TITLE **Editorial improvements to the VDSL2 transmitter model**

PROJECT SpM-2 (study point SP2-6, SP2-7 and SP2-8)

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STATUS for decision, and inclusion into SpM-2

ABSTRACT[1] In a previous contribution (072t10, April 2007, [9]) a calculation model was proposed to model the template PSD of VDSL2 transmitters. The proposed algorithmic approach required only a limited number of PSD tables, to model all variants of VDSL2.
The present contribution proposes a few editorial improvements to increase the consistency of the wording in the text.

1 The need of algorithmic models for VDSL2 transmitters

To perform spectral management studies on the impact of VDSL2 to legacy xDSL systems, or to predict the performance of VDSL2 in a noisy environment, simulation models for VDSL2 transmitters are required. A common strategy for systems like ADSL, SDSL and HDSL is to model these transmitters by describing the nominal output spectra by means of fixed PSD templates. Part 2 of the ETSI spectral management standard [5] is a container document with all kinds of models, and the addition of VDSL2 models via fixed PSD templates have been proposed [6,8] within ETSI-TM6 for inclusion in an update of that document.
However, the number of “standard” signal spectra being defined in the ITU specification G993.2 [2] is so numerous, that a fixed approach will be very inconvenient in practice [7]. In addition, when PSD shaping is applied to VDSL2 downstream signals or power back-off to upstream signals, the number of spectra to be modeled by fixed tables becomes very challenging.

A principal solution to this problem is to make use of an algorithmic approach instead of a fixed one. This has been suggested in [7] and elaborated in detail in [9]. The approach systematizes on how the PSD template should be created for VDSL2 transmitters, and the result is straightforward to program in software tools for simulations. All the basic PSD templates implied with the ITU G993.2 [2] (profiles and masks) can be generated from this model in combination with the proposed parameters.

This approach is gaining acceptance, since it gives sufficient flexibility to control all aspects of VDSL2 spectra. To gain full acceptance, we propose in the present contribution a few editorial changes to the originating contribution.. This makes the present contribution very similar to the previous one in [9]. To simplify comparison, all changes have been highlighted in blue, except for the labeling changes in figure 1 and 2.
In addition minor modifications have been made to the values of the noise floor and boundary frequencies, to reflect the recent changes, found in the ITU amendment from February 2007, literal 2 [2].

[1] **The scientific work behind this contribution has also been funded by MUSE, a European consortium of vendors, operators and knowledge institutes, cooperating within the 6th framework programme of the European Commission.**

2 Literal text proposal

DISCUSSION: A short technical discussion is needed in TM6 to find the best naming and split-up of upstream bands in table 13, 14 and 15. The need for hat is explained in the remarks above these tables

Start of literal text proposal

EDITORIAL NOTE. Al paragraph numbers in the clauses below refer to the clause numbering being used in part 2 of the ETSI Spectral Management standard [5]

4 Transmitter signal models for xDSL

4.17 Transmitter signal models for "VDSL1"

Same text as currently in clause 4.17, but replace "VSDL" by "VDSL1" to avoid confusion with the "VDSL2" models

4.18 Transmitter signal models for "VDSL2"

The PSD templates for VDSL2 are to model the VDSL variants being defined in ITU specification G993.2 [2].

The complexity of VDSL2 (many flavors many kinds of PSD shaping/PBO in downstream and upstream, power restrictions) requires a break-down of the specification of a PSD template for a particular scenario. Figure 1 illustrates how the VDSL2 transmitter model can be broken down into four individual building blocks. Each block has its own set of controlling parameters, to control one or more aspects of the output spectrum of VDSL2.

- A baseline "*noise floor*" being defined for all frequencies of interest, as input for the first building block.
- A "PSD band constructor" that enables the bands requested by the user above this noise floor.
- A "PSD shaper" that modifies the shape of an intermediate template PSD by a parametric formula, guided by the spectrum to be protected in the downstream and by the desired received signal in the upstream.
- A "PSD Notcher" that can "punch" notches in a shaped PSD, to prevent egress levels being too high in radio bands of interest.
- A "PSD power restrictor" that can modify a PSD (template) in such a way that the aggregate power of the PSD does not exceed some pre-defined upper limit.

In addition, pre-defined tables are provided for the "PSD band constructor" to generate spectra that are compliant with those being defined in the ITU specification G993.2 [2].

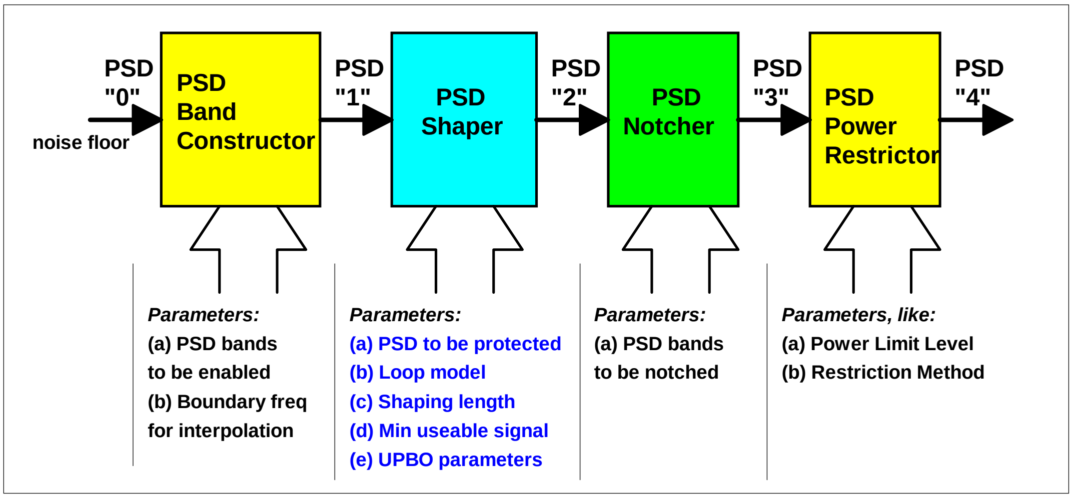

Figure 1: Building blocks of a VDSL2 transmitter model, for defining a wide range of PSD templates with only a few PSD tables and formulas.

4.18.1 Noise floor

The noise floor defines a base line PSD, as input for the first building block. Suitable noise floors are pre-defined in table 1, but the model is not restricted to any of these pre-defined PSDs.

Table 1: Pre-defined noise floors, derived from clause B4.1 in G993.2 [2], as starting PSD for building block #1

f [MHz]	NF_998 P [dBm/Hz]	NF_997 P [dBm/Hz]	NF_HPE P [dBm/Hz]
0	–100	–100	–100
4M	–100	–100	–100
4M	–110	–110	–110
5.1M	interp	–110	interp
5.1M	interp	–112	interp
5.2M	–110	interp	interp
5.2M	–112	interp	interp
7.05M	interp	interp	–110
7.05M	interp	interp	–112
30M	–112	–112	–112

4.18.2 Building block #1 for "PSD Band Constructor"

Building block #1 for the "PSD band constructor" generates a static PSD template, selected from a set of PSD bands. Pre-defined spectra are provided by means of break point tables, up to 30 MHz, but the use of the algorithmic model is not restricted to these tables.
The model in figure 2 starts from a PSD, representing a *noise floor*, and combines it subsequently with as many PSD bands as required. A pre-defined noise floor is provided as well.
Combining means within this context: taking the *maximum* of two PSD levels, where one PSD is the selected PSD band, and the other is a PSD being built-up in previous steps (starting with the noise floor). This maximum is to be evaluated for all frequencies within the selected PSD band. Outside that band, the PSD will remain unchanged.
Figure 3 visualizes such a step in reconstructing a resulting PSD from these two "input" PSDs.

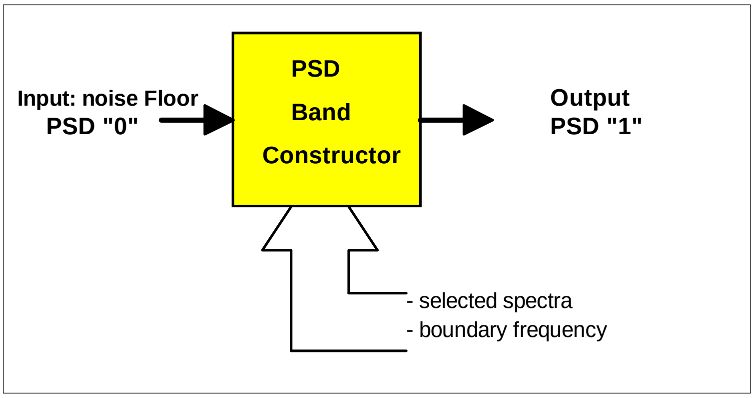

Figure 2: Conceptual description of the "PSD Band Constructor" block

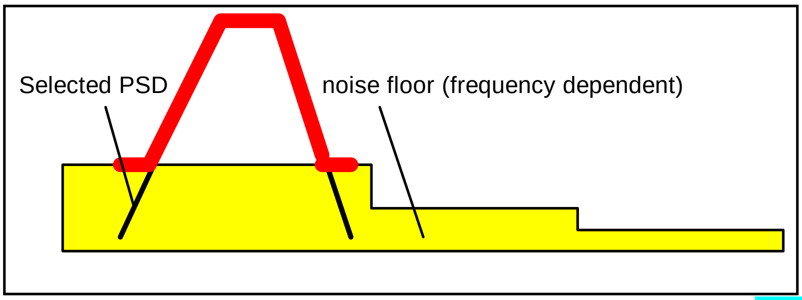

Figure 3: Illustration on how building block #1 combines two PSDs into a third.

The PSD bands can have arbitrary spectra and can be defined in many ways. A commonly used approach is a PSD definition by means of break-point tables. Such a PSD is derived via interpolation, by interconnecting the breakpoints via a straight line when plotted on a linear dB scale. This is called "linear" interpolation, when plotted on a linear frequency axis, "logarithmic" interpolation, when plotted on a logarithmic axis, and "mixed" interpolation when both methods are applied in different frequency bands. When mixed interpolation applies, the boundary frequencies are to be specified as well.

For the purpose of VDSL2 modelling pre-defined PSD bands are provided by means of breakpoint tables, and specified in table 4 to 14 for all band plans and profiles being identified in G993.2 [2]. Each PSD band is essentially the combination of an in-band PSD and transition PSD(s).
For all cases only one boundary frequency applies (fipb), based on the following convention:

- if f $\leq$ fipb do logarithmic interpolation
- if f $>$ fipb do linear interpolation

Table [2] summarizes a set of pre-defined combinations of boundary frequencies, derived from G993.2 ([2], amendment 1).

Table 2: Pre-defined combinations of boundary frequencies, separating logarithmic from linear interpolation of break point tables.

bandplan	f_{ipb} upstream	f_{ipb} downstream	application
998	3575 kHz 3575 kHz	138 kHz 276 kHz	For over POTS, or default For over ISDN or in All Digital Mode
998ADE	3575 kHz 3575 kHz	138 kHz 276 kHz	For over POTS, or default For over ISDN or in All Digital Mode
997	2825 kHz 2825 kHz	138 kHz 276 kHz	For over POTS, or default For over ISDN or in All Digital Mode
HPE	2825 kHz 2825 kHz	138 kHz 276 kHz	For over POTS, or default For over ISDN or in All Digital Mode

4.18.3 Building block #2 for "PSD Shaper"

Building block #2 is typically algorithmic in nature, roughly following the way it is formulated in G997.1 [3]. A difference is that shaping is to be applied in this building block to PSD templates and not to PSD masks. The model in figure 4 provides the generic idea, but details are currently left for further study.

> EDITORIAL NOTE. Some ideas on how to implement this building block, have been summarized in the originating contribution 072t10. These are the results of a brainstorm only, are currently immature and left for further study.

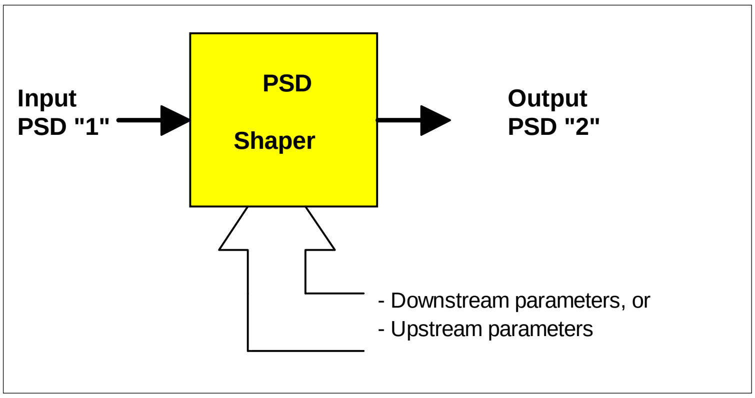

Figure 4: Conceptual description of the "PSD Shaper" block

4.18.4 Building block #3 for "PSD notcher"

Building block #3 enables to punch notches in the spectrum, to reduce the effect of unwanted radiated emissions from VDSL2 causing undue interference to existing licensed users of that part of the spectrum. The description of this building block is roughly the same as for building block #2 ("PSD band constructor"), but its influence on the overall PSD will be different when shaping (in block #3) has been applied. The model in figure 5 starts from an input PSD and combines it subsequently with as many notching PSDs as required.
Combining means within this context: taking the *minimum* of two PSD levels, where one PSD is the selected notching PSD, and the other is a PSD being built-up in previous steps. This minimum is to be evaluated for all frequencies within the band of the selected notching PSD. Outside that band, the PSD will remain unchanged.

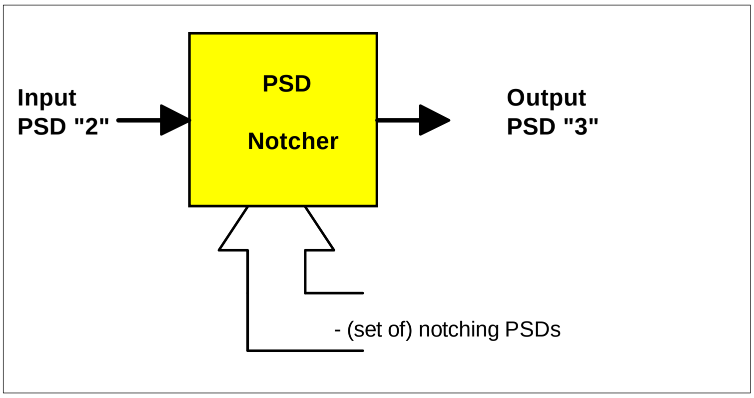

Figure 5: Conceptual description of the "PSD Notcher" block

Table 3 summarizes a set of pre-defined notching PSDs, suitable for reducing egress into internationally standardized amateur radio bands. The model is not restricted to these pre-defined notching PSDs. The numbers are derived from the ETSI VDSL1 standard [1]. If required, this notching can be repeated for multiple frequency intervals when more bands are to be notched. In that case the controlling parameter of this model is a set of notching PSDs.

Table 3: Break point tables of several pre-defined notching PSDs

Band to be notched	f [MHz]	P [dBm/Hz]
NB1	1.81 2.00	-80 -80
NB2	3.50 3.80	-80 -80
NB3	7.00 7.20	-80 -80
NB4	10.10 10.15	-80 -80
NB5	14.00 14.35	-80 -80
NB6	18.068 18.168	-80 -80
NB7	21.000 21.450	-80 -80
NB8	24.890 24.990	-80 -80
NB9	28.000 29.100	-80 -80

4.18.5 Building block #4 for "PSD Power Restrictor"

Building block #4 enables to cut-back the overall PSD when its aggregate power appears to be above a certain power limit. Such a cut-back is to be applied when for instance a modem implementation is unable to generate powers beyond that limit, or when the output PSD has to be compliant with maximum values specified by the profiles from G993.2 [2].

Different modem implementations may follow different strategies to cope with power limitations, and therefore different restriction methods can be applied to this model. A few restriction methods that can ensure that the aggregate power of a modified PSD does not exceed a certain maximum value are pre-defined below, but other methods are not excluded:

- ***Attenuator method***. This power restriction requires an algorithm that causes a (frequency independent) attenuation of the full PSD. When the aggregate power of the PSD exceeds a specified limit, the algorithm is to increase this attenuation until a value that makes the aggregate power of the PSD equal to the specified limit. This method is very simple, and is often inadequate to approximate the power restriction in a real modem implementation.
- ***Water-filling method***. This power restriction requires an algorithm that clips all PSD values above a certain (frequency independent) "ceiling PSD value". When the aggregate power of the PSD exceeds a specified limit, the algorithm is to lower this "ceiling" down to a value that makes the aggregate power of the PSD equal to the specified limit. This method is typically iterative in nature but rather straightforward.
- ***Lower curtain method***. This power restriction requires an algorithm that replaces all PSD values up to a certain "curtain" frequency by a pre-defined PSD floor. When the aggregate power of the PSD exceeds a specified limit, the algorithm is to raise this "curtain" frequency up to a value that makes the aggregate power of the PSD equal to the specified limit. This method is also typically iterative in nature and rather straightforward as well.
- ***Upper curtain method***. This power restriction method is similar to the lower curtain method, with the difference that in this method all PSD values above a certain "curtain" frequency are to be replaced by a pre-defined PSD floor.

Other methods may be applied too, but have not been described here.

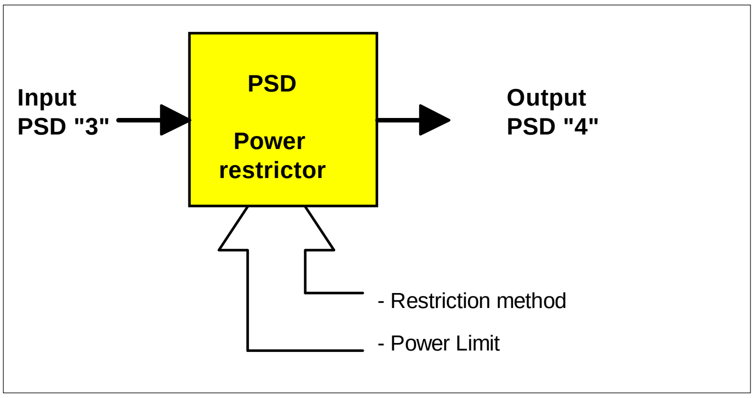

Figure 6: Input/Output Baseline PSD Power Restrictor

4.18.6 Pre-defined downstream tables for "PSD Band Constructor"

The PSD band constructor in building block #1 can be controlled via an arbitrary number of PSD bands. Pre-defined PSD bands for downstream transmission are summarized in table 5 to 9 and specified by means of breakpoints. Each PSD band has its own (unique) identifier (summarized in table 4), for convenient referencing. A full VDSL2 transmit signal can be built-up from a proper selection of these PSD bands. Example of meaningful combinations can be found in table [16].

The values are constructed from the breakpoints of G993.2 masks [2], roughly by correcting 3.5dB difference between mask and template for in-band frequencies, and roughly by corrected the PSD according to the constraints in 1 MHz resolution bands for out-of-band frequencies. In addition, some of the pre-defined values are adjusted via a pragmatic compromise between simplicity and ITU details.

Table 4: Summary of pre-defined PSD bands, for downstream

downstream identifiers for PSD bands	downstream identifiers for PSD bands	Remarks on the naming convention
DS1L.A_998	Tables defining PSD bands suitable for band plan 997 are left for further study	L = (lower part), A = (over POTS, like in annex A of [4])
DS1L.B_998		L = (lower part), B = (over ISDN, like in annex B of [4])
DS1U.M1_998		U = (upper part), M1=(name for regular mask)
DS1U.M2_998		U = (upper part), M2=(name for boosted mask)
DS2.M1_998		M1=(name for regular mask)
DS2.M2_998		M2=(name for boosted mask)
DS3_998.E17		E17=(extended up to 17 MHz)
DS3_998ADE.E17		E17=(extended up to 17 MHz)
DS3_998.E30		E30=(extended up to 30 MHz)
DS3_998ADE.E30		E30=(extended up to 30 MHz)
DS4_998.E30		E30=(extended up to 30 MHz)

Table 5: Pre-defined PSD bands for DS1L (lower part of DS1)

f [Hz]	DS1L.A_998 *P* [dBm/Hz]	DS1L.B_998 *P* [dBm/Hz]
0	-100	-100
3999	-100	-100
4000	-96	-96
80000	-76	interp
101200	interp	-96
137999	-47.7	interp
138000	-40	interp
227110	interp	-65.5
275999	interp	-52
276000	interp	-40
1104000	-40	-40
1622000	-50	-50
2208000	-51.5	-51.5

Table 6: Pre-defined PSD bands for DS1U (upper part of DS1)

f [Hz]	DS1U.M1_998 *P* [dBm/Hz]	DS1U.M2_998 *P* [dBm/Hz]
2208001	-51.5	-51.5
2249000	-53	interp
2500000	-60	interp
3749999	-60	-54.7
3750000	-83.5	-83.5
3894760	-100	-100
3999999	-100	-100
4000000	-110	-110

Table 7: Pre-defined PSD bands for DS2

f [Hz]	DS2.M1_998 *P* [dBm/Hz]	DS2.M2_998 *P* [dBm/Hz]
4999999	-110	-110
5000000	-112	-112
5055624	-112	-112
5055625	-100	-100
5199999	-83.5	-83.5
5200000	-60	-56.2
8499999	-60	-58.3
8500000	-83.5	-83.5
8644566	-100	-100
8644567	-112	-112

Table 8: Pre-defined PSD bands for DS3

f [Hz]	DS3_998.E17 P [dBm/Hz]	DS3_998ADE.E17 P [dBm/Hz]	DS3_998.E30 P [dBm/Hz]	DS3_998ADE.E30 P [dBm/Hz]
11825000	-112	-112	-112	-112
11855638	interp	-112	interp	-112
11855639	interp	-100	interp	-100
11999999	interp	-83.5	interp	-83.5
12000000	interp	-60	interp	-60
13855658	-112	interp	-112	interp
13855659	-100	interp	-100	interp
13999999	-83.5	interp	-83.5	interp
14000000	-60	interp	-60	interp
17664000	-60	-60	interp	interp
21000000	-83.5	-83.5	interp	interp
21372373	-100	-100	interp	interp
21372374	-112	-112	interp	interp
21449999	interp	interp	-60	interp
21450000	interp	interp	-83.5	interp
21594776	interp	interp	-100	interp
21594777	interp	interp	-112	interp
24889999	interp	interp	interp	-60
24890000	interp	interp	interp	-83.5
25034810	interp	interp	interp	-100
25034811	interp	interp	interp	-112
30000000	-112	-112	-112	-112

Table 9: Pre-defined PSD bands for DS4

f [Hz]	DS4_998.E30 P [dBm/Hz]
12000000	-112
24745527	-112
24745528	-100
24889999	-83.5
24890000	-60
29999999	-60
30000000	-83.5
30096499	-100
30096500	-112
31000000	-112

4.18.7 Pre-defined upstream tables for "PSD Band Constructor"
The PSD band constructor in building block #1 can be controlled via an arbitrary number of PSD bands. Pre-defined PSD bands for upstream transmission are summarized in table 11 to 15 and specified by means of breakpoints. Each PSD bands has its own (unique) identifier (summarized in table 10), for convenient referencing. A full VDSL2 transmit signal can be built-up from a proper selection of these PSD bands. Example of meaningful combinations can be found in table 16.

The values are constructed from the breakpoints of G993.2 masks [2], roughly by correcting 3.5dB difference between mask and template for in-band frequencies, and roughly by corrected the PSD according to the constraints in 1 MHz resolution bands for out-of-band frequencies. In addition, some of the pre-defined values are adjusted via a pragmatic compromise between simplicity and ITU details.

Table 10: Overview of pre-defined PSD bands for upstream

downstream identifiers for PSD bands	downstream identifiers for PSD bands	Remarks on the naming convention
US0.A_998 US0.B_998 US0.M_998 US1.M1_998 US1.M2_998 US2.M1_998 US2.M2_998 US3_998 US4_998 US4_998ADE	Tables defining PSD bands suitable for band plan 997 are left for further study	A = (For over POTS, like in annex A of [4]) B = (For over ISDN, like in annex B of [4]) M = (For All Digital Mode, like in annex M of [4]) M1=(name for regular mask) M2=(name for boosted mask) M1=(name for regular mask) M2=(name for boosted mask)

Table 11: Pre-defined PSD bands for US0

	US0.A_998	US0.B_998	US0.M_998
f [Hz]	*P* [dBm/Hz]	*P* [dBm/Hz]	*P* [DBM/HZ]
0	-100	-100	-100
3999	-100	-100	-100
4000	-96	-96	-96
25875	-38	-96	-41
50000	interp	-93.5	interp
80000	interp	-85.3	interp
120000	interp	-38	interp
138000	-38	interp	interp
243000	-96.7	interp	interp
276000	interp	-38	-41
405125	-100	interp	interp
486810	interp	interp	-100
501500	interp	-100	interp
686000	-100	-100	-100

Table 12: Pre-defined PSD bands for US1

	US1.M1_998	US1.M2_998
f [Hz]	*P* [dBm/Hz]	*P* [dBm/Hz]
3575001	-100	-100
3605175	-100	-100
3749999	-83.5	-83.5
3750000	-60	-54.7
5199999	-60	-56.2
5200000	-83.5	-83.5
5344693	-100	-100
5344694	-112	-112

DISCUSSION ON NAMING CONVENTION. ***The naming convention we will choose may need a short discussion during the TM6 meeting***

One idea is to split-up the table into an "US2" part (a table 13, roughly up to 12 MHz) and an "US3" part (a table 14, roughly from 12-14 MHz). This makes really sense if different UPBO settings are to be applied to those bands (the current naming proposal has prepared for this, but it can be reverted)

998ADE30 doesn't have a US4, only 998E30 has this band because of the "splitted" US2/US3. An alternative naming convention could be to rename it as: US3_998E, US3_998ADE, US4_998E

Whatever comes out of it, a split may have editorial consequences for other tables (like table 16 and 17). US2.M2 is probably also applicable to B8-8, B8-9, B8-13 and B8-14 and this may need an adjustment.

Table 13 and 14: Pre-defined PSD bands for US2 and US3

f [Hz]	US2.M1_998 *P* [dBm/Hz]	US2.M2_998 *P* [dBm/Hz]	Obsolete? *P* [dBm/Hz]	*f* [Hz]	US3_998 *P* [dBm/Hz]
8355624	-112	-112	-112		
8355625	-100	-100	-100		
8499999	-83.5	-83.5	-83.5		
8500000	-60	-58.3	-58.3	10350000	-112
10000000	interp	-59	-59	10350001	-100
11999999	-60	-59	-59	11999999	-83.5
12000000	-83.5	-83.5	-60	12000000	-60
12144761	-100	-100	interp		
12144762	-112	-112	interp		
13999999	interp	interp	-60	13999999	-60
14000000	interp	interp	-83.5	14000000	-83.5
14144781	interp	interp	-100	14144781	-100
14144782	interp	interp	-112	14144782	-112
15000000	-112	-112	-112	15000000	-112

Table 15: Pre-defined PSD bands for US4

f [Hz]	US4_998 *P* [dBm/Hz]	US4_998ADE *P* [dBm/Hz]
21275000	-112	-112
21305249	-112	interp
21305250	-110	interp
21449999	-83.5	interp
21450000	-60	interp
24745847	interp	-112
24745848	interp	-100
24889999	-60	-83.5
24890000	-83.5	-60
25034810	-100	interp
25034811	-112	interp
29999999	interp	-60
30000000	interp	-83.5
30096499	interp	-100
30096500	interp	-112
31000000	-112	-112

4.18.8 Example definitions of VDSL2 transmitters

The above pre-defined break point tables enable the construction of all PSD combinations (profiles and band plans) being identified in G993.2 [2]. For example, table 16 shows a full elaboration for several ITU profiles within limiting mask “B8-4”, also known as “998-M2x-A”. In this example, shaping and notching is disabled. The profiles differ in their combination of allocated bands (within the limiting mask) and maximum power. When a VDSL2 transmitter is specified in this way, its output signal is fully defined.

Table 17 shows for each limiting masks being defined in G993.2 [2] what break-point tables can be considered when constructing the PSD for a specific profiles. A full elaboration for all possible combinations has been omitted here for sake of brevity.

Table 16: Full elaboration of the VDSL2 transmit PSD for a few profiles within limiting mask “B8-4”.

ITU profile + limiting mask	PSD Band constructor		PSD Shaper	PSD Notcher	PSD Power restrictor
8a, B8-4 (8a, 998-M2x-A)	NF_998 f_{ipb} = 138 kHz	DS1L.A_998 DS1U.M2_998 DS2.M2_998	<none>	<none>	14.5 dBm Water-fill
	NF_998 f_{ipb} = 3575 kHz	US0.A_998 US1.M2_998	<none>	<none>	14.5 dBm Water-fill
8b, B8-4 (8b, 998-M2x-A)	NF_998 f_{ipb} = 138 kHz	DS1L.A_998 DS1U.M2_998 DS2.M2_998	<none>	<none>	20.5 dBm Water-fill
	NF_998 f_{ipb} = 3575 kHz	US0.A_998 US1.M2_998	<none>	<none>	14.5 dBm Water-fill
8c, B8-4 (8c, 998-M2x-A)	NF_998 f_{ipb} = 138 kHz	DS1L.A_998 DS1U.M2_998 DS2.M2_998	<none>	<none>	11.5 dBm Water-fill
	NF_998 f_{ipb} = 3575 kHz	US0.A_998 US1.M2_998	<none>	<none>	14.5 dBm Water-fill
8d, B8-4 (8d, 998-M2x-A)	NF_998 f_{ipb} = 138kHz	DS1L.A_998 DS1U.M2_998 DS2.M2_998	<none>	<none>	17.5 dBm Water-fill
	NF_998 f_{ipb} = 3575 kHz	US0.A_998 US1.M2_998	<none>	<none>	14.5 dBm Water-fill
12a, B8-4 (12a, 998-M2x-A)	NF_998 f_{ipb} = 138kHz	DS1L.A_998 DS1U.M2_998 DS2.M2_998	<none>	<none>	14.5 dBm Water-fill
	NF_998 f_{ipb} = 3575 kHz	US0.A_998 US1.M2_998 US2.M2_998	<none>	<none>	14.5 dBm Water-fill
12b, B8-4 (12b, 998-M2x-A)	NF_998 f_{ipb} = 138kHz	DS1L.A_998 DS1U.M2_998 DS2.M2_998	<none>	<none>	14.5 dBm Water-fill
	NF_998 f_{ipb} = 3575 kHz	US1.M2_998 US2.M2_998	<none>	<none>	14.5 dBm Water-fill

Table 17: Summary of the set of break-point tables that may play a role within each limiting mask being defined in G993.2 [2].

Mask name	DS1L.A	DS1L.B	DS1U.M1	DS1U.M2	DS2.M1	DS2.M2	DS3_xxx.E17	DS3_xxx.E17 (ADE)	DS3_xxx.E30	DS3_xxx.E30 (ADE)	DS4_xxxE30		US0.A	US0.B	US0.M	US1.M1	US1.M2	US2.M1	US2.M2	US3	US4	US4 (ADE)
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	×			×		×				×							×		×			×
B7-xx	under study																					

End of literal text proposal

3 Conclusions and proposal

Specifying models for DSL transmitters by means of fixed PSD template tables was successful for modelling systems like ADSL and SDSL, but is not favourable for VDSL2. Such an approach would easily result in an exploding number of tables when all VDSL2 variants from ITU G993.2 [2] are to be combined with downstream power back-off (PSD shaping), upstream power back-off and notching. In this contribution, we elaborated on an algorithmic approach, as proposed before in 7.
We demonstrated that our algorithmic approach is flexible enough to model all VDSL2 variants from ITU G993.2 [2] by means of a limited number of tables. ***Therefore we propose to include the literal text of this contribution in the planned revision of the SpM2 standard [5].***

Details related to band plan 997 have not been elaborated, and are left for further study, and the same applies for the details related to PSD shaping. Therefore we also propose to add dedicated study points to the living lists of SpM2, so that agreements on the proposed text can be achieved independently from the additional text.

- ***Adding band plan 997 into the VDSL2 transmitter model***
- ***Adding downstream PSD shaping to the VDSL2 transmitter model***
- ***Adding upstream power back-off to the VDSL2 transmitter model***

4 References

4.1 References being used in the literal text proposal

[1] ETSI TS 101 270-1 (V1.3.1): "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional requirements".

[2] ITU-T Recommendation G993.2: "Very High Speed Digital Subscriber Line 2 (VDSL2)", March 2006. (Plus all amendments and corrections, including "Draft amendment 1 to Recommendation G.993.2, Feb 27, 2007")

[3] ITU-T Recommendation G997.1: "Physical layer management for digital subscriber line (DSL) receivers", June 2006.

[4] ITU-T Recommendation G.992.5: "Asymmetric digital subscriber line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)".

4.2 Additional references being used in the introductory text

[5] ETSI TR 101 830-2 " Transmission and Multiplexing (TM); Access networks; Spectral management on metallic access networks; Part 2: Technical methods for performance evaluations V1.1.1, Oct 2005.

[6] Andreas Thöny, Philippe Repond, *Text proposal on 998 VDSL2 PSD Templates for profiles 8b, 12a and 17a*, Swisscom, ETSI TM6 contribution 063t11, sept 2006.

[7] Rob F.M van den Brink, B. van den Heuvel and T. van der Veen "Algorithmic approach for defining VDSL2 PSD templates for simulation purposes", ETSI TM6 contribution 064t22, nov 2006.

[8] Andreas Thöny, Philippe Repond, Text proposal on 998 VDSL2 PSD Templates for profiles 8b, 12a and 17a, Swisscom, ETSI TM6 contribution 064t27, nov 2006.

[9] Rob F.M. van den Brink, Hernan Cordova "Algorithmic model for VDSL2 transmitters", ETSI TM6 contribution 072t10, april 2007.