TITLE	**Transmitter models for performance evaluations**
PROJECTS	Spectral Management, part 2

SOURCE: Rob F. M. van den Brink,
KPN Research
P.O. Box 421
2260 AK Leidschendam
The Netherlands

tel +31 70 4462389
fax: +31 70 4463166 (or +31 70 4463477)
e-mail: R.F.M.vandenBrink@kpn.com
the above numbers and e-mail address are changed since 9 feb 2001!

STATUS for Decision

ABSTRACT Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. One class of models are transmitter models for defining the PSD templates of individual disturbers and the transmit signal of the device under test, while studying performance. These PSD *templates* are lower in value then the PSD *masks* specified in Part 1. Masks are worst case values and templates are based on nominal values.

1. Rationale behind this proposal

Part 2 of the Spectral management report requires the description of performance models consisting of a range of individual calculation blocks. All these blocks together will enable reproducible and well-defined performance evaluations of (noisy) scenarios. The models of the building blocks that are proposed in this contribution are a few out of many building blocks that are required for part 2.

The models in this contribution are mainly PSD templates. These PSD *templates* are below the PSD *masks* summarized in "Part 1", since "Part 1" is dedicated to upper limits (worst case) while the models in this contribution are intended for simulation purposed.
When nominal values are available from xDSL product standards, the proposed templates approximate these nominal values as much as possible. If nominal values are unavailable, the FSAN templates used in the past for creating the noise models have been used as guideline.

In the case of ISDN.2B1Q and HDSL.2B1Q the templates were created by a piece-wise approximation of a (theoretical) *sync*-curve, so that the envelope power of that PSD is close to what maximum power is allowed by the standard. If the shape of the PSD-mask would have been used as guideline for this PSD template, then the resulting PSD would have been too pessimistic for modeling purposes.

2. Literal text proposal

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

4.2 Cluster 2 transmitter models

4.2.1 Transmitter model for "ISDN.2B1Q"

The PSD template for modeling the "ISDN.2B1Q" transmit spectrum 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 source impedance equals 135Ω.

ISDN 2B1Q	***135** W*
[Hz]	**[dBm/Hz]**
1	-31.8
15k	-31.8
30k	-33.5
45k	-36.6
60k	-42.2
75k	-55
85k	-55
100k	-48
114k	-48
300k	-69
301k	-79
500k	-90
1.4M	-90
3.637M	-120
30M	-120

Table 1 PSD template values at break frequencies for modeling "ISDN.2B1Q"

NOTE: This PSD template is constructed for in-band frequencies from a piece-wise approximation of a (theoretical) sync-shape of 2B1Q encoded signals. For out-of-band frequency the PSD template is guided by the PSD mask. The resulting envelope power of that PSD-template is close to the maximum power is allowed by the ISDN standard.

4.2.2 Transmitter model for "ISDN.MMS.43"

<This model is left for further study>

4.2.3 Transmitter model for "Proprietary.SymDSL.CAP.QAM"

<This model is left for further study>

4.3 Cluster 3 transmitter models

4.3.1 Transmitter model for "HDSL.2B1Q/1"

<This model is left for further study>

4.3.2 Transmitter model for "HDSL.2B1Q/2"

The PSD template for modeling the "HDSL.2B1Q/2" 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 source impedance equals 135Ω.

HDSL 2B1Q	***2 pair 135 W***
[Hz]	**[dBm/Hz]**
1	-40.2
100k	-40.2
200k	-41.6
300k	-44.2
400k	-49.7
500k	-61.5
570k	-80
600k	-80
650k	-72
755k	-72
2.92M	-119
30M	-119

Table 2 PSD template values at break frequencies for modeling "HDSL.2B1Q/2"

NOTE: This PSD template is constructed for in-band frequencies from a piece-wise approximation of a (theoretical) sync-shape of 2B1Q encoded signals. For out-of-band frequency the PSD template is guided by the PSD mask. The resulting envelope power of that PSD-template is close to the maximum power is allowed by the HDSL standard.

4.3.3 Transmitter model for "HDSL.2B1Q/3"

<This model is left for further study>

4.3.4 Transmitter model for "HDSL.CAP/1"

<This model is left for further study>

4.3.5 Transmitter model for "HDSL.CAP/2"

The PSD template for modeling the "HDSL.CAP/2" transmit spectrum 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 source impedance equals 135Ω.

HDSL.CAP/2	***2 pair 135 W***
[Hz]	**[dBm/Hz]**
1	-57
3.98k	-57
21.5k	-43
39.02k	-40
237.58k	-40
255.10k	-43
272.62k	-60
297.00k	-90
1.188M	-120
30M	-120

Table 3 PSD template values at break frequencies for modeling "HDSL.CAP/2"

NOTE: This PSD template is taken from the nominal shape of the transmit signal spectrum, as specified in the ETSI HDSL standard (TS 101 135)

4.3.6 Transmitter model for "SDSL"

The PSD template for modeling the "SDSL." transmit spectrum is defined in three distinct frequency bands, as described in table 4. The break frequency f_{int} is the frequency where the curves for $P_1(f)$ and $P_2(f)$ intersect. The source impedance equals 135Ω.

$f<f_{int}$	$P_1(f) = \frac{K_{SDSL}}{R_s} \times \frac{2 \cdot f_0}{f_{sym}} \times \text{sinc}^2(f/f_{sym}) \times \frac{1}{1+(f/f_H)^{2 \cdot N}} \times \frac{1}{1+(f_L/f)^2}$	[W/Hz]
$f_{int} \le f \le 1.5$ MHz	$P_2(f) = K_X \times (f/f_0)^{1.5}$	[W/Hz]
f> 1.5 MHz	$P_3(f) = -110$	[dBm/Hz]
	$R_s = 135\ \Omega$; $\text{sinc}(x) = \sin(\pi \cdot x) / (\pi \cdot x)$	

Data Rate R	SymbolRate f_{sym}	K_{SDSL}	K_X	N	f_H	f_L	f_0
R < 2.024 Mb/s	(R+ 8 kbit/s)/3	7.86 V^2	$0.5683 \cdot 10^{-4}$ W	6	$f_{sym}/2$	5 kHz	1 Hz
R ≥ 2.024 Mb/s	(R+ 8 kbit/s)/3	9.90 V^2	$0.5683 \cdot 10^{-4}$ W	6	$f_{sym}/2$	5 kHz	1 Hz

Table 4 PSD template expressions for modelling "SDSL"

NOTE: This PSD template is taken from the nominal shape of the transmit signal spectrum, as specified in the ETSI SDSL standard (TS 101 524)

4.3.7 Transmitter model for "Proprietary.XXXXX"

<all proprietary models are left for further study>

4.4 Cluster 4 transmitter models

4.4.1 Transmitter model for "ADSL over POTS" (echo cancelled)

The PSD template for modeling the (echo cancelled) "ADSL over POTS" transmit spectrum is defined in terms of break frequencies, as summarized in table 5. 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 source impedance equals 100Ω.

ADSL over POTS	***Up 100 W***
[Hz]	**[dBm/Hz]**
1	-97.5
3.99k	-97.5
4k	-92.5
25.875k	-38
138k	-38
307k	-90
1.221M	-90
1.630M	-110
30M	-110

ADSL over POTS	***Down 100 W***
[Hz]	**[dBm/Hz]**
1	-97.5
3.99k	-97.5
4k	-92.5
25.875k	-40
1.104M	-40
3.093M	-90
4.545M	-110
30M	-110

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

NOTE: This PSD template is based on a combination of the nominal PSD value for in-band frequencies, and the PSD mask for out-of-band frequencies, as specified in the ETSI ADSL standard.

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 6. 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 source impedance equals 100Ω.

ADSL.FDD over POTS	***Up*** ***100*** *W*
[Hz]	**[dBm/Hz]**
1	-97.5
3.99k	-97.5
4k	-92.5
25.875k	-38
138k	-38
307k	-90
1.221M	-90
1.630M	-110
30M	-110

ADSL.FDD over POTS	***Down*** ***100*** *W*
[Hz]	**[dBm/Hz]**
1	-97.5
3.99 k	-97.5
4 k	-92.5
80 k	-72.5
138.0 k	-44.2
138.1 k	-40
1.104 M	-40
3.093 M	-90
4.545 M	-110
30 M	-110

Table 6 PSD template values at break frequencies for modelling "ADSL.FDD over POTS"

NOTE: This PSD template is based on a combination of the nominal PSD value for in-band frequencies, and the PSD mask for out-of-band frequencies, as specified in the ETSI ADSL standard.

4.4.3 Transmitter model for "ADSL over ISDN" (echo cancelled)

The PSD template for modelling the (echo cancelled) "ADSL over ISDN" transmit spectrum is defined in terms of break frequencies, as summarized in table 7. 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 source impedance equals 100Ω.

ADSL over ISDN	***Up*** ***100*** *W*
[Hz]	**[dBm/Hz]**
1	-90
50k	-90
80k	-81.8
138k	-38
276k	-38
614k	-90
1.221M	-90
1.630M	-110
30M	-110

ADSL over ISDN	***Down*** ***100*** *W*
[Hz]	**[dBm/Hz]**
1	-90
50k	-90
80k	-81.8
138k	-40
1.104M	-40
3.093M	-90
4.545M	-110
30M	-110

Table 7 PSD template values at break frequencies for modeling "ADSL over ISDN"

NOTE: This PSD template is based on a combination of the nominal PSD value for in-band frequencies, and the PSD mask for out-of-band frequencies, as specified in the ETSI ADSL standard.

4.4.4 Transmitter model for "ADSL.FDD over ISDN"

The PSD template for modelling the "ADSL.FDD over ISDN" transmit spectrum is defined in terms of break frequencies, as summarized in table 8. 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 source impedance equals 100Ω.

ADSL.FDD over ISDN	*Up 100 W*
[Hz]	**[dBm/Hz]**
0.001	-90
50 k	-90
80 k	-81.8
120 k	-38
276 k	-38
614 k	-90
1.221 M	-90
1.630 M	-110
30 M	-110

ADSL.FDD over ISDN	*Down 100 W*
[Hz]	**[dBm/Hz]**
0.001	-90
93.1	-90
209	-62
253.99	-48.5
254	-40
1104	-40
3093	-90
4545	-110
30000	-110

Table 8 PSD template values at break frequencies for modeling "ADSL.FDD over ISDN"

NOTE: This PSD template is based on a combination of the nominal PSD value for in-band frequencies, and the PSD mask for out-of-band frequencies, as specified in the ETSI ADSL standard.

End of literal text proposal