ETSI WG TM6
(ACCESS TRANSMISSION SYSTEMS ON METALLIC CABLES)

Permanent Document

TM6(01)21 – rev 5 (a5)

Living List for Spectral Management SpM - part 2 creation of TR 101 830-2

This document is the living list of current issues connected with ETSI's spectral management report TR 101 830, part 2 (*Technical methods for performance evaluations*).
This work item is focussed on the creation of "Part 2", dedicated to calculation and measurement methods for evaluating what the performance of xDSL systems will be for various scenarios.
The target is to achieve working group approval by the end of the ETSI-TM6 meeting in November 2003. This means that the first version of SpM part 2 can be published by ETSI in the beginning of 2004. Issues that are (still) unsolved by that time, may be scheduled for a succeeding revision.
The issues related to the revision of "Part 1", or to the creation of "Part 3", are beyond the scope of this living list.

Work Item Reference	DTS/TM-06030
Permanent Document	**TM6(01)21**
Filename	M01p21a5.pdf
Date	May 28, 2003

Rapporteur/Editor	**Rob F.M. van den Brink**	
(on behalf of KPN)	TNO Telecom	tel: +31 70 4462389
	PO Box 421	fax: +31 70 4463166
	2260 AK Leidschendam	email: R.F.M.vandenBrink@telecom.tno.nl
	The Netherlands	

2. STUDY POINTS PART 2 (TECHNICAL METHODS FOR PERFORMANCE EVALUATIONS)

SP	Title	Owner	Status
2-1	~~Spectral management aspects of non-stationary signals~~.	~~Reuven Franco (Tioga)~~	Deleted
2-2	Basic model of input block	Ragnar Jonsson (Conexant)	Agreed
2-3	Basic model of 2-node cross talk	Rob van den Brink (KPN)	Agreed
2-4	Generic detection models	Rob van den Brink (KPN)	Agreed
2-5	Transmitter/Disturber models - ADSL	Rosaria Persico (TI-labs)	prov agreed
2-6	Transmitter/Disturber models - SDSL	Rob van den Brink (KPN)	Agreed
2-7	Transmitter/Disturber models - HDSL-CAP/2	Rob van den Brink (KPN)	Agreed
2-8	Transmitter/Disturber models - HDSL-2B1Q	Rob van den Brink (KPN)	Prov Agreed
2-9	Performance model for ETSI compliant SDSL	Marc Kimpe (Adtran)	Prov Agreed
2-10	Performance model for ETSI compliant HDSL-CAP	Rob van den Brink (KPN)	Prov Agreed
2-11	Transmitter/Disturber models - ISDN-2B1Q	Rob van den Brink (KPN)	Prov Agreed
2-12	Implementation loss values for PAM, CAP and DMT	Marc Kimpe (Adtran)	US
2-13	Method/Model for Cross talk Cumulative Distribution, etc.	Jack Douglass (Paradyne)	US
2-14	Method/Model for Impairment Combination for multiple disturbers	Jack Douglass (Paradyne)	US
2-15	Method/Model for Loop Cumulative Distribution + Occurrence	Jack Douglass (Paradyne)	US
2-16	Method/Model for Network Model Coverage Score	Jack Douglass (Paradyne)	US
2-17	Transmitter/Disturber models - ISDN-MMS43 (4B3T)	Marko Löffelholz (DTAG)	US
2-18			
2-19			
2-20			
2-21			
2-22			
2-23			

The current agreed procedure for changing the status of living list items is in Annex A of TM6 working methods.

Part 2 study points

SP 2-1. Spectral management rules for non-stationary signals.
It was observed that the combined impairment from modems that are rapidly switching on and off over a period of time is much more destructive to ADSL then when these modems are continuously transmitting their signals. This is identified as "non stationary noise". The effect of non-stationary transmission in general on ADSL modems has not been fully understood. Is it a performance issue, related to the way a victim xDSL modem is implemented, or is it a spectral management issue that requires a way to bound the amount of non-stationary behaviour of signals that are injected into the Local Loop Wiring.
This study point is dedicated to the analysis of the impact of non-stationary cross talkers on legacy systems, and to find a way to model and bound the amount of non stationary noise.
Status: Deleted
Related Contributions:

- *002t24, Helsinki 2000, Impact of non-stationary cross talk on legacy ADSL modems - Orckit*
- *003t52, Vienna - Alcatel*
- *003t53, Vienna 2000, Stationarity requirements for spectral compatibility - Tioga*
- *004t25, TD26,TD35,TD53, Montreux 2000 - Alcatel*

SP 2-2. Basic model of input block.
Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. One of them is the evaluation of SNR, as interim result of an xDSL performance model (receiver). This study point explores possible improvements to the calculation blocks proposed in TD35 (021t35) of the Torino meeting, dedicated to the input block and the associated echo loss model.
Related Contributions:

- *021t35, Torino 2002 - Model of basic input block, within xDSL receivers - KPN*

SP 2-3. Basic model of 2-node cross talk.
Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. One of them is the evaluation of cross talk noise levels in a scenario, in the special case that all disturbers are virtually co-located at no more than 2 nodes. This study point explores possible improvements to the calculation block proposed in TD36 (021t36) of the Torino meeting.
Related Contributions:

- *021t36, Torino 2002 - Generic cross talk models for two-node co-location - KPN*

SP 2-4. Generic Detection models.
Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. One of them is the evaluation of the performance (in terms of noise margin or max bitrate) when a received signal is deteriorated by noise. Models for PAM and CAP/QAM and a linecode independent ("Shifted Shannon") model have been proposed. This study point explores possible improvements of the proposed models, and to study additional models dedicated to DMT.
Related Contributions:

- *022t35, Sophia 2002 - Generic detection models for performance modelling - KPN*

SP 2-5. Transmitter/Disturber models for ADSL
Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. One of them is the evaluation of the expected signal levels of the "modem under study" as well as modems acting as disturber for the "modem under study". The PSD ***masks*** from "part 1" cover worst *case values* and are too pessimistic for this purpose and related to some resolution bandwidth. Performance modelling requires the definition of PSD ***templates*** representing *expected* values, being independent from any resolution bandwidth.
Related Contributions:

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*
- *022t22, Sophia 2002 - FSAN noise models are too pessimistic for SpM - Alcatel*
- *022t23, Sophia 2002 - PSD of ADSL is too pessimistic in FSAN noise models - Alcatel*
- *023t43, Praha 2002 - Defining Xtalk noise models by measuring ADSL transceivers - Alcatel*
- *031t11, Sophia 2003 - Realistic noise model of ADSL for spectral management - Alcatel*
- *031t23, Sophia 2003 - Transmitter models for ADSL modems - KPN/TNO*
- *031w19, Sophia 2003 - Measurement of actual ADSL products - various vendors*

SP 2-6. Transmitter/Disturber models for SDSL
Similar to SP 2-5, but dedicated to SDSL systems

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*

SP 2-7. Transmitter/Disturber models for HDSL-CAP/2
Similar to SP 2-5, but dedicated to two-pair HDSL-CAP systems

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*

SP 2-8. Transmitter/Disturber models for HDSL-2B1Q
Similar to SP 2-5, but dedicated to HDSL-2B1Q systems

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*
- *031t20, Sophia 2003 - Example 2B1Q HDSL PSDs - Keymile*
- *031t21, Sophia 2003 - Proposal on HDSL.2B1q/2 Transmitter signal models - KE*
- *031t22, Sophia 2003 - Transmitter models for ISDN & HDSL-2B1Q modems - KPN/TNO*

SP 2-9. Performance model for ETSI compliant SDSL

Part 2 of SpM requires a range of calculation blocks, to enable performance evaluations. Among them are models that predict the performance (noise margin, or bitrate) of xDSL receivers, when the received signal is disturbed by noise. This study point is dedicated to models that predict 6 dB noise margin under all stress conditions specified by the ETSI SDSL standard, for various bitrates, noise models and testloops. Models of SDSL modems that outperform (or underperform) the ETSI standard requirements are beyond the scope of this study point.

- *023t32, Praha 2002 - Receiver performance model for ETSI compliant SDSL - KPN*
- *024t37, Darmstadt 2002 - Parameters for SDSL performance model - Conexant / Adtran*

SP 2-10. Performance model for ETSI compliant HDSL-CAP

Similar to SP 2-9, but dedicated to HDSL-CAP systems. This means predicting 0 dB noise margin under all stress conditions specified by the ETSI HDSL standard.

- *023t33, Praha 2002 - Receiver performance model for ETSI compliant HDSL/CAP - KPN*

SP 2-11. Transmitter/Disturber models for ISDN-2B1Q

Similar to SP 2-5, but dedicated to ISDN-2B1Q systems. ***Measurements are invited !!!!***

- *991t20, Villach 1999 - Revised noise models for SDSL - KPN*
- *993t22, Edinburgh 1999 - Update of SDSL noise models, as requested by ETSI-TM6 - KPN*
- *022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN*
- *031t22, Sophia 2003 - Transmitter models for ISDN & HDSL-2B1Q modems - KPN/TNO*

SP 2-12. Implementation loss values for PAM, CAP and DMT

The SNR gap Γ, being used in various receiver performance models for xDSL modems, is a combination of various effects. This Γ parameter is usually split-up into the following three parts:

- Its theoretical value $\Gamma_{linecode}$, usually in the order of 9.8 dB, for the chosen line code (e.g. Γ_{PAM}, Γ_{CAP} or Γ_{DMT}).
- A theoretical coding gain $\Delta\Gamma_{coding}$, usually in the order of 3-5 dB, to indicate how much additional improvement is achieved by the chosen coding mechanism.
- The empirical implementation losses $\Delta\Gamma_{impl}$, usually 1.6 dB or more), indicating how much overall deterioration is caused by implementation dependent imperfections in echo cancellation, equalization, etc.

For SDSL this can be expressed as:

SNR gap (linear): $\Gamma_{SDSL} = \Gamma_{PAM} \;/\; \Delta\Gamma_{coding} \times \Delta\Gamma_{impl}$

SNR gap (in dB): $\Gamma_{SDSL\_dB} = \Gamma_{PAM\_dB} - \Delta\Gamma_{coding\_dB} + \Delta\Gamma_{impl\_dB}$

This study point is dedicated to split-up the SNR gap into the above mentioned components for all relevant xDSL modems (HDSL, ADSL, SDSL, VDSL, etc) by deriving the first two theoretical values, and by reconstructing the third empirical values. The resulting SNR gap shall be such that the receiver performance model can predict the performance values required by ETSI, under ETSI test conditions.

- *024t37, Darmstadt 2002 - Parameters for SDSL performance model - Conexant / Adtran*

SP 2-13. Method/model for crosstalk cumulative distribution, etc

To extend current performance evaluation methods (based on scenarios with a fixed set of disturbers) to statistical network modelling (based on scenarios with likelihood of occurrence), various additional parametric models are to be developed. These models are *generic* models only, because the inclusion of empirical values for these parameters and/or the inclusion of other statistical data is beyond the scope op SpM-2.

This study point defines the measurement methods, procedures and calculations required to determine (a) the cross talk cumulative distribution, (b) the likelihood of occurrence (LOO) and (c) severity levels for *cross talk*.

Related Contributions

- *023t56, Praha 2002 - Suggested starting point for NMC Cross talk Models - Paradyne*
- *024t39, Darmstadt 2002 - Calculating the probability of interferers … - Paradyne*

SP 2-14 Methods for Impairment Combinations for multiple disturbers
The objective of this study point is the same as described for SP 2-13, but this one is focussed on how to determine the Impairment Combinations (IC) for multiple types of cross talk.

SP 2-15 Methods for determining Loop Cumulative Distribution
To extend the interpretation of straight-forward reach calculation to the consequences of how many customers are enabled to demand for some service, various additional parametric models are to be developed that account for what percentage of customers live within a certain range. These models are country/region/cable specific, and therefore the models being studied are <u>*generic*</u> models only. This is because the inclusion of empirical values for these parameters and/or the inclusion of other statistical data is beyond the scope op SpM-2.
This study point is focussed on how to determine (a) the cumulative distribution, (b) the likelihood of occurrence (LOO) and (c) severity levels for <u>*Loops*</u>.

- *024t40, Darmstadt 2002 - A simple method of estimating the LOO of loop lengths - Paradyne*
- *031t40, Sophia 2003 - Updated European crosstalk CDFs & example procedure - Paradyne*
- *031t41, Sophia 2003 - Example for approximating European loop distribution - Paradyne*

A proposed generic model for how many customers are located within distance L is based on (a) the <u>knowledge</u> of the distance that encloses 63% of the customers, (b) the <u>knowledge</u> on the slope of this customer count, around this 63% distance, and (c) the <u>assumption</u> that this curve follows a Weibull distribution at all other distances. This model for loop length L, has therefore 2 scenario dependent constants (L_0 and q_0), and equals:

Cumulative distribution function: $$F(L; L_0, q_0) = \left(1 - \exp\left(-\left(\frac{L}{L_0}\right)^{q_0}\right)\right)$$

Probability density function: $$f(L; L_0, q_0) = \left(\frac{q_0}{L_0}\right) \times \left(\left(\frac{L}{L_0}\right)^{q_0} \times \exp\left(-\left(\frac{L}{L_0}\right)^{q_0}\right)\right) = \frac{\partial F}{\partial L}$$

Constant L_0 represent the length covering 63% of all subscribers: $F(L_0)=(1-1/e)$. Constant q_0 represents the slope of $F(L)$ at that length and equals $q_0 = e \cdot L \cdot (dF/dL)$ at $L=L_0$.

SP 2-16 Methods for Determining Network Model Coverage (NMC) Score based on IC LOO and Loop LOO
The study point defines the measurement methods, procedures and calculations required to determine the Network model coverage score(NMC-score) based on IC LOO and Loop LOO

SP 2-17. Transmitter/Disturber models for ISDN-MMS43 (4B3T)
Similar to SP 2-11, but dedicated to ISDN-MMS43 systems. These systems are widely deployed in Germany. ***Measurements are invited !!!!***

Measurements are invited !!!!

Text proposals, being candidate for inclusion into the Draft .

The text fragments below have been proposed for inclusion in the draft version of SpM part 2, but are still in the "under study" status. If agreement is achieved, they will be moved into the Draft

2 References

[1] ETSI TS 102 080 (V1.3.2): "Transmission and Multiplexing (TM); Integrated Services Digital Network (ISDN) basic rate access; Digital transmission system on metallic local lines".

[2] ETSI TS 101 135 (V1.5.3): "Transmission and Multiplexing (TM); High bit-rate Digital Subscriber Line (HDSL) transmission systems on metallic local lines; HDSL core specification and applications for combined ISDN-BA and 2 048 kbit/s transmission".

[3] ETSI TS 101 524: "Transmission and Multiplexing (TM); Access transmission system on metallic access cables; Symmetrical single pair high bitrate Digital Subscriber Line (SDSL)".

Text portion proposed for inclusion into clause 4

4.2 Cluster 2 Transmitter signal models

4.2.1 Transmitter signal model for "ISDN.2B1Q"

The PSD template for modeling the "ISDN.2B1Q" transmit spectrum is defined by the theoretical sinc-shape of PAM encoded signals, with additional filtering and a noise floor. The PSD is the maximum of both power density curves, as summarized in expression 1 and the associated table 1. The coefficient q_N scales the total signal power of $P_1(f)$ to a value that equals P_{ISDN}. This value is dedicated to the used filter characteristics, but q_N=1 when no filtering is applied ($f_L \rightarrow 0$, $f_H \rightarrow \infty$), The source impedance equals 135Ω.

$$P_1(f) = P_{ISDN} \times \frac{2 \times q_N}{f_X} \times \mathrm{sinc}^2\left(\frac{f}{f_X}\right) \times \frac{1}{1+\left(f/f_H\right)^{2 \cdot N_H}} \times \frac{1}{1+\left(f_L/f\right)^2} \quad [W/Hz]$$

$$P_2(f) = \frac{10^{(P_{floor\_dBm}/10)}}{1000} \quad [W/Hz]$$

$$P(f) = \max\left(P_1(f), P_2(f)\right) \quad [W/Hz]$$

Where:

$P_{ISDN} = \left(10^{P_{ISDN\_dBm}/10}\right)/1000$ [W]

R_S = 135 [Ω]

sinc(x) = sin($\pi \cdot x$) / ($\pi \cdot x$)

Default values for remaining parameters are summarized in table 1.

Expression 1: PSD template for modeling "ISDN.2B1Q" signals.

Different ISDN implementations, may use different filter characteristics, and noise floor values. Table 1 specifies *default* values for ISDN implementations, in case 2nd order Butterworth filtering has been applied. The default noise floor equals the maximum PSD level that meets the out-of-band specification of the ISDN standard [1].
In case these default values are not appropriated for specific performance studies, other values may apply as well (provided that they are specified for these studies).

Type	f_X [kHz]	f_H [kHz]	f_L [kHz]	N_H	q_N	P_{ISDN_dBm} [dBm]	P_{floor_dBm} [dBm/Hz]
ISDN.2B1Q	80	1×f_X	0	2	1.1257	13.5	-120

Table 1: Default parameter values for the ISDN.2B1Q templates, as defined in expression 1. These default values are based on 2nd order Butterworth filtering.

4.2.2 Transmitter signal model for "ISDN.MMS.43"

<This model is left for further study>

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

<This model is left for further study>

4.3 Cluster 3 Transmitter signal models

4.3.1 Transmitter signal models for "HDSL.2B1Q"

The PSD templates for modeling the spectra of various "HDSL.2B1Q" transmitters is defined by the theoretical sinc-shape of PAM encoded signals, with additional filtering and a noise floor. The PSD template is the maximum of both power density curves, as summarized in table 2.
The coefficient q_N scales the total signal power of $P_1(f)$ to a value that equals P_0. This value is dedicated to the used filter characteristics, but equals q_N=1 when no filtering is applied ($f_L \to 0$, $f_H \to \infty$), The source impedance equals 135Ω.

$$P_1(f) = P_{HDSL} \times \frac{2 \times q_N}{f_X} \times \text{sinc}^2\left(\frac{f}{f_X}\right) \times \frac{1}{1+\left(f / f_H\right)^{2 \cdot N_H}} \times \frac{1}{1+\left(f_L / f\right)^2} \quad [W/Hz]$$

$$P_2(f) = \frac{10^{(P_{floor\_dBm}/10)}}{1000} \quad [W/Hz]$$

$$P(f) = \max\left(P_1(f), P_2(f)\right) \quad [W/Hz]$$

Where:

$P_{HDSL} = \left(10^{P_{HDSL\_dBm}/10}\right) / 1000$ [W]

R_S = 135 [Ω]

sinc(x) = sin($\pi \cdot x$) / ($\pi \cdot x$)

Default values for remaining parameters are summarized in table 2.

Expression 2: PSD template for modeling "HDSL.2B1Q" signals.

Different HDSL implementations, may use different filter characteristics, and noise floor values. Table 2 summarizes *default* values for HDSL implementations, in case 3rd or 4th order Butterworth filtering has been applied. The default power level P_0 equals the maximum power allowed by the HDSL standard [2], since a nominal specification does not exist. The default noise floor P_{floor} equals the maximum PSD level that meets the out-of-band specification of the HDSL standard [2].
In case these default values are not appropriated for specific performance studies, other values may apply as well (provided that they are specified for these studies).

Type	Wire pair count	f_X [kHz]	f_H	f_L [kHz]	N_H	q_N	P_{HDSL_dBm} [dBm]	P_{floor_dBm} [dBm/Hz]
HDSL.2B1Q/1	1	1160	0.42×f_X	3	3	1.4662	14	-121.5
HDSL.2B1Q/2	2	584	0.50×f_X	3	3	1.3501	14	-119
HDSL.2B1Q/3	3	392	0.50×f_X	3	3	1.3642	14	-117
HDSL.2B1Q/1	1	1160	**<TBD>**	3	4	**<TBD>**	14	-121.5
HDSL.2B1Q/2	2	584	0.68×f_X	3	4	1.1915	14	-119
HDSL.2B1Q/3	3	392	**<TBD>**	3	4	**<TBD>**	14	-117

Table 2: Default parameter values for the HDSL.2B1Q templates, as defined in expression 2. These default values are based on 3rd or 4th order Butterworth filtering.

4.3.2 Transmitter signal model for "HDSL.CAP"

<A model for HDSL.CAP/1 is still under study; only HDSL.CAP/2 has been agreed>

4.3.3 Transmitter signal model for "SDSL"

<This model has been agreed>

4.3.7 Transmitter signal model for "Proprietary.XXXXX"

<all proprietary models are left for further study>

4.4 Cluster 4 Transmitter signal models

4.4.1 Transmitter signal 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 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.

NOTE: The FSAN Legacy 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.

FSAN LEGACY

ADSL over POTS	*Up 100 Ω*
[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 Ω*
[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

KPN PROPOSAL

ADSL over POTS (EC) DMT carriers [k_1:k_2]	**Up [k_1:k_2]**
f [Hz]	**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
$f_1 = (k_1 – ½) \times f_c$ $f_2 = (k_2 + ½) \times f_c$ $f_c = \Delta f = 4.3125$ kHz	

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

ADSL over POTS (EC) DMT carriers [k_3:k_4]	**Down [k_3:k_4]**
f [Hz]	**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
$f_3 = (k_3 – ½) \times f_c$ $f_4 = (k_4 + ½) \times f_c$ $f_c = \Delta f = 4.3125$ kHz	

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

ALCATEL PROPOSAL

ADSL over POTS Spec overlap	*Up 100 Ω*
[Hz]	[dBm/Hz]
1	-101
3.99k	-101
4k	-96
25.875k	-38
138k	-38
229.6k	-92.9
686k	-100
1.411M	-100
1.630M	-110
30M	-110

ADSL over POTS Spec overlap	*Down 100 Ω*
[Hz]	[dBm/Hz]
1	-101
3.99k	-101
4k	-96
25.875k	-40
1.104M	-40
3.093M	?
4.545M	?
30M	?

RAPPORTEURS PROPOSAL: ALCATEL/KPN MIXTURE

ADSL over POTS (EC) DMT carriers [k_1:k_2]	**Up [k_1:k_2]**
f [Hz]	**P [dBm/Hz]**
1	-101
3.99k	-101
4 k	-96
f_1 - 5.5×f_c	-96
f_1	-38
f_2	-38
f_2 + 21.5×f_c	-90
686 k	-100
1.411M	-100
1.221M	-90
1.630M	-110
5.275M	-112
30M	-112
$f_1 = (k_1 - ½) \times f_c$ $f_2 = (k_2 + ½) \times f_c$ $f_c = \Delta f = 4.3125$ kHz	

ADSL over POTS (EC) DMT carriers [k_3:k_4]	**Down [k_3:k_4]**
f [Hz]	**P [dBm/Hz]**
1	-101
3.99 k	-101
4 k	-96
f_3 - 5.5×f_c	-96
f_3	-40
f_4	-40
f_4 + 23×f_c	-90
3.093M	-90
4.545M	-112
30M	-112
$f_3 = (k_3 - ½) \times f_c$ $f_4 = (k_4 + ½) \times f_c$ $f_c = \Delta f = 4.3125$ kHz	

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

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

Table 3. 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 modeling the "ADSL.FDD over POTS" 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 *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.

NOTE: The FSAN legacy 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.

FSAN LEGACY

ADSL.FDD over POTS	*Up 100 Ω*
[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 Ω*
[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

KPN PROPOSAL

ADSL.FDD over POTS DMT carriers [k_1:k_2]	*Up [k_1:k_2]*
f [Hz]	***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	

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

ADSL.FDD over POTS DMT carriers [k_3:k_4]	*Down [k_3:k_4]*
f [Hz]	***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_3 : k_4] = [38:255]

ALCATEL PROPOSAL

ADSL over POTS Spec nonoverlap	*Up 100 Ω*
[Hz]	**[dBm/Hz]**
0	-101
3.99k	-101
4k	-96
25.875k	-38
138k	-38
229.6k	-92.9
686k	-100
1.411M	-100
1.630M	-110
30M	-110

ADSL over POTS Spec nonoverlap	*Down 100 Ω*
[Hz]	**[dBm/Hz]**
0	-101
3.99k	-101
4k	-96
80k	-76
138	-47.7
138	-40
1.104M	-40
3.093M	?
4.545M	?
30M	?

RAPPORTEURS PROPOSAL: ALCATEL/KPN MIXTURE

ADSL.FDD over POTS* *DMT carriers [k_1:k_2]	***Up* *[k_1:k_2]***
f [Hz]	***P [dBm/Hz]***
0	-101
3.99k	-101
4 k	-96
f_1 - 5.5×f_c	-96
f_1	-38
f_2	-38
f_2 + 10×f_c	-90
686 k	-100
1.411M	-100
1.221M	-90
1.630M	-110
5.275M	-112
30M	-112
$f_1 = (k_1–½) × f_c$ $f_2 = (k_2+½) × f_c$ $f_c = \Delta f$ = 4.3125 kHz	

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

ADSL.FDD over POTS* *DMT carriers [k_3:k_4]	***Down* *[k_3:k_4]***
f [Hz]	***P [dBm/Hz]***
0	-101
3.99 k	-101
4 k	-96
f_3 - 10×f_c	-76
f_3 - 0.5×f_c	-47.7
f_3	-40
f_4	-40
f_4 + 23×f_c	-90
3.093M	-90
4.545M	-112
30M	-112
$f_3 = (k_3–½) × f_c$ $f_4 = (k_4+½) × f_c$ $f_c = \Delta f$ = 4.3125 kHz	

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

Table 4. PSD template values at break frequencies for modelling "ADSL.FDD over POTS"

4.4.3 Transmitter signal 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 5. 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.

NOTE: The FSAN legacy 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.

FSAN LEGACY

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

KPN PROPOSAL

ADSL over ISDN (EC) DMT carriers [k_1:k_2]	***Up [k_1:k_2]***
f [Hz]	***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	

ADSL over ISDN (EC) DMT carriers [k_3:k_4]	***Down [k_3:k_4]***
f [Hz]	***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_1 : k_2] = [33:63]

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

ALCATEL PROPOSAL

ADSL over ISDN Spec overlap	***Up 100 Ω***
[Hz]	**[dBm/Hz]**
0	-90
50k	-90
80k	-85.3
120k	-38
276k	-38
491k	-97.8
686k	-100
1.411M	-100
1.630M	-110
5.275M	-112
30M	-112

ADSL over ISDN Spec overlap	***Down 100 Ω***
[Hz]	**[dBm/Hz]**
0	-90
50k	-90
80k	-85.3
120k	-40
1.104M	-40
3.093M	?
4.545M	?
30M	?

RAPPORTEURS PROPOSAL: ALCATEL/KPN MIXTURE

ADSL over ISDN (EC) DMT carriers [k_1:k_2]	***Up [k_1:k_2]***
f [Hz]	***P [dBm/Hz]***
0	-90
50	-90
$f_1 - 10 \times f_c$	-85.3
f_1	-38
f_2	-38
$f_2 + 4 \times f_c$	-55
$f_2 + 11 \times f_c$	-60
$f_2 + 17 \times f_c$	-97.8
686	-100
1.411M	-100
1.630M	-110
5.275M	-112
30M	-112
$f_1 = (k_1 – ½) \times f_c$ $f_2 = (k_2 + ½) \times f_c$ $f_c = \Delta f$ = 4.3125 kHz	

ADSL over ISDN (EC) DMT carriers [k_3:k_4]	***Down [k_3:k_4]***
f [Hz]	***P [dBm/Hz]***
0	-90
50 k	-90
$f_3 - 10 \times f_c$	-85.3
f_3	-40
f_4	-40
$f_4 + 23 \times f_c$	-90
3.093M	-90
4.545M	-112
30M	-112
$f_3 = (k_3 – ½) \times f_c$ $f_4 = (k_4 + ½) \times f_c$ $f_c = \Delta f$ = 4.3125 kHz	

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

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

Table 5. 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 modeling the "ADSL.FDD over ISDN" 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 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.

NOTE: The FSAN legacy 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.

FSAN LEGACY

ADSL.FDD over ISDN	***Up 100 Ω***
[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 Ω***
[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

KPN PROPOSAL

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	

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_1 : k_2] = [33:56]

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

ALCATEL PROPOSAL

ADSL over ISDN Spec nonoverlap	***Up 100 Ω***
[Hz]	**[dBm/Hz]**
0	-90
50k	-90
80k	-85.3
120k	-38
276k	-38
491k	-97.8
686k	-100
1.411M	-100
1.630M	-110
5.275M	-112
30M	-112

ADSL over ISDN Spec nonoverlap	***Down 100 Ω***
[Hz]	**[dBm/Hz]**
0	-90
93.1k	-90
209k	-65.5
253.99	-52
254k	-40
1.104M	-40
3.093M	?
4.545M	?
30M	?

RAPPORTEURS PROPOSAL: ALCATEL/KPN MIXTURE

ADSL.FDD over ISDN DMT carriers [k_1:k_2]	*Up [k_1:k_2]*
f [Hz]	*P [dBm/Hz]*
0	-90
50	-90
f_1 - 10×f_c	-85.4
f_1	-38
f_2	-38
f_2 + 4×f_c	-55
f_2 + 11×f_c	-60
f_2 + 17×f_c	-97.8
686	-100
1.411M	-100
1.630M	-110
5.275M	-112
30M	-112
f_1 = (k_1–½) × f_c f_2 = (k_2+½) × f_c f_c = Δf = 4.3125 kHz	

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

ADSL.FDD over ISDN DMT carriers [k_3:k_4]	*Down [k_3:k_4]*
f [Hz]	*P [dBm/Hz]*
0	-90
f_3 - 10×f_c	-90
f_3 - 0.5×f_c	-52
f_3	-40
f_4	-40
f_4 +23×f_c	-90
3.093M	-90
4.545M	-112
30M	-112
f_3 = (k_3–½) × f_c f_4 = (k_4+½) × f_c f_c = Δf = 4.3125 kHz	

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

Table 6. PSD template values at break frequencies for modeling "ADSL.FDD over ISDN"

Text portion proposed for inclusion into clause 6

6 Specific receiver performance models for xDSL

6.1 Receiver performance model for "HDSL.2B1Q"

<left for further study>

6.2 Receiver performance model for "HDSL-CAP"

This calculation model is capable for predicting the performance of an ETSI compliant HDSL-CAP modem [2]. The validity of the model has been demonstrated for stress conditions (loss, noise) equal to the ETSI stress conditions described in the ETSI HDSL specification [2].

6.2.1 Building blocks of the receiver performance model.

The receiver performance model for ETSI compliant HDSL-CAP is build-up from the following building blocks:

- The echo-loss model, specified in clause 7.2
- The basic model for the input block, specified in clause 5.1
- The generic CAP/QAM detection model, specified in clause 5.2.3
- The parameter values specified in the succeeding clause 6.2.2 and 6.2.3.

6.2.2 Parameters, of the receiver performance model.

The parameter values, used in the receiver performance model for ETSI compliant HDSL-CAP, are summarized in table 7. Parts of them are directly based on HDSL specifications. The remaining values are based on theory, followed by an iterative fit of the model to meet the ETSI reach requirements for HDSL-CAP under the associated stress conditions.

Various parameters are derived directly from the above-mentioned parameters. Their purpose is to simplify the required expression of the used CAP/QAM-detection model.

Model Parameter		**HDSL.CAP/2**	**HDSL.CAP/1**
SNR-Gap (effective)	$\Gamma_{\_dB}$	6.8 dB	6.8 dB
SNR-Gap in parts	Γ_{CAP_dB} $\Delta\Gamma_{coding\_dB}$ $\Delta\Gamma_{impl\_dB}$	**<TBD>** **<TBD>** **<TBD>**	**<TBD>** **<TBD>** **<TBD>**
Echo suppression	η_e	60 dB	60 dB
Receiver noise	P_{RN0_dB}	–105 dBm @ 135 Ω	–105 dBm @ 135 Ω
Data rate	f_d	2×1024 kb/s	1×2048 kb/s
Line rate	f_b	1168 kb/s	2330 kb/s
Carrier frequency	f_c	138.30 kHz	226.33 kHz
bits per symbol	b	5	6
Summation bounds in the CAP/QAM model	N_H N_L	+3 0	+3 0
Derived Parameter			
Symbol rate	f_s	f_b/b = 233.6 kbaud	f_b/b = 388.3 kbaud
Required SNR	SNR_{req}	$\Gamma\times(2^b-1)$	$\Gamma\times(2^b-1)$
	SNR_{req_dB}	*≈ 21.7 dB*	*≈ 24.8 dB*

Table 7. Values for the parameters of the performance model, obtained from ETSI requirements for HDSL-CAP [2].

6.3 Receiver performance model for "SDSL"

This calculation model is capable for predicting the performance of an ETSI compliant SDSL modem. The reach predictions of this model are close to the ETSI reach requirements under the ETSI stress conditions (loss, noise), as specified in the ETSI SDSL specification [3]. Deviations of predictions and requirements are less then 4.5% in reach, and less then 125m. The validity of the predicted performance holds for a wider range of stress conditions.

6.3.1 Building blocks of the receiver performance model.

The receiver performance model for ETSI compliant SDSL is build-up from the following building blocks:

- The echo-loss model, specified in clause 7.2
- The basic model for the input block, specified in clause 5.1
- The generic PAM detection model, specified in clause 5.2.2
- The parameter values specified in table 8 of the succeeding clause.

6.3.2 Parameters, of the receiver performance model.

The parameter values, used in the receiver performance model for ETSI compliant SDSL, are summarized in table 8. Part of them are directly based on SDSL specifications. The remaining values are based on theory.
Various parameters are derived from the above-mentioned parameters. Their purpose is to simplify the required expression of the used PAM-detection model.

Model parameter		***PAM model***	
		≤ 256 kb/s	**> 256 kb/s**
SNR-Gap (effective)	$\Gamma_{\_dB}$	6.95 dB	6.25 dB
SNR-Gap in parts	Γ_{PAM_dB} $\Delta\Gamma_{coding\_dB}$ $\Delta\Gamma_{impl\_dB}$	*9.75 dB* *4.4 dB* *1.6 dB*	*9.75 dB* *5.1 dB* *1.6 dB*
Echo suppression	η_e	∞	
Receiver noise	P_{RN0_dB}	–140 dBm @ 135 Ω	
Data rate	f_d	192 … 2304 kb/s	
Line rate	f_b	f_d + 8 kb/s	
bits per symbol	b	3	
Summation bounds in PAM model	N_H N_L	+1 –2	
Derived Parameter			
Required SNR	SNR_{req}	$\Gamma\times(2^{2b}-1)$	
	SNR_{req_dB}	*≈18 dB*	
Symbol rate	f_s	f_b / 3	

Table 8. Values for the parameters of the performance model, obtained from ETSI requirements for SDSL [3]. The echo suppression is captured in the overall implementation loss ($\Delta\Gamma_{impl}$)

End of literal text proposals

Hidden definitions: