TITLE **Transmitter models for ISDN.2B1Q & HDSL.2B1Q modems**

PROJECTS Spectral Management, part 2; study points 2-8 and 2-11

SOURCE: KPN

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STATUS for Decision

ABSTRACT Part 2 of SpM requires a range of calculation blocks, including transmitter models for the 2B1Q-variants of ISDN and HDSL. A Tabular approach was proposed before, following the assumption used by FSAN for years. ETSI-TM6 has indicated preference for a formula approach rather than a tabular approach. This contribution provides the requested formula approach.

1. Rationale behind this proposal

Part 2 of the Spectral management report [1] requires the description of various transmitter models, including models dedicated to the 2B1Q variants of ISDN and HDSL. An adequate model for the PSD templates of these systems was proposed before [3], following the assumption used within FSAN for years. This model was defined in a tabular way, however ETSI-TM6 has indicated to give preference for a formula approach rather than a tabular approach.
In this contribution, we provide a similar model, but now following the requested formula approach

Table 1 and 2 show the proposed formulas, based on the (theoretical) *sync*-curves of 2B1Q encoded signals. The addition of low-pass filtering makes that there is no simple relation between maximum PSD level and envelope power. Therefore an empirical scaling factor q_N has been introduced to facilitate this. The result is that the parameter P_0 equals the envelope power, and its value has been made equal to the maximum power allowed by the standard.

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 by the theoretical sinc-shape of 2B1Q encoded signals ($P_1(f)$) with a noise floor ($P_2(f)$). The PSD is the maximum of both power density curves, as summarized in Table 1. The coefficient q_N scales the total signal power of $P_1(f)$ to a value that equals P_0. The source impedance equals 135Ω.

$$P_1(f) = q_N \cdot K_{ISDN} \cdot \frac{2}{f_0} \cdot \mathrm{sinc}^2\left(f/f_0\right) \cdot \frac{1}{\left[1+\left(f/f_0\right)^{2\cdot N}\right]} \quad \text{[W/Hz]}$$

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

$$P(f) = \max(P_1(f), P_2(f)) \quad \text{[W/Hz]}$$

Where:

$$K_{ISDN} = (10^{(P_0/10)})/1000 \quad \text{[W]}$$

R_S=135 Ω and sinc(x) = sin(π·x) / (π·x)

Type	q_N	f_0	N	P_0	P_{floor}
ISDN.2B1Q	1.1257	80 kHz	2	13.5 dBm	-120 dBm/Hz

Table 1: PSD template for modeling "ISDN.2B1Q".

NOTE: For out-of-band frequencies, the PSD template is guided by noise floor being defined in the ISDN standard. The resulting envelope power of that PSD-template is close to the maximum power that is allowed by the ISDN standard.

4.3 Cluster 3 transmitter models

4.3.1 Transmitter model for "HDSL.2B1Q"

The PSD template for modeling the "HDSL.2B1Q" transmit spectrum is defined by the theoretical sinc-shape of 2B1Q encoded signals (P_1(f)) with a noise floor (P_2(f)) as defined in [2]. The PSD 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. The source impedance equals 135Ω.

$$P_1(f) = q_N \cdot K_{HDSL} \cdot \frac{2}{f_0} \cdot \mathrm{sinc}^2\left(f/f_0\right) \cdot \frac{1}{\left[1+\left(f/f_{3dB}\right)^{2\cdot N}\right]} \quad \text{[W/Hz]}$$

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

$$P(f) = \max(P_1(f), P_2(f)) \quad \text{[W/Hz]}$$

Where:

$$K_{HDSL} = (10^{(P_0/10)})/1000 \quad \text{[W]}$$

R_S=135 Ω and sinc(x) = sin(π·x) / (π·x)

Type	f_0	f_{3dB}	q_N	N	P_0	P_{floor}
HDSL.2B1Q/1	*1160 kHz*	*485 kHz*	*1.322*	*3*	*14 dBm*	*-121.5 dBm/Hz*
HDSL.2B1Q/2	*584 kHz*	*292 kHz*	*1.322*	*3*	*14 dBm*	*-119 dBm/Hz*
HDSL.2B1Q/3	*392 kHz*	*196 kHz*	*1.322*	*3*	*14 dBm*	*-117 dBm/Hz*

Table 2: PSD template for modeling "HDSL.2B1Q".

NOTE: For out-of-band frequency the PSD template is guided by the noise floor being defined in the HDSL standard. The resulting envelope power of that PSD-template is close to the maximum power that is allowed by the HDSL standard.

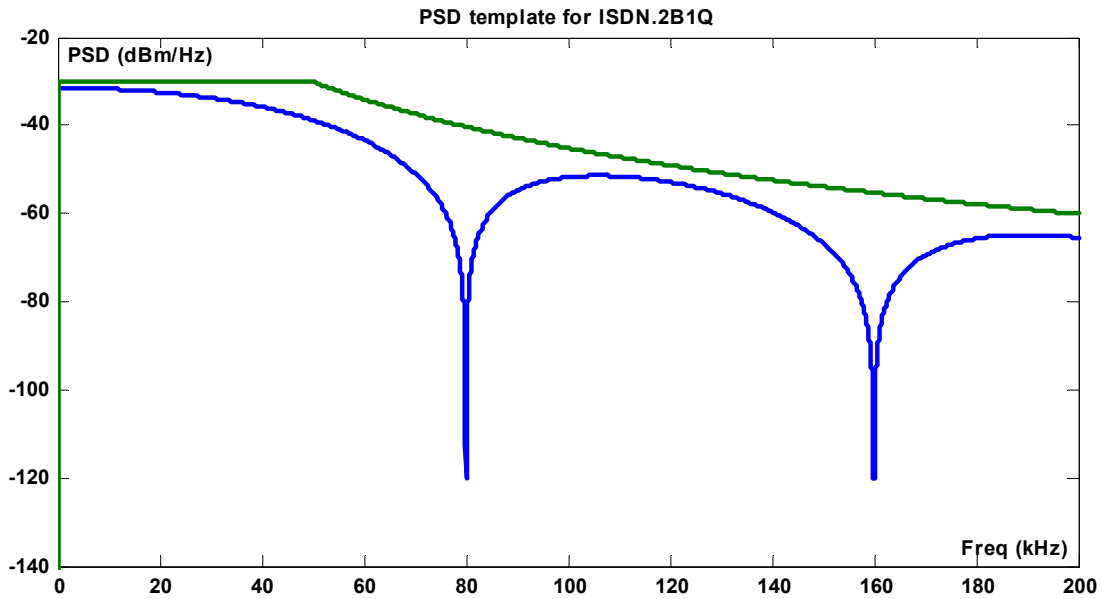
End of literal text proposal

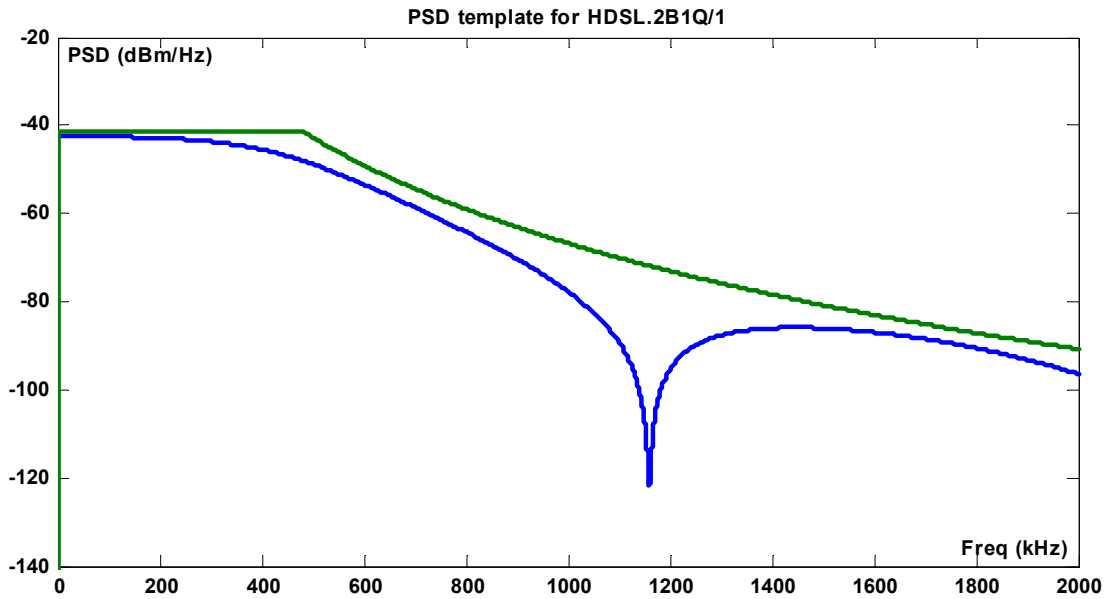
3. Conclusions

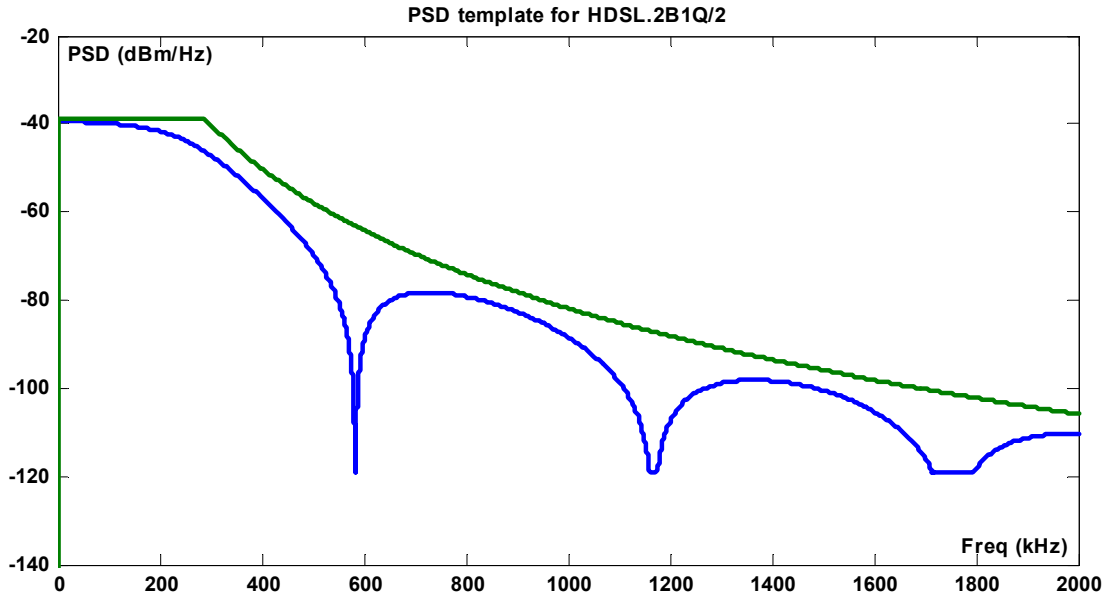
This contribution seeks an agreement in ETSI TM6 related to the spectral management part 2 report. The proposed PSD templates for ISDN.2B1Q and HDSL.2B1Q are based on the theoretical sinc formula, and do also approximate the transmit spectrum of commercially available HDSL system.

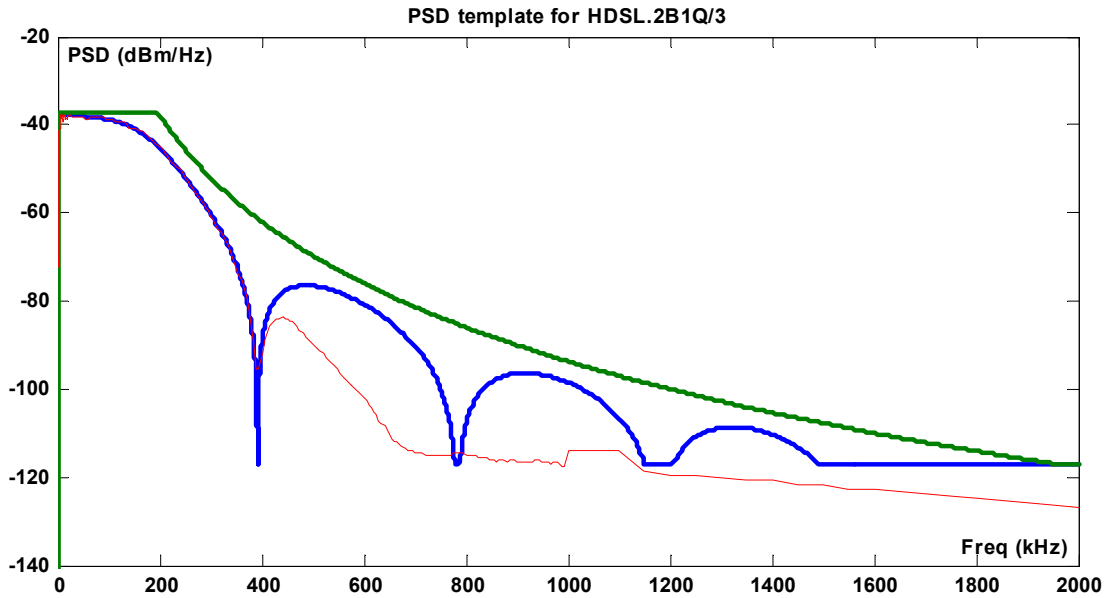
4. Appendix

Figure 1 depicts the comparison of the proposed PSD template for ISDN 2B1Q with ETSI Mask. The shape of the first lob is in line with what has been used within FSAN. The proposed PSD does not violate the ETSI Mask.
Figure 2, 3 and 4 do the same for the proposed PSD template for HDSL 2B1Q. Figure 4 has also a curve based on measurement on a 3-pair HDSL modem [4]. This comparison shows a good match beteen measurement and first lob. Higher lobs look more different, probably due to a higher order filtering in the modem being tested. This is implementation specific, and not mandatory by the ETSI mask, so we have chosen to include that in the proposed template.









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 101 135 v1.5.2, “Transmission and Multiplexing (TM); High bit-rate Digital Subscriber Line (HDSL) transmission systems on metallic local lines; HDSL core specification and application for combined ISDN-BA and 2048 kbit/s transmission”, ETSI technical Specification RTS/TM-06014, September 1999.

[3] 022t36, Sophia 2002 - Transmitter models for performance evaluations - KPN

[4] Private communications with Josef Waldinger (Siemens), about measurement result on Siemens equipment.