	N/A	N/A	N/A	7050	10125	12000	14000	17664	N/A	N/A
HPE30	N/A	N/A	N/A	N/A	7050	10125	12000	14000	21450	24890	30000

NOTE 1 – Flexibility in the bandwidth used for US0 is under study in ETSI TC-TM6.

NOTE 2 – N/A in the columns f_{0L} and f_{0H} designates a band plan variant that does not use US0.

NOTE 3 – The support of US0 together with profile 17a is not required. This band plan and PSD definitions are given in case profile 17a and US0 are selected during handshake.

The f_i in Table B.1 are defined as follows:

- f_{0L} and f_{0H} : define lower and upper frequency of US0;
- f_1 to f_5 are the boundary frequencies of the bands DS1, US1, DS2, US2 as defined for VDSL1 for 997 and 998;
- f_5 to f_9 are the boundary frequencies for the bands US3, DS3, US4 and DS4 (extended bands);
- The extension of an existing band is considered as a separate band (e.g., 998E17: US3 12 MHz-14 MHz).

B.2 Limit PSD mask options

The Limit PSD mask options defined in this annex are shown in Tables B.2 and B.3, for various band plans.

Table B.2 – European Limit PSD mask options for band plans 997 (and its extensions), HPE17 and HPE30

Short name	Limit PSD mask (Long name)	Frequency	
		US0 type A/B/M (see Note)	Highest used upstream or downstream frequency (kHz)
B7-1	997-M1c-A-7	A	7050
B7-2	997-M1x-M-8	M	8832
B7-3	997-M1x-M	M	12000
B7-4	997-M2x-M-8	M	8832
B7-5	997-M2x-A	A	12000
B7-6	997-M2x-M	M	12000
B7-7	HPE17-M1-NUS0	N/A	17664
B7-8	HPE30-M1-NUS0	N/A	30000
B7-9	997E17-M2x-A	A	17664
B7-10	997E30-M2x-NUS0	N/A	30000
NOTE – The US0 types stand for: • US0 type A corresponds to Annex A/G.992.5; • US0 type B corresponds to Annex B/G.992.5; • US0 type M corresponds to Annex M/G.992.3/G.992.5; • US0 type N/A designates a band plan variant that does not use US0.			

Table B.3 – European Limit PSD mask options for band plan 998 (and its extensions)

Short name	Limit PSD Mask (Long name)	Frequency	
		US0 type A/B/M (see Note)	Highest used upstream or downstream frequency (kHz)
B8-1	998-M1x-A	A	12000
B8-2	998-M1x-B	B	12000
B8-3	998-M1x-NUS0	N/A	12000
B8-4	998-M2x-A	A	12000
B8-5	998-M2x-M	M	12000
B8-6	998-M2x-B	B	12000

Table B.3 – European Limit PSD mask options for band plan 998 (and its extensions)

Short name	Limit PSD Mask (Long name)	Frequency	
		US0 type A/B/M (see Note)	**Highest used upstream or downstream frequency (kHz)**
B8-7	998-M2x-NUS0	N/A	12000
B8-8	998E17-M2x-NUS0	N/A	17664
B8-9	998E17-M2x-NUS0-M	N/A	17664
B8-10	998ADE17-M2x-NUS0-M	N/A	17664
B8-11	998ADE17-M2x-A	A	17664
B8-12	998ADE17-M2x-B	B	17664
B8-13	998E30-M2x-NUS0	N/A	30000
B8-14	998E30-M2x-NUS0-M	N/A	30000
B8-15	998ADE30-M2x-NUS0-M	N/A	30000
B8-16	998ADE30-M2x-NUS0-A	N/A	30000

NOTE – The US0 types stand for:
- US0 type A corresponds to Annex A/G.992.5;
- US0 type B corresponds to Annex B/G.992.5;
- US0 type M corresponds to Annex M/G.992.3/G.992.5;
- US0 type N/A designates a band plan variant that does not use US0;
- 998Exx-M2x-NUS0-M designate the variants in which DS1 starts at 276 kHz instead of 138 kHz.

B.2.1 General requirements in the band below 4 kHz

A psophometric weighted measurement limit for the PSD within the band 0 to 4 kHz is for further study. This would require the power in the band to be measured with a psophometric weighting as defined in Annex A/O.41.

B.2.2 VTU-R Limit PSD masks for band plans 997 (and its extensions), HPE17 and HPE30

Table B.4 – VTU-R Limit PSD masks for band plans 997 (and its extensions), HPE17 and HPE30

Name	**B7-1**	**B7-2**	**B7-3**	**B7-4**	**B7-5**	**B7-6**	**B7-7**	**B7-8**	**B7-9**	**B7-10**
Long name	**997-M1-c-A-7**	**997-M1-x-M-8**	**997-M1-x-M**	**997-M2x-M-8**	**997-M2x-A**	**997-M2x-M**	**HPE17-M1-NUS0**	**HPE30-M1-NUS0**	**997E17-M2x-A**	**997E30-M2x-NUS0**
kHz	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**
0	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–100	–100	–97.5	–100
4	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–100	–100	–97.5	–100
4	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–100	–100	–97.5	–100

Table B.4 – VTU-R Limit PSD masks for band plans 997 (and its extensions), HPE17 and HPE30

Name	**B7-1**	**B7-2**	**B7-3**	**B7-4**	**B7-5**	**B7-6**	**B7-7**	**B7-8**	**B7-9**	**B7-10**
Long name	**997-M1-c-A-7**	**997-M1-x-M-8**	**997-M1-x-M**	**997-M2x-M-8**	**997-M2x-A**	**997-M2x-M**	**HPE17-M1-NUS0**	**HPE30-M1-NUS0**	**997E17-M2x-A**	**997E30-M2x-NUS0**
kHz	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**
25.875	–34.5	–37.5	–37.5	–37.5	–34.5	–37.5	–100	–100	–34.5	–100
50	–34.5	–37.5	–37.5	–37.5	–34.5	–37.5	–100	–100	–34.5	–100
80	–34.5	–37.5	–37.5	–37.5	–34.5	–37.5	–100	–100	–34.5	–100
120	–34.5	–37.5	–37.5	–37.5	–34.5	–37.5	–100	–100	–34.5	–100
138	–34.5	–37.5	–37.5	–37.5	–34.5	–37.5	–100	–100	–34.5	–100
225	Interp	–37.5	–37.5	–37.5	Interp	–37.5	–100	–100	Interp	–100
243	–93.2	–37.5	–37.5	–37.5	–93.2	–37.5	–100	–100	–93.2	–100
276	Interp	–37.5	–37.5	–37.5	Interp	–37.5	–100	–100	Interp	–100
493.41	Interp	–97.9	–97.9	–97.9	Interp	–97.9	–100	–100	Interp	–100
686	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
2825	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
3000	–80	–80	–80	–80	–80	–80	–100	–100	–80	–80
3000	–56.5	–56.5	–56.5	–50.3	–50.3	–50.3	–100	–100	–50.3	–50.3
3575	–56.5	–56.5	–56.5	Interp	Interp	Interp	–100	–100	Interp	Interp
3750	–56.5	–56.5	–56.5	Interp	Interp	Interp	–100	–100	Interp	Interp
5100	–56.5	–56.5	–56.5	–52.6	–52.6	–52.6	–100	–100	–52.6	–52.6
5100	–80	–80	–80	–80	–80	–80	–100	–100	–80	–80
5275	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
6875	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
7050	–100	–80	–80	–80	–80	–80	–100	–100	–80	–80
7050	–100	–56.5	–56.5	–54	–54	–54	–100	–100	–54	–54
8325	–100	–56.5	–56.5	Interp	Interp	Interp	–100	–100	Interp	Interp
9950	–100	–56.5	–56.5	Interp	Interp	Interp	–100	–100	Interp	Interp
10125	–100	–56.5	–56.5	–55.5	–55.5	–55.5	–80	–80	–55.5	–55.5
10125	–100	–56.5	–56.5	–55.5	–55.5	–55.5	–56.5	–56.5	–55.5	–55.5
12000	–100	–56.5	–56.5	–55.5	–55.5	–55.5	–56.5	–56.5	–55.5	–55.5
12000	–100	–80	–80	–80	–80	–80	–56.5	–56.5	–80	–80
12175	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100
13825	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100
14000	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–80	–80
14000	–100	–100	–100	–100	–100	–100	–80	–80	–56.5	–56.5
14175	–100	–100	–100	–100	–100	–100	–100	–100	Interp	Interp
17664	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5
19500	–100	–100	–100	–100	–100	–100	–100	–100	–80	–56.5
19500	–100	–100	–100	–100	–100	–100	–100	–100	–80	–80
19675	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100

Table B.4 – VTU-R Limit PSD masks for band plans 997 (and its extensions), HPE17 and HPE30

Name	B7-1	B7-2	B7-3	B7-4	B7-5	B7-6	B7-7	B7-8	B7-9	B7-10
Long name	997-M1-c-A-7	997-M1-x-M-8	997-M1-x-M	997-M2x-M-8	997-M2x-A	997-M2x-M	HPE17-M1-NUS0	HPE30-M1-NUS0	997E17-M2x-A	997E30-M2x-NUS0
kHz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz
21275	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
21450	–100	–100	–100	–100	–100	–100	–100	–80	–100	–100
21450	–100	–100	–100	–100	–100	–100	–100	–56.5	–100	–100
24890	–100	–100	–100	–100	–100	–100	–100	–56.5	–100	–100
24890	–100	–100	–100	–100	–100	–100	–100	–80	–100	–100
25065	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
26825	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
27000	–100	–100	–100	–100	–100	–100	–100	–100	–100	–80
27000	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5
30000	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5
30000	110	110	110	110	110	110	110	110	110	–80
30175	110	110	110	110	110	110	110	110	110	110
≥30175	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110
NOTE – The PSD values between breakpoints including the values marked by "Interp" shall be obtained by interpolation between adjacent breakpoints as follows: – below 2825 kHz on a dB/log(*f*) basis; and – above 2825 kHz on a dB/*f* basis.										

NOTE – In the limit PSD masks B7-2 and B7-4, the PSD above 8832 kHz should be considered preliminary. Reduction in the mask in the band from 8832 kHz to 12000 kHz is for further study. The minimum roll-off of the anti-alias filter should be specified to limit unnecessary FEXT to full bandwidth solutions sharing the same cable, to protect the amateur radio band (10.10 MHz to 10.15 MHz), and to provide flexibility for future band plan evolution.

B.2.3 VTU-O Limit PSD masks for band plans 997 (and its extensions), HPE17 and HPE30

Table B.5 – VTU-O Limit PSD masks for band plans 997 (and its extensions), HPE17 and HPE30

Name	B7-1	B7-2	B7-3	B7-4	B7-5	B7-6	B7-7	B7-8	B7-9	B7-10
Long name	997-M1c-A-7	997-M1x-M-8	997-M1x-M	997-M2x-M-8	997-M2x-A	997-M2x-M	HPE17-M1-NUS0	HPE30-M1-NUS0	997E17-M2x-A	997E30-M2x-NUS0
kHz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz
0	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5
4	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5
4	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–97.5	–97.5	–92.5	–92.5
80	–72.5	–92.5	–92.5	–92.5	–72.5	–92.5	–97.5	–97.5	–72.5	–72.5

Table B.5 – VTU-O Limit PSD masks for band plans 997 (and its extensions), HPE17 and HPE30

Name	B7-1	B7-2	B7-3	B7-4	B7-5	B7-6	B7-7	B7-8	B7-9	B7-10
Long name	997-M1c-A-7	997-M1x-M-8	997-M1x-M	997-M2x-M-8	997-M2x-A	997-M2x-M	HPE17-M1-NUS0	HPE30-M1-NUS0	997E17-M2x-A	997E30-M2x-NUS0
kHz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz
101.2	Interp	–92.5	–92.5	–92.5	Interp	–92.5	–97.5	–97.5	Interp	Interp
138	–49.5	Interp	Interp	Interp	–44.2	Interp	–100	–100	–44.2	–44.2
138	–49.5	Interp	Interp	Interp	–36.5	Interp	–100	–100	–36.5	–36.5
227.11	–49.5	–62	–62	–62	–36.5	–62	–100	–100	–36.5	–36.5
276	–49.5	–48.5	–48.5	–48.5	–36.5	–48.5	–100	–100	–36.5	–36.5
276	–49.5	–36.5	–36.5	–36.5	–36.5	–36.5	–100	–100	–36.5	–36.5
1104	–49.5	–36.5	–36.5	–36.5	–36.5	–36.5	–100	–100	–36.5	–36.5
1622	–49.5	–46.5	–46.5	–46.5	–46.5	–46.5	–100	–100	–46.5	–46.5
2208	–49.5	–48	–48	Interp	Interp	Interp	–100	–100	Interp	Interp
2236	–49.5	Interp	Interp	Interp	Interp	Interp	–100	–100	Interp	Interp
2249	–49.5	–49.5	–49.5	Interp	Interp	Interp	–100	–100	Interp	Interp
2423	–56.5	Interp	Interp	Interp	Interp	Interp	–100	–100	Interp	Interp
2500	–56.5	–56.5	–56.5	Interp	Interp	Interp	–100	–100	Interp	Interp
3000	–56.5	–56.5	–56.5	–49.6	–49.6	–49.6	–100	–100	–49.6	–49.6
3000	–80	–80	–80	–80	–80	–80	–100	–100	–80	–80
3175	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
4925	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
5100	–80	–80	–80	–80	–80	–80	–100	–100	–80	–80
5100	–56.5	–56.5	–56.5	–52.6	–52.6	–52.6	–100	–100	–52.6	–52.6
5200	–56.5	–56.5	–56.5	Interp	Interp	Interp	–100	–100	Interp	Interp
6875	–56.5	–56.5	–56.5	Interp	Interp	Interp	–100	–100	Interp	Interp
7050	–56.5	–56.5	–56.5	–54	–54	–54	–80	–80	–54	–54
7050	–80	–80	–80	–80	–80	–80	–56.5	–56.5	–80	–80
7225	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100
10125	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100
10125	–100	–100	–100	–100	–100	–100	–80	–80	–100	–100
10300	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
11825	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
12000	–100	–100	–100	–100	–100	–100	–100	–100	–80	–80
12000	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5
13825	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5
14000	–100	–100	–100	–100	–100	–100	–80	–80	–56.5	–56.5
14000	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–80	–80
14175	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100
17664	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100
19325	–100	–100	–100	–100	–100	–100	Interp	–56.5	–100	–100

Table B.5 – VTU-O Limit PSD masks for band plans 997 (and its extensions), HPE17 and HPE30

Name	B7-1	B7-2	B7-3	B7-4	B7-5	B7-6	B7-7	B7-8	B7-9	B7-10
Long name	**997-M1c-A-7**	**997-M1x-M-8**	**997-M1x-M**	**997-M2x-M-8**	**997-M2x-A**	**997-M2x-M**	**HPE17-M1-NUS0**	**HPE30-M1-NUS0**	**997E17-M2x-A**	**997E30-M2x-NUS0**
kHz	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**
19500	–100	–100	–100	–100	–100	–100	Interp	–56.5	–100	–80
19500	–100	–100	–100	–100	–100	–100	Interp	–56.5	–100	–56.5
21000	–100	–100	–100	–100	–100	–100	–80	–56.5	–100	–56.5
21450	–100	–100	–100	–100	–100	–100	–100	–56.5	–100	–56.5
21450	–100	–100	–100	–100	–100	–100	–100	–80	–100	–56.5
21625	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5
24715	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5
24890	–100	–100	–100	–100	–100	–100	–100	–80	–100	–56.5
24890	–100	–100	–100	–100	–100	–100	–100	–56.5	–100	–56.5
27000	–100	–100	–100	–100	–100	–100	–100	–56.5	–100	–56.5
27000	–100	–100	–100	–100	–100	–100	–100	–56.5	–100	–80
27175	–100	–100	–100	–100	–100	–100	–100	–56.5	–100	–100
30000	–100	–100	–100	–100	–100	–100	–100	–56.5	–100	–100
30000	–110	–110	–110	–110	–110	–110	–110	–80	–110	–110
30175	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110
≥30175	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110

NOTE – The PSD values between breakpoints including the values marked by "Interp" shall be obtained by interpolation between adjacent breakpoints as follows:

– below f_1 on a dB/log(f) basis; and
– above f_1 on a dB/f basis,

where f_1 is defined in Table B.1 as either 138 or 276 kHz.

For Limit PSD masks B7-7 and B7-8, where f_1 is N/A, the PSD values between breakpoints including the values marked by "Interp" shall be obtained by interpolation between adjacent breakpoints as follows:

– below 138 kHz on a dB/log(f) basis; and
– above 138 kHz on a dB/f basis.

B.2.4 VTU-R Limit PSD masks for band plan 998 (and its extensions)

Table B.6 – VTU-R Limit PSD masks for band plan 998 (and its extensions)

Name	B8-1	B8-2	B8-3	B8-4	B8-5	B8-6	B8-7	B8-8	B8-9	B8-10	B8-11	B8-12	B8-13	B8-14	B8-15	B8-16
Long name	998-M1x-A	998-M1x-B	998-M1x-NUS0	998-M2x-A	998-M2x-M	998-M2x-B	998-M2x-NUS0	998E17-M2x-NUS0	998E17-M2x-NUS0-M	998ADE17-M2x-NUS0-M	998ADE17-M2x-A	998ADE17-M2x-B	998E30-M2x-NUS0	998E30-M2x-NUS0-M	998ADE30-M2x-NUS0-M	998ADE30-M2x-NUS0-A
kHz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz
0	–97.5	–97.5	–100	–97.5	–97.5	–97.5	–100	–100	–100	–100	–97.5	–97.5	–100	–100	–100	–100
4	–97.5	–97.5	–100	–97.5	–97.5	–97.5	–100	–100	–100	–100	–97.5	–97.5	–100	–100	–100	–100
4	–92.5	–92.5	–100	–92.5	–92.5	–92.5	–100	–100	–100	–100	–92.5	–92.5	–100	–100	–100	–100
25.875	–34.5	Interp	–100	–34.5	–37.5	–92.5	–100	–100	–100	–100	–34.5	–92.5	–100	–100	–100	–100
50	–34.5	–90	–100	–34.5	–37.5	–90	–100	–100	–100	–100	–34.5	–90	–100	–100	–100	–100
80	–34.5	–81.8	–100	–34.5	–37.5	–81.8	–100	–100	–100	–100	–34.5	–81.8	–100	–100	–100	–100
120	–34.5	–34.5	–100	–34.5	–37.5	–34.5	–100	–100	–100	–100	–34.5	–34.5	–100	–100	–100	–100
138	–34.5	–34.5	–100	–34.5	–37.5	–34.5	–100	–100	–100	–100	–34.5	–34.5	–100	–100	–100	–100
225	Interp	–34.5	–100	Interp	–37.5	–34.5	–100	–100	–100	–100	Interp	–34.5	–100	–100	–100	–100
243	–93.2	–34.5	–100	–93.2	–37.5	–34.5	–100	–100	–100	–100	–93.2	–34.5	–100	–100	–100	–100
276	Interp	–34.5	–100	Interp	–37.5	–34.5	–100	–100	–100	–100	Interp	–34.5	–100	–100	–100	–100
307	Interp	Interp	–100	Interp	Interp	Interp	–100	–100	–100	–100	Interp	Interp	–100	–100	–100	–100
493.41	Interp	Interp	–100	Interp	–97.9	Interp	–100	–100	–100	–100	Interp	Interp	–100	–100	–100	–100
508.8	Interp	–98	–100	Interp	Interp	–98	–100	–100	–100	–100	Interp	–98	–100	–100	–100	–100
686	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
3575	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
3750	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80
3750	–56.5	–56.5	–56.5	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2

Table B.6 – VTU-R Limit PSD masks for band plan 998 (and its extensions)

Name	B8-1	B8-2	B8-3	B8-4	B8-5	B8-6	B8-7	B8-8	B8-9	B8-10	B8-11	B8-12	B8-13	B8-14	B8-15	B8-16
Long name	998-M1x-A	998-M1x-B	998-M1x-NUS0	998-M2x-A	998-M2x-M	998-M2x-B	998-M2x-NUS0	998E17-M2x-NUS0	998E17-M2x-NUS0-M	998ADE17-M2x-NUS0-M	998ADE17-M2x-A	998ADE17-M2x-B	998E30-M2x-NUS0	998E30-M2x-NUS0-M	998ADE30-M2x-NUS0-M	998ADE30-M2x-NUS0-A
kHz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz	dBm/Hz
5100	–56.5	–56.5	–56.5	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp
5200	–56.5	–56.5	–56.5	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7
5200	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80
5375	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
8325	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
8500	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80
8500	–56.5	–56.5	–56.5	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8
10000	–56.5	–56.5	–56.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5
12000	–56.5	–56.5	–56.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5	–55.5
12000	–80	–80	–80	–80	–80	–80	–80	–56.5	–56.5	–80	–80	–80	–56.5	–56.5	–80	–80
12175	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100	–100	–56.5	–56.5	–100	–100
14000	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100	–100	–56.5	–56.5	–100	–100
14000	–100	–100	–100	–100	–100	–100	–100	–80	–80	–100	–100	–100	–80	–80	–100	–100
14175	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
21275	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
21450	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–80	–80	–100	–100
21450	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100
24715	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100
24890	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–80	–80
24890	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–80	–80	–56.5	–56.5

Table B.6 – VTU-R Limit PSD masks for band plan 998 (and its extensions)

Name	B8-1	B8-2	B8-3	B8-4	B8-5	B8-6	B8-7	B8-8	B8-9	B8-10	B8-11	B8-12	B8-13	B8-14	B8-15	B8-16
Long name	**998-M1x-A**	**998-M1x-B**	**998-M1x-NUS0**	**998-M2x-A**	**998-M2x-M**	**998-M2x-B**	**998-M2x-NUS0**	**998E17-M2x-NUS0**	**998E17-M2x-NUS0-M**	**998ADE17-M2x-NUS0-M**	**998ADE17-M2x-A**	**998ADE17-M2x-B**	**998E30-M2x-NUS0**	**998E30-M2x-NUS0-M**	**998ADE30-M2x-NUS0-M**	**998ADE30-M2x-NUS0-A**
kHz	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**
25065	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5
30000	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5
30000	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–80	–80
30175	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110
≥30175	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110

NOTE – The PSD values between breakpoints including the values marked by "Interp" shall be obtained by interpolation between adjacent breakpoints as follows:

– below 3575 kHz on a dB/log(*f*) basis; and
– above 3575 kHz on a dB/*f* basis.

B.2.5 VTU-O Limit PSD masks for band plan 998 (and its extensions)

Table B.7 – VTU-O Limit PSD masks for band plan 998 (and its extensions)

Name	**B8-1**	**B8-2**	**B8-3**	**B8-4**	**B8-5**	**B8-6**	**B8-7**	**B8-8**	**B8-9**	**B8-10**	**B8-11**	**B8-12**	**B8-13**	**B8-14**	**B8-15**	**B8-16**
Long name	**998-M1x-A**	**998-M1x-B**	**998-M1x-NUS0**	**998-M2x-A**	**998-M2x-M**	**998-M2x-B**	**998-M2x-NUS0**	**998E17-M2x-NUS0**	**998E17-M2x-NUS0-M**	**998ADE17-M2x-NUS0-M**	**998ADE17-M2x-A**	**998ADE17-M2x-B**	**998E30-M2x-NUS0**	**998E30-M2x-NUS0-M**	**998ADE30-M2x-NUS0-M**	**998ADE30-M2x-NUS0-A**
kHz	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**
0	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5
4	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5	–97.5
4	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5	–92.5
80	–72.5	–92.5	–72.5	–72.5	–92.5	–92.5	–72.5	–72.5	–92.5	–92.5	–72.5	–92.5	–72.5	–92.5	–92.5	–72.5
101.2	Interp	–92.5	Interp	Interp	–92.5	–92.5	Interp	Interp	–92.5	–92.5	Interp	–92.5	Interp	–92.5	–92.5	Interp
138	–44.2	Interp	–44.2	–44.2	Interp	Interp	–44.2	–44.2	Interp	Interp	–44.2	Interp	–44.2	Interp	Interp	–44.2
138	–36.5	Interp	–36.5	–36.5	Interp	Interp	–36.5	–36.5	Interp	Interp	–36.5	Interp	–36.5	Interp	Interp	–36.5
227.11	–36.5	–62	–36.5	–36.5	–62	–62	–36.5	–36.5	–62	–62	–36.5	–62	–36.5	–62	–62	–36.5
276	–36.5	–48.5	–36.5	–36.5	–48.5	–48.5	–36.5	–36.5	–48.5	–48.5	–36.5	–48.5	–36.5	–48.5	–48.5	–36.5
276	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5
1104	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5	–36.5
1622	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5	–46.5
2208	–48	–48	–48	–48	–48	–48	–48	–48	–48	–48	–48	–48	–48	–48	–48	–48
2249	–49.5	–49.5	–49.5	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp
2500	–56.5	–56.5	–56.5	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp
3750	–56.5	–56.5	–56.5	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2	–51.2
3750	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80
3925	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
5025	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
5200	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80
5200	–56.5	–56.5	–56.5	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7	–52.7
7050	–56.5	–56.5	–56.5	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp

Table B.7 – VTU-O Limit PSD masks for band plan 998 (and its extensions)

Name	**B8-1**	**B8-2**	**B8-3**	**B8-4**	**B8-5**	**B8-6**	**B8-7**	**B8-8**	**B8-9**	**B8-10**	**B8-11**	**B8-12**	**B8-13**	**B8-14**	**B8-15**	**B8-16**
Long name	**998-M1x-A**	**998-M1x-B**	**998-M1x-NUS0**	**998-M2x-A**	**998-M2x-M**	**998-M2x-B**	**998-M2x-NUS0**	**998E17-M2x-NUS0**	**998E17-M2x-NUS0-M**	**998ADE17-M2x-NUS0-M**	**998ADE17-M2x-A**	**998ADE17-M2x-B**	**998E30-M2x-NUS0**	**998E30-M2x-NUS0-M**	**998ADE30-M2x-NUS0-M**	**998ADE30-M2x-NUS0-A**
kHz	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**
7225	–56.5	–56.5	–56.5	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp	Interp
8500	–56.5	–56.5	–56.5	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8	–54.8
8500	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80	–80
8675	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
11825	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100
12000	–100	–100	–100	–100	–100	–100	–100	–100	–100	–80	–80	–80	–100	–100	–80	–80
12000	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–56.5	–100	–100	–56.5	–56.5
13825	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–56.5	–100	–100	–56.5	–56.5
14000	–100	–100	–100	–100	–100	–100	–100	–80	–80	–56.5	–56.5	–56.5	–80	–80	–56.5	–56.5
14000	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–56.5	–56.5	–56.5	–56.5	–56.5	–56.5	–56.5
17664	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–56.5	–56.5	–56.5	–56.5	–56.5	–56.5	–56.5
21000	–100	–100	–100	–100	–100	–100	–100	–80	–80	–80	–80	–80	–56.5	–56.5	–56.5	–56.5
21450	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–56.5	–56.5
21450	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–80	–80	–56.5	–56.5
21625	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5
24715	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5
24890	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–80	–80	–56.5	–56.5
24890	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–80	–80
25065	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100
30000	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–100	–56.5	–56.5	–100	–100

Table B.7 – VTU-O Limit PSD masks for band plan 998 (and its extensions)

Name	B8-1	B8-2	B8-3	B8-4	B8-5	B8-6	B8-7	B8-8	B8-9	B8-10	B8-11	B8-12	B8-13	B8-14	B8-15	B8-16
Long name	**998-M1x-A**	**998-M1x-B**	**998-M1x-NUS0**	**998-M2x-A**	**998-M2x-M**	**998-M2x-B**	**998-M2x-NUS0**	**998E17-M2x-NUS0**	**998E17-M2x-NUS0-M**	**998ADE17-M2x-NUS0-M**	**998ADE17-M2x-A**	**998ADE17-M2x-B**	**998E30-M2x-NUS0**	**998E30-M2x-NUS0-M**	**998ADE30-M2x-NUS0-M**	**998ADE30-M2x-NUS0-A**
kHz	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**	**dBm/Hz**
30000	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–80	–80	–110	–110
30175	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110
≥30175	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110	–110

NOTE – The PSD values between breakpoints including the values marked by "Interp" shall be obtained by interpolation between adjacent breakpoints as follows:

– below f_I on a dB/log(f) basis; and
– above f_I on a dB/f basis,

where f_I is defined in Table B.1 as either 138 kHz or 276 kHz.

B.3 UPBO reference PSDs

Specification of parameters '*a*' and '*b*' is for further study.

B.4 Transmit PSD mask options

Transmit PSD mask options are for further study.

B.5 Template PSD

B.5.1 Definition

The Template PSD is set to 3.5 dB below the PSD mask in frequency bands in which the PSD is at or above −96.5 dBm/Hz. Elsewhere the template is set to −100 dBm/Hz below 4 MHz, −110 dBm/Hz between 4 MHz and f_3, or −112 dBm/Hz between f_3 and 30 MHz, where f_3 is defined in Table B.1. These values are chosen to satisfy the requirements of 7.2.2.

B.5.2 Narrow-band PSD verification

Narrow-band compliance with the PSD masks in this annex shall be verified by power measurements using a 10-kHz measurement bandwidth centred on the frequency in question above 4 kHz, and in a 100-Hz measurement bandwidth in the band up to 4 kHz.

B.5.3 Wideband PSD verification

Verification of the Template PSD is for further study.

NOTE 1 – In the interim, the method described in ETSI Technical Specification TS 101 270-1 V1.3.1 (2003-07) Annex E may be used. The Template PSD, as defined above, would be used as the 'template' in the method defined in this Recommendation.

NOTE 2 – Wideband PSD limits are defined to verify conformance with stopband PSD requirements in Table 7-2, and to verify that the in-band PSD is consistent with the template as an expectation of the transmitter PSD taking into account fine gain adjustments, filter ripple, and manufacturing variability.

B.5.4 Use in simulation (Informative)

The Template PSD may be used in simulations of VDSL2 performance as representative of an average transmitter conformant with the associated Limit PSD mask.

B.6 Compliance

Compliance requires meeting either of the generic or specific compliance rules below.

B.6.1 Generic compliance

Generic compliance requires conformance with at least one Limit PSD mask.

B.6.2 Specific compliance

Specific compliance requires conformance with at least one transmit PSD mask (see B.4).

30) Annex C

Revise Annex C as follows:

Annex C

Region C (Japan)

C.1 Band plan

The band plan shall be specified as shown in Figure C.1. According to the profiles defined in Table 6-1, adequate subsets of US0, DS1, US1, DS2, US2, DS3, and US3 shall be selected. The transition frequency between US0 and DS1 is 138 kHz or 276 kHz as defined in C.2.1.~~The use of US0 is for further study.~~

US0	DS1	US1	DS2	US2	DS3	US3

.025 3.75 5.2 8.5 12 18.1 30 MHz

Figure C.1 – The band plan between 25 kHz and 30 MHz

C.2 Limit PSD masks

~~C.2.1 Transmit signal PSD masks~~

C.2.1~~.1~~ VDSL2 system operating at frequencies above the POTS band

The frequencies above 25 kHz are used for VDSL2. ~~The use of US0 is for further study. For frequencies above US0 and below 11.825 MHz, the PSDs shall comply with Annex F.1.2.1/G.993.1 [1]. For frequencies above 11.825 MHz, t~~The downstream PSD shall comply with the Limit PSD masks defined in Table C.1, Table C.2, Table C.5 or Table C.6 and the upstream PSD shall comply with the PSD masks defined in Table C.3, Table C.4, Table C.7 or Table C.8. Other PSD limitations are for further study.

Table C.1 – VTU-O Limit PSD mask (VDSL2 above POTS band; 25-138 kHz Type(b))

Band attribute	Frequency band f (MHz)	Limit PSD mask level (dBm/Hz)	Maximum power limitation in a 1-MHz sliding window (dBm)
DS1	$0 < f < 0.12$	–120	–
	$0.12 \le f \le 0.138$	$-60 + (50/0.018) \times (f - 0.138)$	–
	$0.138 < f < 3.75$	–60 + 3.5 (= –56.5)	–
	$3.75 \le f \le 3.925$	$-80 - (20/0.175) \times (f - 3.75)$	–
	$3.925 < f < 5.025$	–100	–50
	$5.025 \le f \le 5.2$	$-80 + (20/0.175) \times (f - 5.2)$	–
DS2	$5.2 < f < 8.5$	–60 + 3.5 (= –56.5)	–
	$8.5 \le f \le 8.675$	$-80 - (20/0.175) \times (f - 8.5)$	–
	$8.675 < f < 11.825$	–100	–52
	$11.825 \le f \le 12$	$-80 + (20/0.175) \times (f - 12)$	–
DS3	$12 < f < 18.1$	–60 + 3.5 (= –56.5)	–
	$18.1 \le f \le 18.275$	$-80 - (20/0.175) \times (f - 18.1)$	–
	$18.275 < f < 30$	–100	–52
	$30 \le f$	–110	–

NOTE 1 – All PSD and power measurements are in 100 Ω.

NOTE 2 – The Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

Table C.2 – VTU-O Limit PSD mask (VDSL2 above POTS band; 25-276 kHz Type(b))

Band attribute	Frequency band f (MHz)	Limit PSD mask level (dBm/Hz)	Maximum power limitation in a 1-MHz sliding window (dBm)
DS1	$0 < f < 0.12$	–120	–
	$0.12 \le f < 0.225$	–110	–
	$0.225 \le f \le 0.276$	$-60 + (50/0.051) \times (f - 0.276)$	–
	$0.276 < f < 3.75$	–60 + 3.5 (= –56.5)	–
	$3.75 \le f \le 3.925$	$-80 - (20/0.175) \times (f - 3.75)$	–
	$3.925 < f < 5.025$	–100	–50
	$5.025 \le f \le 5.2$	$-80 + (20/0.175) \times (f - 5.2)$	–
DS2	$5.2 < f < 8.5$	–60 + 3.5 (= –56.5)	–
	$8.5 \le f \le 8.675$	$-80 - (20/0.175) \times (f - 8.5)$	–
	$8.675 < f < 11.825$	–100	–52
	$11.825 \le f \le 12$	$-80 + (20/0.175) \times (f - 12)$	–
DS3	$12 < f < 18.1$	–60 + 3.5 (= –56.5)	–
	$18.1 \le f \le 18.275$	$-80 - (20/0.175) \times (f - 18.1)$	–
	$18.275 < f < 30$	–100	–52
	$30 \le f$	–110	–

NOTE 1 – All PSD and power measurements are in 100 Ω.

NOTE 2 – The Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

Table C.3 – VTU-R Limit PSD mask (VDSL2 above POTS band; 25-138 kHz Type(b))

Band attribute	Frequency band f (MHz)	Limit PSD mask level (dBm/Hz)	Maximum power limitation in a 1-MHz sliding window (dBm)
US0	$0 < f < 0.004$	–97.5	–
	$0.004 \le f \le 0.025875$	$-92.5 + 13.4 \times \log_2(f/0.004)$	–
	$0.025875 < f < 0.138$	–60 + 3.5 (= –56.5)	–
	$0.138 \le f \le 0.210$	$-56.5 - 72 \times \log_2(f/0.138)$	–
	$0.210 < f < 3.575$	100	–
	$3.575 \le f \le 3.75$	$-80 + (20/0.175) \times (f - 3.75)$	–
US1	$3.75 < f < 5.2$	–60 + 3.5 (= –56.5)	–
	$5.2 \le f \le 5.375$	$-80 - (20/0.175) \times (f - 5.2)$	–
	$5.375 < f < 8.325$	–100	–52
	$8.325 \le f \le 8.5$	$-80 + (20/0.175) \times (f - 8.5)$	–
US2	$8.5 < f < 12$	–60 + 3.5 (= –56.5)	–
	$12 \le f \le 12.175$	$-80 - (20/0.175) \times (f - 12)$	–
	$12.175 < f < 17.925$	–100	–52
	$17.925 \le f \le 18.1$	$-80 + (20/0.175) \times (f - 18.1)$	–
US3	$18.1 < f < 30$	–60 + 3.5 (= –56.5)	–
	$30 \le f \le 30.175$	$-80 - (30/0.175) \times (f - 30)$	–
	$30.175 < f$	–110	–

NOTE 1 – All PSD and power measurements are in 100 Ω.

NOTE 2 – The Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

Table C.4 – VTU-R Limit PSD mask (VDSL2 above POTS band; 25-276 kHz Type(b))

Band attribute	**Frequency band f (MHz)**	**Limit PSD mask level (dBm/Hz)**	**Maximum power limitation in a 1-MHz sliding window (dBm)**
US0	$0 < f < 0.004$	–97.5	–
	$0.004 \le f \le 0.025875$	$-92.5 + 13.4 \times \log_2(f/0.004)$	–
	$0.025875 < f < 0.276$	–60 + 3.5 (= –56.5)	–
	$0.276 \le f \le 0.420$	$-56.5 - 72 \times \log_2(f/0.276)$	–
	$0.420 < f < 3.575$	–100	–
	$3.575 \le f \le 3.75$	$-80 + (20/0.175) \times (f - 3.75)$	–
US1	$3.75 < f < 5.2$	–60 + 3.5 (= –56.5)	–
	$5.2 \le f \le 5.375$	$-80 - (20/0.175) \times (f - 5.2)$	–
	$5.375 < f < 8.325$	–100	–52
	$8.325 \le f \le 8.5$	$-80 + (20/0.175) \times (f - 8.5)$	–
US2	$8.5 < f < 12$	–60 + 3.5 (= –56.5)	–
	$12 \le f \le 12.175$	$-80 - (20/0.175) \times (f - 12)$	–
	$12.175 < f < 17.925$	–100	–52
	$17.925 \le f \le 18.1$	$-80 + (20/0.175) \times (f - 18.1)$	–
US3	$18.1 < f < 30$	–60 + 3.5 (= –56.5)	–
	$30 \le f \le 30.175$	$-80 - (30/0.175) \times (f - 30)$	–
	$30.175 < f$	–110	–

NOTE 1 – All PSD and power measurements are in 100 Ω.

NOTE 2 – The Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

Table C.5 – VTU-O Limit PSD mask (VDSL2 above POTS band; 25-138 kHz Type(co))

Band attribute	Frequency band f (MHz)	Limit PSD mask level (dBm/Hz)	Maximum power limitation in a 1-MHz sliding window (dBm)
DS1	$0 < f < 0.004$	–97.5	–
	$0.004 \le f < 0.08$	$-92.5 + 4.63 \times \log_2(f/0.004)$	–
	$0.08 \le f \le 0.138$	$-72.5 + 36 \times \log_2(f/0.08)$	–
	$0.138 < f \le 1.104$	–40 + 3.5 (= –36.5)	–
	$1.104 < f < 1.622$	$-36.5 - 18 \times \log_2(f/1.104)$	–
	$1.622 \le f < 3.75$	$-46.5 - 2.9 \times \log_2(f/1.622)$	–
	$3.75 \le f \le 3.925$	$-80 - (20/0.175) \times (f - 3.75)$	
	$3.925 < f < 5.025$	–100	–50
	$5.025 \le f \le 5.2$	$-80 + (20/0.175) \times (f - 5.2)$	–
DS2	$5.2 < f < 8.5$	–55 + 3.5 (= –51.5)	–
	$8.5 \le f \le 8.675$	$-80 - (20/0.175) \times (f - 8.5)$	–
	$8.675 < f < 30$	–100	–52
	$30 \le f$	–110	–

NOTE 1 – All PSD and power measurements are in 100 Ω.

NOTE 2 – The Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

Table C.6 – VTU-O Limit PSD mask (VDSL2 above POTS band; 25-276 kHz Type(co))

Band attribute	Frequency band f (MHz)	Limit PSD mask level (dBm/Hz)	Maximum power limitation in a 1-MHz sliding window (dBm)
DS1	$0 < f < 0.004$	-97.5	–
	$0.004 \le f < 0.1012$	-90	–
	$0.1012 \le f < 0.2271$	$-90 + 24 \times \log_2(f/0.1012)$	–
	$0.2271 \le f \le 0.276$	$-62 + 63 \times \log_2(f/0.2271)$	–
	$0.276 < f \le 1.104$	$-40 + 3.5$ ($= -36.5$)	–
	$1.104 < f < 1.622$	$-36.5 - 18 \times \log_2(f/1.104)$	–
	$1.622 \le f < 3.75$	$-46.5 - 2.9 \times \log_2(f/1.622)$	–
	$3.75 \le f \le 3.925$	$-80 - (20/0.175) \times (f - 3.75)$	
	$3.925 < f < 5.025$	-100	-50
	$5.025 \le f \le 5.2$	$-80 + (20/0.175) \times (f - 5.2)$	–
DS2	$5.2 < f < 8.5$	$-55 + 3.5$ ($= -51.5$)	–
	$8.5 \le f \le 8.675$	$-80 - (20/0.175) \times (f - 8.5)$	–
	$8.675 < f < 30$	-100	-52
	$30 \le f$	-110	–

NOTE 1 – All PSD and power measurements are in 100 Ω.

NOTE 2 – The Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

Table C.7 – VTU-R Limit PSD mask (VDSL2 above POTS bands; 25-138 kHz Type(co))

Band attribute	**Frequency band f (MHz)**	**Limit PSD mask level (dBm/Hz)**	**Maximum power limitation in a 1-MHz sliding window (dBm)**
US0	$0 < f < 0.004$	–97.5	–
	$0.004 \le f \le 0.025875$	$-92.5 + 21.5 \times \log_2(f/0.004)$	–
	$0.025875 < f < 0.138$	–38 + 3.5 (= –34.5)	–
	$0.138 \le f < 0.24292$	$-34.5 - 72 \times \log_2(f/0.138)$	–
	$0.24292 \le f \le 0.686$	$-93.2 - 15 \times \log_{10}(f/0.24292)$	–
	$0.686 < f < 3.575$	–100	–
	$3.575 \le f \le 3.75$	$-80 + (20/0.175) \times (f - 3.75)$	–
US1	$3.75 < f < 5.2$	–53 + 3.5 (= –49.5)	–
	$5.2 \le f \le 5.375$	$-80 - (20/0.175) \times (f - 5.2)$	–
	$5.375 < f < 8.325$	–100	–52
	$8.325 \le f \le 8.5$	$-80 + (20/0.175) \times (f - 8.5)$	–
US2	$8.5 < f < 12$	–54 + 3.5 (= –50.5)	–
	$12 \le f \le 12.175$	$-80 - (20/0.175) \times (f - 12)$	–
	$12.175 < f < 30$	–100	–52
	$30 \le f$	–110	–

NOTE 1 – All PSD and power measurements are in 100 Ω.

NOTE 2 – The Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

Table C.8 – VTU-R Limit PSD mask (VDSL2 above POTS bands; 25-276 kHz Type(co))

Band attribute	Frequency band f (MHz)	Limit PSD mask level (dBm/Hz)	Maximum power limitation in a 1-MHz sliding window (dBm)
US0	$0 < f < 0.004$	-97.5	–
	$0.004 \le f \le 0.025875$	$-92.5 + 20.4 \times \log_2(f/0.004)$	–
	$0.025875 < f < 0.276$	$-41 + 3.5$ $(= -37.5)$	–
	$0.276 \le f < 0.49341$	$-37.5 - 72 \times \log_2(f/0.276)$	–
	$0.49341 \le f \le 0.686$	$-97.9 - 15 \times \log_{10}(f/0.49341)$	–
	$0.686 < f < 3.575$	-100	–
	$3.575 \le f \le 3.75$	$-80 + (20/0.175) \times (f - 3.75)$	–
US1	$3.75 < f < 5.2$	$-53 + 3.5$ $(= -49.5)$	–
	$5.2 \le f \le 5.375$	$-80 - (20/0.175) \times (f - 5.2)$	–
	$5.375 < f < 8.325$	-100	-52
	$8.325 \le f \le 8.5$	$-80 + (20/0.175) \times (f - 8.5)$	–
US2	$8.5 < f < 12$	$-54 + 3.5$ $(= -50.5)$	–
	$12 \le f \le 12.175$	$-80 - (20/0.175) \times (f - 12)$	–
	$12.175 < f < 30$	-100	-52
	$30 \le f$	-110	–

NOTE 1 – All PSD and power measurements are in 100 Ω.

NOTE 2 – The Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

C.2.2~~1.2~~ VDSL2 system operating at frequencies above the TCM-ISDN DSL band

The frequencies above 640 kHz are used for VDSL2. The frequencies below 320 kHz are used for TCM-ISDN DSL. The band between 320 kHz and 640 kHz is a guard band. US0 shall not be used and DS1 shall start at 640 kHz.

The Limit PSD masks are defined in Table C.9~~1~~ and Table C.10~~2~~ below. Other PSDs are for further study.

Table C.9~~1~~ – VTU-O ~~transmit~~ Limit PSD ~~requirements~~ mask (VDSL2 above TCM-ISDN bands)

Band attribute	Frequency band f (~~[~~MHz)~~]~~	Limit PSD mask level~~Maximum PSD limitation (PSD mask)~~ (~~[~~dBm/Hz)~~]~~	Maximum power limitation in a 1-MHz sliding window (~~[~~dBm)~~]~~
DS1	$0 < f < 0.12$	-120	–
	$0.12 \le f < 0.225$	-110	–
	$0.225 \le f < 0.465$	-100	–
	$0.465 \le f \le 0.640$	$-60 + (40/0.175) \times (f - 0.64)$	–
	$0.640 < f < 3.75$	$-60 + 3.5$ $(= -56.5)$	–
	$3.75 \le f \le 3.925$	$-80 - (20/0.175) \times (f - 3.75)$	–
	$3.925 < f < 5.025$	-100	-50
	$5.025 \le f \le 5.2$	$-80 + (20/0.175) \times (f - 5.2)$	–
DS2	$5.2 < f < 8.5$	$-60 + 3.5$ $(= -56.5)$	–
	$8.5 \le f \le 8.675$	$-80 - (20/0.175) \times (f - 8.5)$	–
	$8.675 < f < 11.825$	-100	-52
	$11.825 \le f \le 12$	$-80 + (20/0.175) \times (f - 12)$	–
DS3	$12 < f < 18.1$	$-60 + 3.5$ $(= -56.5)$	–
	$18.1 \le f \le 18.275$	$-80 - (20/0.175) \times (f - 18.1)$	–
	$18.275 < f < 30$	-100	-52
	$30 \le f$	-110	–

NOTE 1 – All PSD and power measurements are in~~to~~ 100 Ω.

NOTE 2 – The ~~maximum~~ Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

NOTE 5 – The integral of the PSD does not exceed 11.0 dBm in the 30-MHz frequency range.

NOTE 6 – When SUPPORTEDCARRIERSds starts at 1104 MHz, the Limit PSD mask below 1104 MHz shall comply with Table F.4/G.993.1.

Table C.10~~2~~ – VTU-R ~~transmit~~ Limit PSD ~~requirements~~ mask (VDSL2 above TCM-ISDN bands)

Band attribute	Frequency band f ~~[~~(MHz)~~]~~	Limit PSD mask level~~Maximum PSD limitation (PSD mask)~~ (~~[~~dBm/Hz)~~]~~	Maximum power limitation in a 1-MHz sliding window (~~[~~dBm)~~]~~
US1	$0 < f < 0.12$	-120	–
	$0.12 \leq f < 0.225$	-110	–
	$0.225 \leq f < 3.575$	-100	–
	$3.575 \leq f \leq 3.75$	$-80 + (20/0.175) \times (f - 3.75)$	–
	$3.75 < f < 5.2$	$-60 + 3.5\ (= -56.5)$	–
	$5.2 \leq f \leq 5.375$	$-80 - (20/0.175) \times (f - 5.2)$	–
	$5.375 < f < 8.325$	-100	-52
	$8.325 \leq f \leq 8.5$	$-80 + (20/0.175) \times (f - 8.5)$	–
US2	$8.5 < f < 12$	$-60 + 3.5\ (= -56.5)$	–
	$12 \leq f \leq 12.175$	$-80 - (20/0.175) \times (f - 12)$	–
	$12.175 < f < 17.925$	-100	-52
	$17.925 \leq f \leq 18.1$	$-80 + (20/0.175) \times (f - 18.1)$	–
US3	$18.1 < f < 30$	$-60 + 3.5\ (= -56.5)$	–
	$30 \leq f \leq 30.175$	$-80 - (30/0.175) \times (f - 30)$	–
	$30.175 < f$	-110	–

NOTE 1 – All PSD and power measurements are in~~to~~ 100 Ω.

NOTE 2 – The ~~maximum~~ Limit PSD mask level shall be measured with a 10-kHz resolution bandwidth.

NOTE 3 – The maximum power in a 1-MHz sliding window shall be measured with a 1-MHz resolution bandwidth.

NOTE 4 – The requirements for the stopband PSD are compliant with 7.2.2.

NOTE 5 – The integral of the PSD does not exceed 12.3 dBm in the 30-MHz frequency range.

C.3~~2.1.3~~ VDSL2 system with PSD reduction at frequencies below DPBOFMAX~~2.208 MHz~~

The downstream transmit PSD mask~~s~~ for frequencies below DPBOFMAX~~2.208 MHz~~ shall not exceed RESULTMASKds(f) defined in 7.3.1.2.13/G.997.1. An example set of parameters intended to protect ADSL2plus is described in Appendix I. The upstream transmit PSD mask for frequencies below DPBOFMAX shall comply with Table C.3, Table C.4, Table C.7, Table C.8 or Table C.10~~−56.5 dBm/Hz~~. ~~The PSD masks for these frequencies are for further study.~~ For frequencies between DPBOFMAX~~2.208 MHz~~ and ~~11.825~~30 MHz, the downstream transmit PSD~~s~~ mask shall comply with Table C.5 or Table C.9 and the upstream transmit PSD~~s~~ mask shall comply with Table C.7 or Table C.10~~F.1.2.1/G.993.1 [1]~~. ~~For frequencies above 11.825 MHz, the downstream PSD and upstream PSD shall comply with either the PSD mask defined in Table C-1 or the PSD mask defined in Table C-2.~~ Other PSD limitations, including US0 power reduction, are for further study.

C.4~~2.1.4~~ Upstream power back-off (UPBO) PSD masks

The VTU-R shall calculate the required UPBO and its upstream PSD mask as specified in 7.2.1.3.2.

The UPBO reference PSD, UPBOPSD*(f)*, is parameterized as $-a - b\sqrt{f}$ dBm/Hz, with *f* expressed in MHz.

For US1 and US2 as defined in Figure C.1, values of *a* and *b* are given in Table C.11~~3~~. These values shall apply when the Limit PSD mask for US1 and US2 does not exceed –56.5 dBm/Hz.

When the Limit PSD mask for US1 and US2 is different from the one defined not to exceed −56.5 dBm/Hz, the values of *a* and *b* for UPBOPSD are for further study. For US3 defined not to exceed −56.5 dBm/Hz~~in Figure C.1~~, the values of *a* and *b* for UPBOPSD are given in Table C.11~~for further study~~.

Table C.11~~3~~ – UPBOPSD parameters

		a	***b***
Limit PSD mask ≤ −56.5 dBm/Hz	US1	60	10.2
	US2	60	6.42
	US3	40 (Note)~~For further study~~	0 (Note)~~For further study~~
Other Limit PSD masks	US1	For further study	For further study
	US2		
	US3		
NOTE – ITU-T Rec. G.997.1 defines the set of parameter values *a* = 40 dBm/Hz, *b* = 0 dBm/Hz as a special configuration to disable UPBO in the respective upstream band.			

C.5~~3~~ Service Splitter

See F.2/G.993.1 [1].

For operation according to Annex C, the requirements applying over a frequency band up to 12 MHz in ITU-T Rec. G.993.1 [1] shall be met over a frequency band up to 30 MHz.

However, the return loss of the POTS splitter in the band between 12 MHz and 30 MHz shall be measured as shown in Figure C.2.

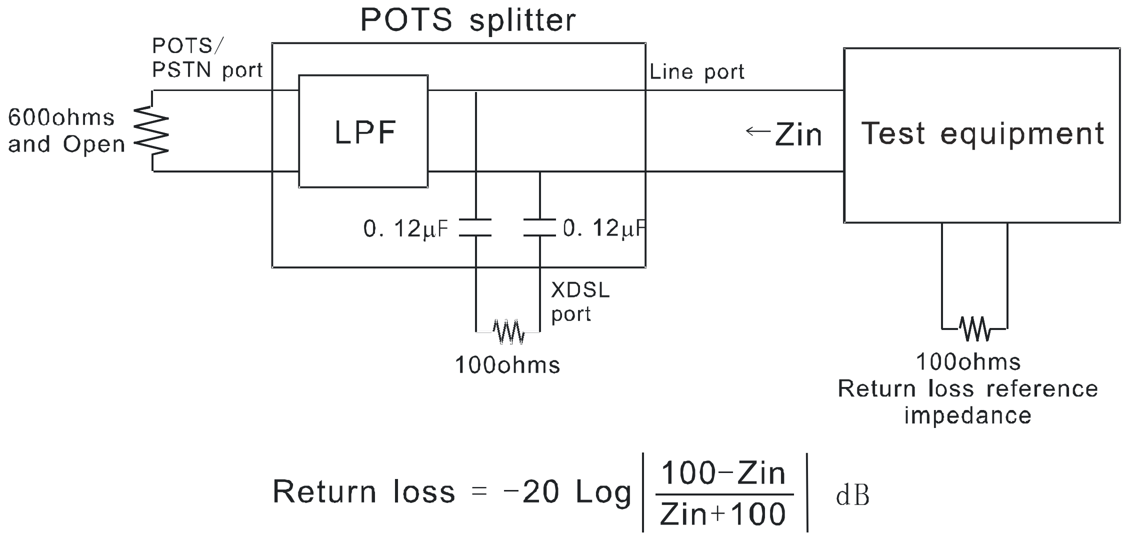

Figure C.2 – Impedance measurements in the band between 12 MHz and 30 MHz for the CO and remote POTS splitters

C.64 Test loops and crosstalk disturbers

C.64.1 Test loops

C.64.1.1 Loop configurations

For frequency bands below 12 MHz, see F.3.1.1/G.993.1 [1]. For VDSL2 using frequency bands above 12 MHz, the following settings for bridged tap parameter Y_2 shall be added to test loop VLOOP-J3 (see Figure F.10/G.993.1 [1]):

Y_2 = 1-10 m at every 1 m step.

C.64.1.2 Primary line constants

See F.3.1.2/G.993.1 [1].

The equations of primary line constants are applicable up to 30 MHz.

C.64.1.3 Line transfer function and test loop characteristics

See F.3.1.3/G.993.1 [1].

C.64.2 Crosstalk disturbers

C.64.2.1 Disturber types

See F.3.2.1/G.993.1 [1].

The five disturber types shown below using G.992.1 (Annex I), VDSL2 self, and PNT3 (ITU-T Rec. G.9954) shall be added:

- Noise B_5 = 9 VDSL2 self NEXT and FEXT (see Tables C.1 to C.10~~, and Table C.2~~, for the disturber PSD);
- Noise B_6 = 9 ADSL [9] NEXT and FEXT (see Figure I.13/G.992.1 (I.4.8.1/G.992.1) for the disturber PSD);
- Noise B_7 = 9 PNT3_(mask #1) NEXT (see Table 6-10/G.9954 (mask #1) in 6.8.3.1/G.9954 for the disturber PSD);
- Noise B_8 = 9 PNT3_(mask #2) NEXT (see Table 6-12/G.9954 (mask #2) in 6.8.3.1/G.9954 for the disturber PSD); and

- Noise B_9 = 9 PNT3 (mask #3) NEXT (see Table 6-14/G.9954 (mask #3) in 6.8.3.1/G.9954 for the disturber PSD).

Other disturbers are for further study.

C.6~~4~~.2.2 Power spectral density of disturbers

See F.3.2.2/G.993.1 [1].

For Annex I/G.992.1, see Figure I.13/G.992.1 (I.4.8.1/G.992.1). The disturber has an offset of −3.5 dB with respect to the peak mask defined in Figure I.13/G.992.1. For VDSL2 self, see Tables C.1 to C.10~~, and Table C.2~~. In the in-band regions, the disturber has an offset of −3.5 dB with respect to the peak mask defined in Tables C.1 to C.10~~, and Table C.2~~. For PNT3 (ITU-T Rec. G.9954 [8]), see Table 6-10/G.9954 (mask #1), Table 6-12/G.9954 (mask #2) and Table 6-14/G.9954 (mask #3) in 6.8.3/G.9954 [8].

C.6~~4~~.2.3 Power spectral density of crosstalk

See F.3.2.3/G.993.1 [1].

31) Annex K

Revise Annex K as follows:

…

Table K.2 – STM-TC Parameters

Parameter	Definition
Minimum net data rate net_min_n	The minimum net data rate supported by the STM-TC stream #*n*. The VTU shall implement appropriate initialization and reconfiguration procedures to provide net_min_n data rate.
Maximum net data rate net_max_n	The maximum net data rate supported by STM-TC stream #*n*. During initialization and reconfiguration procedures, the net data rate shall not exceed this value.
Minimum reserved data rate $net\_reserve_n$	The minimum reserved data rate supported by STM-TC stream #*n* that shall always be available upon request by an appropriate reconfiguration procedure. The value of $net\_reserve_n$ shall be constrained such that $net\_min_n \le net\_reserve_n \le net\_max_n$. This parameter is not used in this version of this Recommendation and shall be set to net_min_n. The OLR procedures that utilize this parameter will be defined in a future revision of this Recommendation.
Maximum PMS-TC latency $delay\_max_n$	The STM-TC stream #*n* shall be transported with underlying PMS-TC functions configured such that the derived parameter $delay_p$ is no larger than this control parameter $delay\_max_n$.
Minimum PMS-TC impulse noise protection INP_min_n	The STM-TC stream #*n* shall be transported with underlying PMS-TC functions configured such that the derived parameter INP_p is not lower than this control parameter INP_min_n.
Channel initialization policy $CIpolicy_n$	This parameter controls the policy to be applied in setting the transceiver configuration parameters during initialization (see 12.3.7).
Maximum delay variation DV_max_n	The STM-TC stream #n shall be transported with underlying PMS-TC OLR function as defined in 13.4 such that the derived parameter DV_p is not lower than this control parameter DV_max_n.

• • •

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

Parameter	Capability
$type_n$	1
net_min_n	net_min_n may be supported for all valid framing configurations.
net_max_n	net_max_n may be supported for all valid framing configurations.
$net\_reserve_n$	$net\_reserve_n$ may be supported for all valid framing configurations.
$delay\_max_n$	All valid values of $delay\_max_n$ (see Table 12-42).
INP_min_n	All valid values of INP_min_n (Table 12-42).
$CIpolicy_n$	0, 1

• • •

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

Parameter	Capability
$type_n$	1
$delay\_max_n$	All valid values shall be supported.
INP_min_n	All valid values shall be supported.
$CIpolicy_n$	0

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

Parameter	Capability
$type_n$	1
$delay\_max_n$	All valid values shall be supported.
INP_min_n	All valid values shall be supported.
$CIpolicy$	0

• • •

Table K.8 – ATM-TC parameters

Parameter	Definition
Minimum net data rate net_min_n	The minimum net data rate supported by the ATM-TC stream #*n*. The VTU shall implement appropriate initialization and reconfiguration procedures to provide net_min_n data rate.
Maximum net data rate net_max_n	The maximum net data rate supported by ATM-TC stream #*n*. During activation and reconfiguration procedures, the net data rate shall not exceed this value.
Minimum reserved data rate $net\_reserve_n$	The minimum reserved data rate supported by ATM-TC stream #*n* that shall always be available upon request by an appropriate reconfiguration procedure. The value of $net\_reserve_n$ shall be constrained such that $net\_min_n \leq net\_reserve_n \leq net\_max_n$. This parameter is not used in this version of this Recommendation and shall be set to net_min_n. The OLR procedures that utilize this parameter will be defined in a future revision of this Recommendation.
Maximum PMS-TC latency $delay\_max_n$	The ATM-TC stream #*n* shall be transported with underlying PMS-TC functions configured such that the derived parameter $delay_p$ is no larger than this control parameter $delay\_max_n$.
Minimum PMS-TC impulse noise protection INP_min_n	The ATM-TC stream #*n* shall be transported with underlying PMS-TC functions configured such that the derived parameter INP_p is not lower than this control parameter INP_min_n.
Channel initialization policy $CIpolicy_n$	This parameter controls the policy to be applied in setting the transceiver configuration parameters during initialization (see 12.3.7).
Maximum delay variation DV_max_n	The ATM-TC stream #n shall be transported with underlying PMS-TC OLR function as defined in 13.4 such that the derived parameter DV_p is not lower than this control parameter DV_max_n.

• • •

Table K.9 – Valid configuration for ATM-TC function

Parameter	Capability
$type_n$	2
net_min_n	net_min_n may be supported for all valid framing configurations.
net_max_n	net_max_n may be supported for all valid framing configurations.
$net\_reserve_n$	$net\_reserve_n$ may be supported for all valid framing configurations.
$delay\_max_n$	All valid values of $delay\_max_n$ (see Table 12-42).
INP_min_n	All valid values of INP_min_n (Table 12-42).
$\underline{CIpolicy_n}$	<u>0, 1</u>

• • •

Table K.10 – Mandatory downstream configuration for ATM-TC function #0

Parameter	Capability
$type_n$	2
$delay\_max_n$	All valid values shall be supported.
INP_min_n	All valid values shall be supported.
$\underline{CIpolicy_n}$	<u>0</u>

Table K.11 – Mandatory upstream control configuration for ATM-TC function #0

Parameter	Capability
$type_n$	2
$delay\_max_n$	All valid values shall be supported.
INP_min_n	All valid values shall be supported.

• • •

Table K.15 – PTM-TC parameters

Parameter	Definition
Minimum net data rate net_min_n	The minimum net data rate supported by the PTM-TC stream #*n*. The VTU shall implement appropriate initialization and reconfiguration procedures to provide net_min_n data rate.
Maximum net data rate net_max_n	The maximum net data rate supported by PTM-TC stream #*n*. During initialization and reconfiguration procedures, the net data rate shall not exceed this value.
Minimum reserved data rate $net\_reserve_n$	The minimum reserved data rate supported by PTM-TC stream #*n* that shall always be available upon request by an appropriate reconfiguration procedure. The value of $net\_reserve_n$ shall be constrained such that $net\_min_n \leq net\_reserve_n \leq net\_max_n$. This parameter is not used in this version of this Recommendation and shall be set to net_min_n. The OLR procedures that utilize this parameter will be defined in a future revision of this Recommendation.
Maximum PMS-TC latency $delay\_max_n$	The PTM-TC stream #*n* shall be transported with underlying PMS-TC functions configured such that the derived parameter $delay_p$ is no larger than this control parameter $delay\_max_n$.
Minimum PMS-TC impulse noise protection INP_min_n	The PTM-TC stream #*n* shall be transported with underlying PMS-TC functions configured such that the derived parameter INP_p is not lower than this control parameter INP_min_n.
Channel initialization policy $CIpolicy_n$	This parameter controls the policy to be applied in setting the transceiver configuration parameters during initialization (see 12.3.7).
Maximum delay variation DV_max_n	The PTM-TC stream #n shall be transported with underlying PMS-TC OLR function as defined in 13.4 such that the derived parameter DV_p is not lower than this control parameter DV_max_n.

• • •

Table K.16 – Valid configuration for PTM-TC function

Parameter	Capability
$type_n$	3
net_min_n	net_min_n may be supported for all valid framing configurations.
net_max_n	net_max_n may be supported for all valid framing configurations.
$net\_reserve_n$	$net\_reserve_n$ may be supported for all valid framing configurations.
$delay\_max_n$	All valid values of $delay\_max_n$ (see Table 12-42).
INP_min_n	All valid values of INP_min_n (Table 12-42).
$CIpolicy_n$	0, 1

• • •

Table K.17 – Mandatory downstream configuration for PTM-TC function #0

Parameter	Capability
$type_n$	3
$delay\_max_n$	All valid values shall be supported.
INP_min_n	All valid values shall be supported.
$CIpolicy_n$	0

Table K.18 – Mandatory upstream control configuration for PTM-TC function #0

Parameter	Capability
$type_n$	3
$delay\_max_n$	All valid values shall be supported.
INP_min_n	All valid values shall be supported.

32) New Appendix I

Add new Appendix I as follows:

Appendix I

Example values of DPBO parameters to protect ADSL2plus for clause C.3

This appendix defines example values of DPBO parameters defined in 7.3.1.2.13/G.997.1.

These example values are for reducing crosstalk to ADSL2plus.

The set of breakpoints defining PSDMASKds(t_i, PSD_i) should be monotonic in frequency, i.e., $t_i \le t_{i+1}$ for $0 < i \le 32$, except when the DPBOLFO function is used. An interruption in the monotonic frequency progression indicates that DPBOLFO is requested and that the breakpoints following the interruption are for the DPBOLFO.

NOTE – PSDMASKds in this appendix is the G.997.1 parameter that is referred to as MIBMASKds in this Recommendation.

I.1 Example PSD parameters

In this clause, PSD parameters to define PEPSD(f), PSDMASKds(f) and DPBOMPSD(f) are described. In Table I.1, DPBOEPSD, DPBOPSDMASKds(f), DPBOLFO and DPBOMUS are defined.

Table I.1 – PSD parameters of DPBO

	***DPBOEPSD* (dBm/Hz)**	***DPBOPSDMASKds* (dBm/Hz)**	***DPBOLFO* (dBm/Hz)**	***DPBOMUS* (dBm/Hz)**
VDSL2 in the building	Limit PSD mask = Table C.5	Limit PSD mask = Table C.9~~1/G.993.2~~	−100	−100
VDSL2 from the cabinet	Limit PSD mask = Table C.5	Limit PSD mask = Table C.5~~d138_co~~ or Table C.6~~d276_co~~		

I.2 Example Cable parameters

In this clause, cable parameters to define PEPSD(f) are exemplified. PEPSD(f) is defined as the following equation:

$$PEPSD(f) = DPBOEPSD(f) - \left(DPBOESCMA + DPBOESCMB \cdot \sqrt{f} + DPBOESCMC \cdot f\right)DPBOESEL$$

In Table I.2, DPBOESCMA, DPBOESCMB and DPBOESCMC are defined.

Table I.2 – E-side cable model

	***DPBOESCMA* (No-dimension)**	***DPBOESCMB* ($1/\sqrt{\mathrm{MHz}}$)**	***DPBOESCMC* (1/MHz)**
VDSL2 in the building	$\dfrac{-10\mathrm{Log}\left(\dfrac{DPBOESEL + DPBORSEL}{DPBORSEL}\right)}{DPBOESEL}$	1	0
VDSL2 from the cabinet			

$DPBOESEL = length(m) \times 1\left(\sqrt{MHz}\right) \times 0.0259\left(dB/\left[m\sqrt{MHz}\right]\right)$; with *length* (m) equal to the distance in metres between CO and Cabinet (for Japanese cable).

$DPBORSEL = length(m) \times 1\left(\sqrt{MHz}\right) \times 0.0259\left(dB/\left[m\sqrt{MHz}\right]\right)$; with *length* (m) equal to the distance in metres between Cabinet and VTU-R (for Japanese cable).

I.3 Example frequency parameters

In this clause, frequency parameters to define a frequency range where DPBO is in action are described. In Table I.3, DPBOFMIN is from which DPBO starts and DPBOFMAX is at which DPBO ends.

Table I.3 – Frequency range of DPBO

	***DPBOFMIN* (kHz)**	***DPBOFMAX* (kHz)**
VDSL2 in the building	138	2208
VDSL2 from the cabinet		

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