TITLE **Proposal to complete PSD template of ADSL**

PROJECTS Spectral Management, part 2. Study point 2-5.2

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STATUS for Decision

ABSTRACT The PSD template for modeling the ADSL transmit spectrum is defined in terms of break frequencies as summarized in table 5 through 10 in SpM2. However, the definition of a value f_x representing the steepness of the downstream slope near 1.1MHz has been left for further study. This contribution proposes a downstream slope based on measurements on a widely deployed modem.

1. Rationale behind this proposal

The PSD template for modeling the ADSL transmit spectrum is defined in terms of break frequencies as summarized in table 5 through 10 in SpM2. However, the definition of a value f_x, representing the steepness of the downstream slope near 1.1 MHz, has been left for further study.
Values like f_x = 3093 kHz, based on the PSD mask specification in the standard, require a slope of at least –36 dB/octave. These values are seen as too pessimistic for a PSD template definition.
Values like f_x = 1201 kHz have been proposed as an alternative, and require a slope of at least –402 dB/octave. These values are seen as too optimistic and unrealistic although adequate information was lacking.
This contribution proposes a downstream slope based on measurements on a widely deployed modem and illustrates that a small adjustment of the original numbers appear to be adequate for the job.

2. PSD of a widely deployed modem

The PSD of a modem[1], that is widely deployed in the Netherlands, is measured and used as basis to determine the steepness of the downstream slope near 1.1 MHz. Note that in [1,2] also measured PSD's were given, however from the figures on logarithmic scale shown in these contributions it is impossible to extract a realistic template.

Figure 1 depicts the measured PSD and the proposed downstream slope for the PSD template of ADSL. There is chosen for two frequency breakpoints instead of one to define the downstream slope for the PSD template of ADSL. This results in a more realistic template. From figure 1, it can be seen that the proposed downstream slope gives a good approximation of the measured PSD. The downstream slope starts at 1101.84 kHz, after carrier 255. Figure 1 shows that the modem under test does not transmit at maximum power in the frequency band of the highest tones.

[1] The downstream PSD is measured on an ATU-C from Alcatel. The DSLAM version is the ASAM 7300 with High Density line cards (2001) and software release 4.2. About 80% of the deployed ADSL lines in the Netherlands use this type of ATU-C.

When the modem transmits at maximum power in these tones, the PSD at these frequencies will be higher which means that the downstream slope rolls off a bit slower. The proposed template accounts for this by giving 3dB 'space'.
Figure 2 depicts the downstream slope of the ADSL mask and the proposed downstream slope for the PSD template of ADSL. From figure 2, it can be seen that the mask is far too pessimistic. Note that the downstream slope of the ADSL mask for each of the ADSL types is the same.

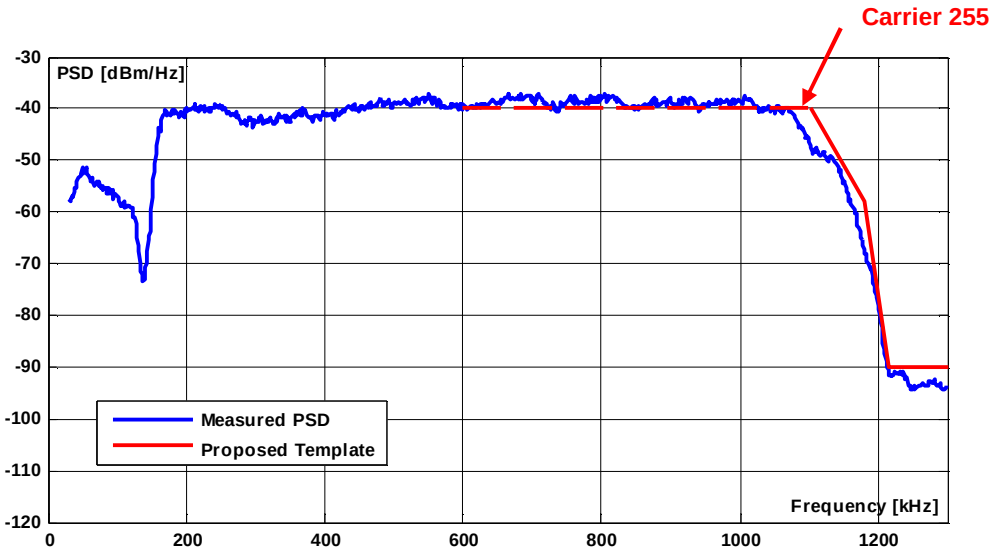

Figure 1: Measured PSD and proposed downstream slope for PSD template o f ADSL (Resolution Bandwidth = 10 kHz)

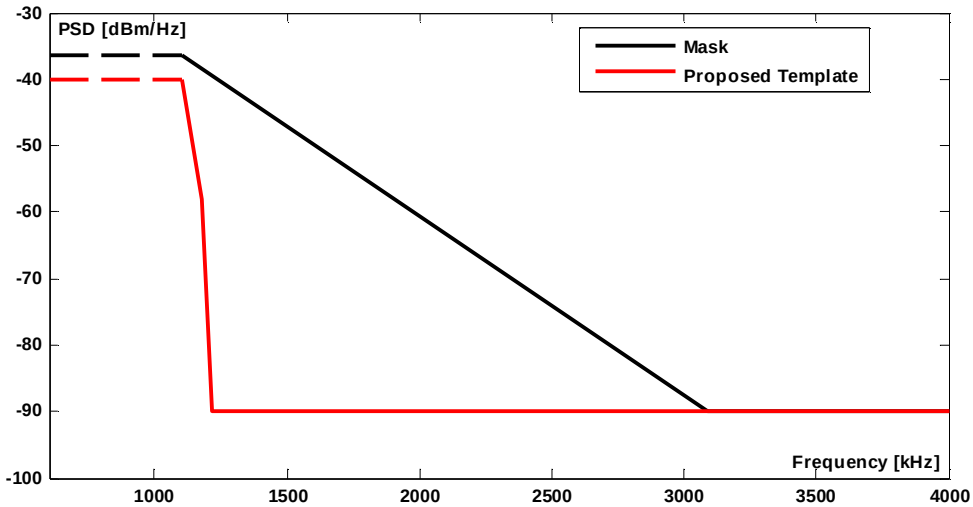

Figure 2: Mask compared with the proposed downstream slope for PSD template o f ADSL

Based on the measured PSD of figure 1, two new frequency breakpoint are defined as shown in table 1.

Downstream slope for template of ADSL	
f [Hz]	P [dBm/Hz]
1.180M	-58
1.216M	–90

Table 1: Two new frequency breakpoints

In Annex A the complete transmitter models, for the four different ADSL flavours, from SpM part 2 are reproduced. The yellow marked rows in each table give the proposed downstream slope for the PSD template of ADSL.

3. Conclusion

This contribution proposes a downstream slope for the PSD template of ADSL. The downstream slope is based on measurements on a widely deployed modem. This contribution shows that the proposed slope results in a realistic template.

To our knowledge, this type of modm is widely deployed in other coutries as well. therefore we propose to use this slope for the PSD templates of ADSL.

4. References

[1] Peter Reusens: *"Proposed Measurements of actual ADSL CPE products to serve as input in the definition of realistic noise model of ADSL fro spectral management",* ETSI TM6, Contribution WD 19, March 10-14, 2003 Sophia Antipolis, France.

[2] Peter Reusens: *"Defining Xtalk models by measuring actual ADSL transceivers",* ETSI TM6/TD43 (023t43), September 9-13, 2002 Praha, Czech Republic.

Annex A

4.4.1 Transmitter signal model for "ADSL over POTS"

The PSD template for modelling the "ADSL over POTS" transmit spectrum (EC variant) is defined in terms of break frequencies, as summarized in table 5.

ADSL over POTS (EC) DMT carriers [k_1:k_2]	**Up [7:31]**
***f* [Hz]**	***P* [dBm/Hz]**
0	–101
3.99k	–101
4 k	–96
6.5×Δf (≈ 28.03)	–38
31.5×Δf (≈ 135.84)	–38
53.0×Δf (≈ 228.56)	–90
686 k	–100
1.411M	–100
1.630M	–110
5.275M	–112
30M	–112
Δf = 4.3125 kHz	

ADSL over POTS (EC) DMT carriers [k_3:k_4]	**Down [7:255]**
***f* [Hz]**	***P* [dBm/Hz]**
0	–101
3.99 k	–101
4 k	–96
6.5×Δf (≈ 28.03)	–40
255.5×Δf (≈ 1101.84)	–40
1.180M	***-58***
1.216M	***–90***
3.093M	–90
4.545M	–112
30M	–112
Δf = 4.3125 kHz	

Table 5: PSD template values at break frequencies for modeling "ADSL over POTS".

4.4.2 Transmitter signal model for "ADSL.FDD over POTS"

The PSD template for modelling "ADSL.FDD over POTS" transmit spectra is defined in terms of break frequencies, as summarized in table 6 and 7.

Guard band FDD (using filters)

ADSL.FDD over POTS DMT carriers [k_1:k_2]	*Up [7:30]*	*ADSL.FDD over POTS DMT carriers [k_3:k_4]*	*Down [38:255]*
f [Hz]	*P [dBm/Hz]*	*f [Hz]*	*P [dBm/Hz]*
0	–101	0	–101
3.99k	–101	3.99 k	–101
4 k	–96	4 k	–96
6.5×Δf (≈ 28.03)	–38	27.5×Δf (≈ 118.59)	–96
30.5×Δf (≈ 131.53)	–38	37.0×Δf (≈ 159.56)	–47.7
40.5×Δf (≈ 174.66)	–90	37.5×Δf (≈ 161.72)	–40
686 k	–100	255.5×Δf (≈ 1101.84)	–40
1.411M	–100	***1.180M***	***-58***
1.630M	–110	***1.216M***	***–90***
5.275M	–112	3.093M	–90
30M	–112	4.545M	–112
		30M	–112
Δf = 4.3125 kHz		Δf = 4.3125 kHz	

Table 6: PSD template values at break frequencies for modeling "ADSL.FDD over POTS", implemented as "guard band FDD" (with filtering). This PSD allocates 7 unused sub-carriers.

Adjacent FDD (using echo cancellation)

ADSL.FDD over POTS DMT carriers [k_1:k_2]	*Up* **[7:31]**	*ADSL.FDD over POTS DMT carriers [k_3:k_4]*	*Down* **[33:255]**
f [Hz]	*P [dBm/Hz]*	*f [Hz]*	*P [dBm/Hz]*
0	–101	0	–101
3.99k	–101	3.99 k	–101
4 k	–96	4 k	–96
6.5×Δf (≈ 28.03)	–38	22.5×Δf (≈ 97.03)	–96
31.5×Δf (≈ 135.84)	–38	32.0×Δf (≈ 138.00)	–47.7
41.5×Δf (≈ 178.97)	–90	32.5×Δf (≈ 140.16)	–40
686 k	–100	255.5×Δf (≈ 1101.84)	–40
1.411M	–100	***1.180M***	***-58***
1.630M	–110	***1.216M***	***–90***
5.275M	–112	3.093M	–90
30M	–112	4.545M	–112
		30M	–112
Δf = 4.3125 kHz		Δf = 4.3125 kHz	

Table 7: PSD template values at break frequencies for modeling "ADSL.FDD over POTS", implemented as "adjacent FDD" (with echo canceling). This PSD allocates 1 unused sub carrier, since a guard band is not required here.

4.4.3 Transmitter signal model for "ADSL over ISDN"

The PSD template for modelling the "ADSL over ISDN" transmit spectrum (EC variant) is defined in terms of break frequencies, as summarized in table 8.

ADSL over ISDN (EC) DMT carriers [k_1:k_2]	*Up* **[33:63]**
f [Hz]	***P [dBm/Hz]***
0	–90
50	–90
22.5×Δf (≈ 97.03)	–85.3
32.5×Δf (≈ 140.16)	–38
63.5×Δf (≈ 273,84)	–38
67.5×Δf (≈ 291.09)	–55
74.5×Δf (≈ 321.28)	–60
80.5×Δf (≈ 347.16)	–97.8
686	–100
1.411M	–100
1.630M	–110
5.275M	–112
30M	–112
Δf = 4.3125 kHz	

ADSL over ISDN (EC) DMT carriers [k_3:k_4]	*Down* **[33:255]**
f [Hz]	***P [dBm/Hz]***
0	–90
50 k	–90
22.5×Δf (≈ 97.03)	–85.3
32.5×Δf (≈ 140.16)	–40
255.5×Δf (≈ 1101.84)	–40
1.180M	***-58***
1.216M	***–90***
3.093M	–90
4.545M	–112
30M	–112
Δf = 4.3125 kHz	

Table 8: PSD template values at break frequencies for modeling "ADSL over ISDN (EC)".

4.4.4 Transmitter signal model for "ADSL.FDD over ISDN"

The PSD template for modelling “ADSL.FDD over ISDN" transmit spectra is defined in terms of break frequencies, as summarized in table 9 and 10.

Guard band FDD (using filters)

ADSL.FDD over ISDN DMT carriers [k_1:k_2]	*Up [33:56]*
f [Hz]	***P [dBm/Hz]***
0	–90
50	–90
22.5×Δf = 97.03	–85.3
32.5×Δf = 140.16	–38
56.5×Δf = 243.66	–38
60.5×Δf = 260.91	–55
67.5×Δf = 291.09	–60
73.5×Δf = 316.97	–97.8
686	–100
1.411M	–100
1.630M	–110
5.275M	–112
30M	–112
Δf = 4.3125 kHz	

ADSL.FDD over ISDN DMT carriers [k_3:k_4]	*Down [64:255]*
f [Hz]	***P [dBm/Hz]***
0	–90
53.5×Δf = 230.72	–90
63.0×Δf = 271.79	–52
63.5×Δf = 273.84	–40
255.5×Δf = 1101.84	–40
1.180M	***-58***
1.216M	***–90***
3.093M	–90
4.545M	–112
30M	–112
Δf = 4.3125 kHz	

Table 9: PSD template values at break frequencies for modeling "ADSL.FDD over ISDN", implemented as "guard band FDD" (with filtering). This PSD allocates 7 unused sub-carriers.

adjacent FDD (using echo cancellation)

ADSL.FDD over ISDN DMT carriers [k_1:k_2]	*Up [33:63]*
f [Hz]	***P [dBm/Hz]***
0	–90
50	–90
22.5×Δf = 97.03	–85.3
32.5×Δf = 140.16	–38
63.5×Δf = 273.84	–38
67.5×Δf = 291.09	–55
74.5×Δf = 321.28	–60
80.5×Δf = 347.16	–97.8
686	–100
1.411M	–100
1.630M	–110
5.275M	–112
30M	–112
Δf = 4.3125 kHz	

ADSL.FDD over ISDN DMT carriers [k_3:k_4]	*Down [64:255]*
f [Hz]	***P [dBm/Hz]***
0	–90
53.5×Δf = 230.72	–90
63.0×Δf = 271.79	–52
63.5×Δf = 273.84	–40
255.5×Δf = 1101.84	–40
1.180M	***-58***
1.216M	***–90***
3.093M	–90
4.545M	–112
30M	–112
Δf = 4.3125 kHz	

Table10: PSD template values at break frequencies for modeling "ADSL.FDD over ISDN", implemented as "adjacent FDD" (with echo canceling). This PSD has no guard band.