TITLE	**Transmitter models for ADSL modems**
PROJECTS	Spectral Management, part 2; study point 2-5
SOURCE:	KPN:

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STATUS for Decision

ABSTRACT Part 2 of SpM requires a range of calculation blocks, including transmitter models for ADSL. A previous contribution, based on what has been used within FSAN for years, follows nominal PSD values for in-band frequencies and follows the PSD mask values on the edges. This makes the model on the edges somewhat pessimistic. The proposed adjustments in this contribution are to solve this imperfection.

1. Rationale behind this proposal

A previous proposal on ADSL PSD templates for modeling purposes [3] was based on nominal PSD values for in-band frequencies and followed the PSD mask values on the edges. This was the approach that has been used within FSAN for years.
Two problems were identified within TM6 for the previous proposal

- The previous proposal is somewhat pessimistic at the edges of the ADSL spectrum and this needed improvement. PSD masks, are dedicated to upper limits (worst case), and therefore not suitable for the "average" case.
- Another problem that was identified was that not all ADSL systems are using all DMT carriers being allowed by the standards: especially some FDD variants leave a few DMT tones unused to create some guard band between upstream and downstream spectra.

The current contribution proposes a solution that solves both identified problems, in the PSD template:

- The roll-off at the "edges" of the PSD was made steeper then required by the PSD mask, guided by observations from measurement on ADSL modems.
- The PSD template is not fixed, but flexible. The frequency location of the edges are a function of the tones being used, and these tones are to be specified for each simulation that will use the ADSL templates. For instance tone 33 to 56 for an FDD upstream spectrum of interest, and tone 64 to 255 for an FDD downstream spectrum of interest.

Figure 1 shows the difference between the PSD mask, for some FDD variant of "ADSL over ISDN", and the associated PSD template being proposed in this contribution. Mark the significant change in steepness at the high-end edge.
Due to the fact the new PSD templates are flexible, with respect to the DMT tones being used, and that (in this example) less tones are activated than allowed by the standard, the start frequency of the low-end edge is also different from the mask.

Figure 2 shows another example of this added flexibility. The proposed template allows the use of a guard band between up and downstream signals, when a few DMT tones in the "middle" have been left unused as well.

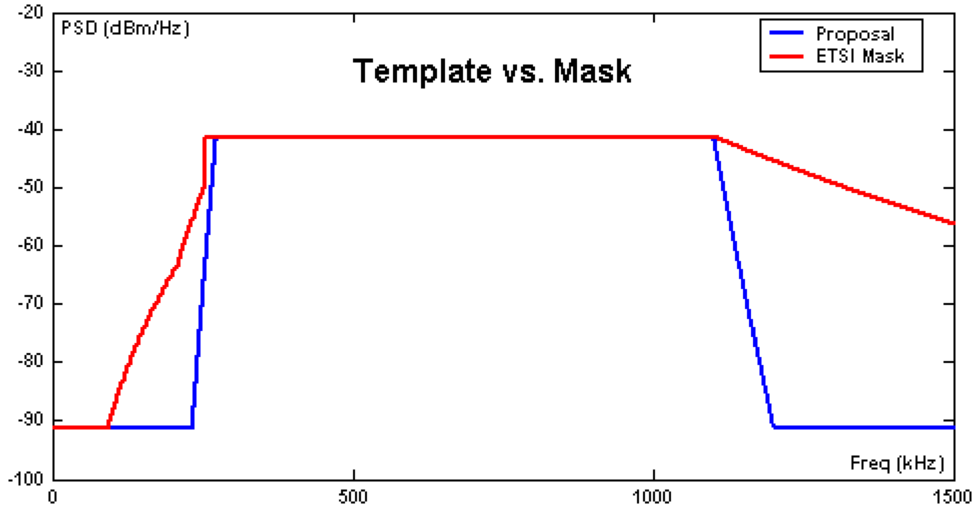

Fig 1

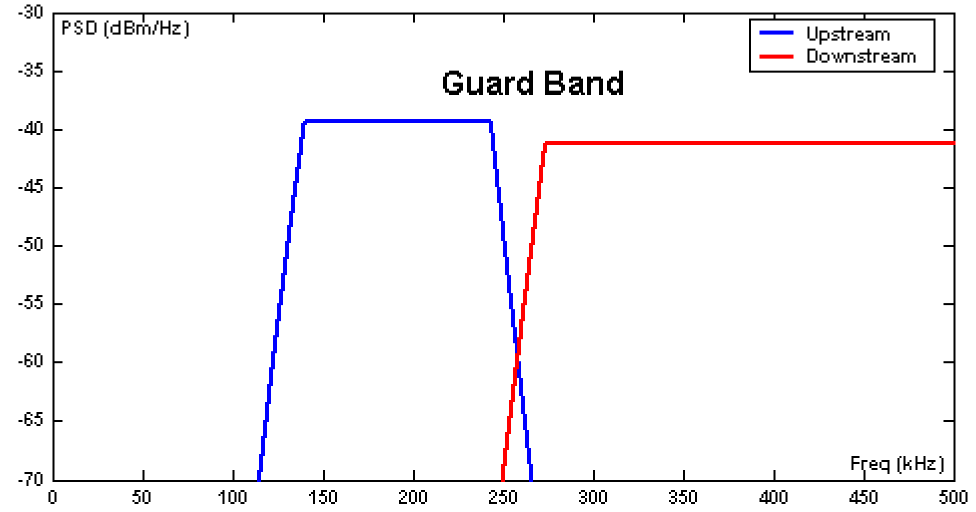

Fig 2

Table 1 through Table 4 define the upstream and downstream PSD template for all ETSI variants of ADSL, being used for simulation purposes. The frequency location of the edges are a function of the DMT tones being used, and specified by the associated (integer) tone numbers. The associated slopes were based on measurements in our lab, as well as measured slopes being provided to ETSI in [4].

2. Literal text proposal

The text below proposes literal text for inclusion in clause 4 of the Spectral Management draft, part 2.

4.4 Cluster 4 transmitter models

4.4.1 Transmitter model for "ADSL over POTS" (EC)

The PSD template for modeling the "ADSL over POTS" transmit spectrum (EC variant) is defined in terms of break frequencies, as summarized in Table 1. The associated values are constructed with straight lines between these break frequencies, when plotted against a *logarithmic* frequency scale and a *linear* dBm scale.
The break frequencies, (f_1 and f_2) and ((f_3 and f_4), are dependent on the used DMT tones, (k_1 to k_2) and (k_3 to k_4), and they are to be specified first when using this PSD template. Default values are given for guidance only. The source impedance equals 100Ω.

ADSL over POTS (EC) ***DMT carriers [k_1:k_2]*** ***f* [Hz]**	***Up*** ***[k_1:k_2]*** ***P* [dBm/Hz]**
1	-97.5
3.99k	-97.5
4 k	-92.5
f_1 -20k	-92.5
f_1	-38
f_2	-38
f_2 +40k	-90
1.221M	-90
1.630M	-110
30M	-110
$f_1 = (k_1–½) × f_c$ $f_2 = (k_2+½) × f_c$ $f_c = \Delta f$ = 4.3125 kHz	

ADSL over POTS (EC) ***DMT carriers [k_3:k_4]*** ***f* [Hz]**	***Down*** ***[k_3:k_4]*** ***P* [dBm/Hz]**
1	-97.5
3.99 k	-97.5
4 k	-92.5
f_3 -20k	-92.5
f_3	-40
f_4	-40
f_4 +100k	-90
3.093M	-90
4.545M	-110
30M	-110
$f_3 = (k_3–½) × f_c$ $f_4 = (k_4+½) × f_c$ $f_c = \Delta f$ = 4.3125 kHz	

Default values: [k_1 : k_2] = [7:31]

Default values: [k_3 : k_4] = [7:255]

Table 1: PSD template values at break frequencies for modeling "ADSL over POTS" (EC)

4.4.2 Transmitter model for "ADSL.FDD over POTS"

The PSD template for modeling the "ADSL.FDD over POTS" transmit spectrum is defined in terms of break frequencies, as summarized in Table 2. The associated values are constructed with straight lines between these break frequencies, when plotted against a logarithmic frequency scale and a linear dBm scale.
The break frequencies, (f_1 and f_2) and ((f_3 and f_4), are dependent on the used DMT tones, (k_1 to k_2) and (k_3 to k_4), and they are to be specified first when using this PSD template. Default values are given for guidance only. The source impedance equals 100Ω.

ADSL.FDD over POTS ***DMT carriers [k_1:k_2]*** ***f* [Hz]**	***Up*** ***[k_1:k_2]*** ***P* [dBm/Hz]**
1	-97.5
3.99 k	-97.5
4 k	-92.5
f_1 -20k	-92.5
f_1	-38
f_2	-38
f_2 +40k	-90
1.221M	-90
1.630M	-110
30M	-110
$f_1 = (k_1–½) × f_c$ $f_2 = (k_2+½) × f_c$ $f_c = \Delta f$ = 4.3125 kHz	

ADSL.FDD over POTS ***DMT carriers [k_3:k_4]*** ***f* [Hz]**	***Down*** ***[k_3:k_4]*** ***P* [dBm/Hz]**
1	-97.5
3.99 k	-97.5
4 k	-92.5
f_3 -40k	-92.5
f_3	-40
f_4	-40
f_4 +100k	-90
3.093M	-90
4.545M	-110
30M	-110
$f_3 = (k_3–½) × f_c$ $f_4 = (k_4+½) × f_c$ $f_c = \Delta f$ = 4.3125 kHz	

Default values: [k_1 : k_2] = [7:30]

Default values: [k_3 : k_4] = [38:255]

Table 2: PSD template values at break frequencies for modeling "ADSL.FDD over POTS".

4.4.3 Transmitter model for "ADSL over ISDN" (EC)

The PSD template for modeling the "ADSL over ISDN" transmit spectrum (EC variant) is defined in terms of break frequencies, as summarized in Table 3. The associated values are constructed with straight lines between these break frequencies, when plotted against a logarithmic frequency scale and a linear dBm scale.
The break frequencies, (f_1 and f_2) and ((f_3 and f_4), are dependent on the used DMT tones, (k_1 to k_2) and (k_3 to k_4), and they are to be specified first when using this PSD template. Default values are given for guidance only. The source impedance equals 100Ω.

ADSL over ISDN (EC) DMT carriers [k_1:k_2] f [Hz]	Up [k_1:k_2] P [dBm/Hz]
1	-90
f_1 -40k	-90
f_1	-38
f_2	-38
f_2 +40k	-90
1.221M	-90
1.630M	-110
30M	-110
$f_1 = (k_1–½) \times f_c$ $f_2 = (k_2+½) \times f_c$ $f_c = \Delta f$ = 4.3125 kHz	

Default values: [k_1 : k_2] = [33:63]

ADSL over ISDN (EC) DMT carriers [k_3:k_4] f [Hz]	Down [k_3:k_4] P [dBm/Hz]
1	-90
f_3 -40k	-90
f_3	-40
f_4	-40
f_4 +100k	-90
3.093M	-90
4.545M	-110
30M	-110
$f_3 = (k_3–½) \times f_c$ $f_4 = (k_4+½) \times f_c$ $f_c = \Delta f$ = 4.3125 kHz	

Default values: [k_3 : k_4] = [33:255]

Table 3: PSD template values at break frequencies for modeling "ADSL over ISDN" (EC)

4.4.4 Transmitter model for "ADSL.FDD over ISDN"

The PSD template for modeling the "ADSL.FDD over ISDN" transmit spectrum is defined in terms of break frequencies, as summarized in Table 4. The associated values are constructed with straight lines between these break frequencies, when plotted against a <u>logarithmic</u> frequency scale and a <u>linear</u> dBm scale.
The break frequencies, (f_1 and f_2) and ((f_3 and f_4), are dependent on the used DMT tones, (k_1 to k_2) and (k_3 to k_4), and they are to be specified first when using this PSD template. Default values are given for guidance only. The source impedance equals 100Ω.

ADSL.FDD over ISDN DMT carriers [k_1:k_2] f [Hz]	Up [k_1:k_2] P [dBm/Hz]
1	-90
f_1 -40k	-90
f_1	-38
f_2	-38
f_2 +40k	-90
1.221M	-90
1.630M	-110
30M	-110
$f_1 = (k_1–½) \times f_c$ $f_2 = (k_2+½) \times f_c$ $f_c = \Delta f$ = 4.3125 kHz	

Default values: [k_1 : k_2] = [33:56]

ADSL.FDD over ISDN DMT carriers [k_3:k_4] f [Hz]	Down [k_3:k_4] P [dBm/Hz]
1	-90
f_3 -40k	-90
f_3	-40
f_4	-40
f_4 +100k	-90
3.093M	-90
4.545M	-110
30M	-110
$f_3 = (k_3–½) \times f_c$ $f_4 = (k_4+½) \times f_c$ $f_c = \Delta f$ = 4.3125 kHz	

Default values: [k_3 : k_4] = [64:255]

Table 4: PSD template values at break frequencies for modeling "ADSL.FDD over ISDN".

End of literal text proposal

5. References

[1] ETSI WG TM6, permanent document TM6(01)21: ETSI document M01p21r3, “, Living List for SpM part 2”, Oct 25, 2002.
[2] ETSI-TS 101 388 v1.3.1 (2002-05): “*Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Asymmetrical Digital Subscriber Line (ADSL)-European specific requirements*”, *ETSI, May 2002.*
[3] ETSI TM6/WD 20 (021wd20*): “Proposal for ADSL Performance Requirements”, ETSI, Torino, Italy, February 4-8, 2002*.
[4] ETSI TM6/TD43 (023t43): *“Defining Xtalk noise models by measuring actual ADSL transceivers” ETSI, Praha, Czech Republic, September 9-13, 2002.*