TITLE	**Description of "VDSL2-NL2" signals, for spectral management in the Netherlands.**
PROJECT	SpM-1

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STATUS: For decision and inclusion into SpM-1

ABSTRACT[1]: This contribution proposes a second signal description for VDSL2, fully tailored to the Dutch access network, for inclusion into SpM-1 (ETSI TR 101 830-1). This second one is for use "over ISDN", while the previous one is for use "over POTS". It has been derived from band plan 998, uses PSD mask B8-6 (up to 12 MHz), and is shaped in such a way that systems (from the cabinet) complying with these signal limits can coexist with deployed systems (from the local exchange).

1. Introduction

Background of enhancing SpM-1 with country-specific VDSL2 signal descriptions.
In a previous contribution [5] we proposed a description of shaped VDSL2 signal description for use over POTS. The proposal in [5] was to include the attached signal description to the "library" of descriptions already captured in ETSI TR 101 830-1 (Spectral Management part 1). By the inclusion of such signal descriptions in SpM-1, ETSI will by no means impose anybody to make use of these limits. Using it is purely an issue of national concern and national regulation.
Next, we invited operators from other countries to communicate similar limits, tailored to their own needs, and to contribute it also for inclusion in SpM-1. Such an inclusion will serve both operators and vendors need, especially to enable and stimulate that VDSL2 products from different vendors are flexible enough (and well prepared) to operate within all these (national) limits. These considerations stimulated ETSI TM6 to open a new work item for revising SpM-1 by adding such signal descriptions.

Current status in the Netherlands
The VDSL2 signal descriptions in [5] and the present contribution were designed to become mandatory in the Netherlands. *Technical* objections against these limits were not raised against the proposed VDSL2 signal descriptions. Therefore these two signal descriptions have been officially published on the website of the Dutch network owner (http://www.kpn-wholesale.com/) in the so called "reference offer subloop unbundling".
Our first proposal in [5] addressed only the application where VDSL2 and POTS are sharing the same line. Other applications were note foreseen. However, to comply with Dutch regulations this second description (for use "over ISDN") was designed as well.

About the proposed signal description "VDSL2-NL2"
It is obvious that the "over ISDN" signal description (VDSL2-NL2) is very similar to the previous "over POTS" signal description (VDSL2-NL1) [5]. For your convenience, we have highlighted the

[1] **The scientific work behind this contribution has also been funded by MUSE, a European consortium of vendors, operators and knowledge institutes, cooperating within the 6th framework programme of the European Commission.**

relevant differences in the text in yellow. The differences are concentrated at aggregate power and lower frequencies, to make room for spectra generated by ISDN systems:

- The signal description is based on the B8-6 VDSL2 mask [1]
- The upstream band US0 starts at 120 kHz and stops at 276 kHz
- The first downstream band starts at 276 kHz.

For further introduction please refer to the “VDSL2-NL1” (over POTS) signal description [5].
We propose to include both the “VDSL2-NL1” and “VDSL2-NL2” descriptions in a revised SpM-1 standard.

2. Full description of the proposed signals

START OF LITERAL TEXT PROPOSAL
(References to clauses without further specification refer to the SpM-1 standard itself)

2.1. "VDSL2-NL2” (over ISDN) signals

This category covers signals up to 12 MHz, generated by VDSL2 transmission equipment using band plan 998 (limit PSD mask B8-6). These signals may share the same wire pair with ISDN signals.
This signal description is derived from the ITU VDSL2 recommendation [1], and enhanced by loop dependent PSD shaping, also known as downstream Power Backoff. The signal limits are therefore dependent on the insertion loss (IL) of the loop (“primary cable”) between the local exchange and cabinet, measured at 300 kHz into a resistive load of 100 Ω.
The limits in this description are specified for a discrete number of (integer) IL-values. For all other IL-values, the limits for the nearest specified IL-values apply, and not by means of interpolating limits.
A signal can be classified as a “VDSL2-NL2” (over ISDN) signal if it is compliant with all clauses below.

2.1.1. Total signal power (downstream only)

To be compliant with this signal category, the mean downstream signal power into a resistive load of 100 Ω shall not exceed the levels given in table 1, measured within a frequency band from at least 4 kHz to 30 MHz. In the special case of VDSL2 deployment from the local exchange, the limits associated with IL=0 apply.

Table 1: Total downstream signal power as function of the measured insertion loss of the loop between local exchange and cabinet.

IL [dB @ 300 kHz]	Downstream Total signal power [dBm]	L [m]
0	20,8	0
1	19,5	101
2	18,4	202
3	17,4	303
4	16,4	404
5	15,5	506
6	14,8	607
7	14,1	708
8	13,6	809
9	13,1	910
10	12,7	1011
11	12,4	1112
12	12,1	1213
13	11,9	1315
14	11,8	1416
15	11,7	1517
16	11,6	1618
17	11,5	1719
18	11,5	1820
19	11,4	1921
20	11,4	2022
21	11,4	2123
22	11,4	2225
23	11,3	2326
24	11,3	2427
25	11,6	2528
26	11,8	2629
27	12,1	2730
28	12,3	2831
29	12,5	2932
30	12,6	3034
31	12,8	3135
32	12,9	3236
33	13,1	3337
34	13,3	3438
35	13,5	3539
36	13,8	3640
37	14,0	3741
38	14,3	3842
39	14,7	3944
40	15,0	4045
41	15,4	4146
42	16,1	4247
43	16,6	4348
44	17,1	4449
45	17,5	4550
>45	17,5	>4550

NOTE 1: The IL-values are normative. The L-values are informative and represent estimated loop lengths for a commonly used Dutch cable.

NOTE 2: Current implementations of VDSL2 transmitters, compliant with [1], are not expected to be capable of generating output powers of more then 20,5 dBm

NOTE 3: The power limit specified for IL>45 dB may be too restrictive for VDSL2; refinement is for further study.

2.1.2. Total signal power (upstream only)

To be compliant with this signal category, the mean upstream signal power into a resistive load of 100 Ω shall not exceed a level of +14,5 dBm, measured within a frequency band from at least 4 kHz to 30 MHz.

NOTE: This power limit is based on maxima specified in [1]. The use of (mandatory) upstream Power Back-off is foreseen, but left for further study

Reference: ITU- T Recommendation G.993.2 [1], chapter 6.

2.1.3. Peak amplitude (upstream and downstream)

To be compliant with this signal category, the nominal voltage peak of the largest signal pulse into a resistive load of 100 Ω shall not exceed a level of 19V (38 V peak-peak), measured within a frequency band from at least 100 Hz to 30 MHz. The definition and measurement method of peak amplitude is specified in clause 13.1.

2.1.4. Narrow-band signal power (downstream only)

To be compliant with this signal category, the Narrow-Band Signal Power (NBSP) into a resistive load impedance ***R*** for a given IL-value, shall not exceed the limits given in table 2 and table 3, at any point in the frequency range 100 Hz to 30 MHz. These tables specify the break points of these limits. Limits for intermediate frequencies can be found by drawing a straight line between the break points on a logarithmic (Hz) - linear (dB) scale below 2500 kHz and on a linear (Hz) - linear (dB) scale above 2500 kHz. Figure 1 and figure 2 illustrate the NBSP in a bandwidth-normalized way.
The NBSP is the average power ***P*** of a sending signal into a load resistance ***R***, within a *power* bandwidth ***B***. The measurement method of the NBSP is described in clause 13.2.

NOTE 1: The NBSP specification in table 2 is reconstructed from the commonly used PSD specifications in [1] (similar to figure 1), and used here since it is much wider applicable. This enables a unified specification method. PSD specifications are adequate when signals are purely random in nature, but cannot cover harmonic components in a signal (would cause infinite high "PSD" levels at these harmonic frequencies). NBSP specifications cover both signal types.

NOTE 2: The NBSP specification of this signal category has been split into three overlapping limits: "X", “Y” and "Z". All these upper limits shall hold simultaneously. The 10 kHz bandwidth values represent the "maximum PSD values" [1], and includes the pass band ripple. The 100 kHz bandwidth values represent the "average PSD values" in the passband to smooth out the spectral ripple of 3,5 dB. The 1 MHz bandwidth specification is equivalent to the sliding window specification being common for ADSL (see [3] and [5]).

Reference: ITU-T Recommendation G.993.2 [1], clause B.2.5.

The description of this signal characteristic is derived from VDSL2 “band plan 998” signals with PSD mask “B8-6”. Downstream PSD Shaping has been applied between 101.2 KHz and 2500 kHz.

Table 2: Break points of the narrow-band power limits

Centre frequency f	Impedance R	Signal Level P	Power bandwidth B	Spectral Power P/B	
0,1 kHz	600 Ω	-77,5 dBm	100 Hz	-97,5 dBm/Hz	“X”
4 kHz	600 Ω	-77,5 dBm	100 Hz	-97,5 dBm/Hz	
4 kHz	100 Ω	-52,5 dBm	10 kHz	-92,5 dBm/Hz	
80 kHz	100 Ω	-52,5 dBm	10 kHz	-92,5 dBm/Hz	
f_1	100 Ω	P_1 + 40 dB	10 kHz	P_1	
f_2	100 Ω	P_2 + 40 dB	10 kHz	P_2	

Centre frequency f	Impedance R	Signal Level P	Power bandwidth B	Spectral Power P/B	
f_3	100 Ω	P_3 + 40 dB	10 kHz	P_3	
f_4	100 Ω	P_4 + 40 dB	10 kHz	P_4	
f_5	100 Ω	P_5 + 40 dB	10 kHz	P_5	
f_6	100 Ω	P_6 + 40 dB	10 kHz	P_6	
f_7	100 Ω	P_7 + 40 dB	10 kHz	P_7	
f_8	100 Ω	P_8 + 40 dB	10 kHz	P_8	
f_9	100 Ω	P_9 + 40 dB	10 kHz	P_9	
f_{10}	100 Ω	P_{10} + 40 dB	10 kHz	P_{10}	
f_{11}	100 Ω	P_{11} + 40 dB	10 kHz	P_{11}	
f_{12}	100 Ω	P_{12} + 40 dB	10 kHz	P_{12}	
f_{13}	100 Ω	P_{13} + 40 dB	10 kHz	P_{13}	
f_{14}	100 Ω	P_{14} + 40 dB	10 kHz	P_{14}	
2500 kHz	100 Ω	-8,8 dBm	10 kHz	-48,8 dBm/Hz	
3749,999 kHz	100 Ω	-11,2 dBm	10 kHz	-51,2 dBm/Hz	
3750 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
3925 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
4925 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
5025 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
5199,999 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
5200 kHz	100 Ω	-12,7 dBm	10 kHz	-52,7 dBm/Hz	
8499,999 kHz	100 Ω	-14,8 dBm	10 kHz	-54,8 dBm/Hz	
8500 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
8675 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
50 kHz	100 Ω	-46 dBm	100 kHz	-96 dBm/Hz	"Y"
80 kHz	100 Ω	-46 dBm	100 kHz	-96 dBm/Hz	
f_1	100 Ω	P_1 + 46,5 dB	100 kHz	P_1 –3,5 dB	
f_2	100 Ω	P_2 + 46,5 dB	100 kHz	P_2 –3,5 dB	
f_3	100 Ω	P_3 + 46,5 dB	100 kHz	P_3 –3,5 dB	
f_4	100 Ω	P_4 + 46,5 dB	100 kHz	P_4 –3,5 dB	
f_5	100 Ω	P_5 + 46,5 dB	100 kHz	P_5 –3,5 dB	
f_6	100 Ω	P_6 + 46,5 dB	100 kHz	P_6 –3,5 dB	
f_7	100 Ω	P_7 + 46,5 dB	100 kHz	P_7 –3,5 dB	
f_8	100 Ω	P_8 + 46,5 dB	100 kHz	P_8 –3,5 dB	
f_9	100 Ω	P_9 + 46,5 dB	100 kHz	P_9 –3,5 dB	
f_{10}	100 Ω	P_{10} + 46,5 dB	100 kHz	P_{10} –3,5 dB	
f_{11}	100 Ω	P_{11} + 46,5 dB	100 kHz	P_{11} –3,5 dB	
f_{12}	100 Ω	P_{12} + 46,5 dB	100 kHz	P_{12} –3,5 dB	
f_{13}	100 Ω	P_{13} + 46,5 dB	100 kHz	P_{13} –3,5 dB	
f_{14}	100 Ω	P_{14} + 46,5 dB	100 kHz	P_{14} –3,5 dB	
2500 kHz	100 Ω	-2,3 dBm	100 kHz	-52,3 dBm/Hz	
3749,999 kHz	100 Ω	-4,5 dBm	100 kHz	-54,7 dBm/Hz	
3750 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
3894 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
3999,999 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
4000 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
5055 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
5056 kHz	100 Ω	-62 dBm	100 kHz	-99,9 dBm/Hz	
5199,999 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
5200 kHz	100 Ω	-6,2 dBm	100 kHz	-56,2 dBm/Hz	
8499,999 kHz	100 Ω	-8,3 dBm	100 kHz	-58,3 dBm/Hz	
8500 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
8644 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
8645 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
30000 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
9145 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	"Z"
30000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
Note 1: The limits between breakpoints shall be obtained by interpolation between adjacent					

Centre frequency f	Impedance R	Signal Level P	Power bandwidth B	Spectral Power P/B	
breakpoints on a dB/ log(f) basis below 2500 kHz and on a dB/f basis above 2500 kHz Note 2: The limits “Y” between 50 kHz and 2500 kHz are 3,5 dB lower then the associated limits “X”. This may be a bit too restrictive for VDSL2 when the PSD slope in this shaping region becomes steep. Refinements for the limits at these breakpoints require further study.					

Table 3: Definition of parameter f_i and P_i, (with i = 1 to 14) as used in table 2. Note: N/A in the table denotes that a breakpoint is not used.

IL		f_1 P_1	f_2 P_2	f_3 P_3	f_4 P_4	f_5 P_5	f_6 P_6	f_7 P_7	f_8 P_8	f_9 P_9	f_{10} P_{10}	f_{11} P_{11}	f_{12} P_{12}	f_{13} P_{13}	f_{14} P_{14}
0	f	101.2	227.11	275.999	276	1104	1622	2208	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	P	-92.5	-62	-48.5	-36.5	-36.5	-46.5	-48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	f	101.2	227.11	275.999	276	850	1104	1622	2208	2211	N/A	N/A	N/A	N/A	N/A
	P	-92.5	-62	-48.5	-37.3	-38	-38.2	-48.6	-50.3	-48	N/A	N/A	N/A	N/A	N/A
2	f	101.2	227.11	275.999	276	600	1104	1622	2208	2214	N/A	N/A	N/A	N/A	N/A
	P	-92.5	-62	-48.5	-38.1	-38.9	-39.8	-50.6	-52.7	-48	N/A	N/A	N/A	N/A	N/A
3	f	101.2	227.11	275.999	276	600	850	1104	1622	2208	2217	N/A	N/A	N/A	N/A
	P	-92.5	-62	-48.5	-38.9	-40.1	-40.9	-41.5	-52.7	-55.2	-48	N/A	N/A	N/A	N/A
4	f	101.2	227.11	275.999	276	400	600	850	1104	1622	2208	2220	N/A	N/A	N/A
	P	-92.5	-62	-48.5	-39.7	-40.4	-41.4	-42.3	-43.2	-54.8	-57.6	-48	N/A	N/A	N/A
5	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2208	2223	N/A	N/A
	P	-92.5	-62	-48.5	-40.5	-41.4	-42.6	-43.8	-44.9	-51.1	-56.8	-60.1	-48.1	N/A	N/A
6	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2208	2226	2500	N/A
	P	-92.5	-62	-48.5	-41.3	-42.4	-43.8	-45.2	-46.5	-52.9	-58.9	-62.5	-48.1	-48.8	N/A
7	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2208	2229	2500	N/A
	P	-92.5	-62	-48.5	-42.1	-43.4	-45	-46.7	-48.2	-54.8	-61	-65	-48.2	-48.8	N/A
8	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2208	2232	2500	N/A
	P	-92.5	-62	-48.5	-42.9	-44.4	-46.2	-48.1	-49.9	-56.7	-63	-67.5	-48.3	-48.8	N/A
9	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2208	2235	2500	N/A
	P	-92.5	-62	-48.5	-43.7	-45.4	-47.4	-49.6	-51.6	-58.5	-65.1	-69.9	-48.3	-48.8	N/A
10	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2208	2239	N/A	N/A
	P	-92.5	-62	-48.5	-44.6	-46.4	-48.7	-51.1	-53.3	-60.5	-67.3	-72.5	-48.1	N/A	N/A
11	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2208	2242	2500	N/A
	P	-92.5	-62	-48.5	-45.5	-47.5	-50.1	-52.8	-55.2	-62.6	-69.6	-75.3	-48.2	-48.8	N/A
12	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2208	2246	N/A	N/A
	P	-92.5	-62	-48.5	-46.4	-48.6	-51.5	-54.4	-57.1	-64.7	-71.9	-78.1	-48.1	N/A	N/A
13	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2198	2208	2248	N/A
	P	-92.5	-62	-48.5	-47.3	-49.7	-52.8	-56	-58.9	-66.8	-74.2	-80.6	-80	-48.1	N/A
14	f	101.2	227.11	275.999	276	400	600	850	1104	1350	1622	2162	2208	2248	N/A
	P	-92.5	-62	-48.5	-48.1	-50.7	-54.1	-57.6	-60.7	-68.8	-76.4	-82.9	-80	-48.1	N/A
15	f	101.2	227.11	274	276	400	600	850	1104	1350	1622	2129	2208	2248	N/A
	P	-92.5	-62	-49	-49	-51.8	-55.4	-59.1	-62.5	-70.7	-78.6	-85.1	-80	-48.1	N/A
16	f	101.2	227.11	271	276	400	600	850	1104	1350	1622	2097	2208	2248	N/A
	P	-92.5	-62	-49.8	-49.8	-52.8	-56.6	-60.6	-64.2	-72.6	-80.7	-87.2	-80	-48.1	N/A
17	f	101.2	227.11	268	276	400	600	850	1104	1350	1622	2067	2208	2248	N/A
	P	-92.5	-62	-50.6	-50.6	-53.8	-57.8	-62	-65.9	-74.5	-82.8	-89.2	-80	-48.1	N/A
18	f	101.2	227.11	265	276	400	600	850	1104	1350	1622	2039	2208	2248	N/A
	P	-92.5	-62	-51.4	-51.4	-54.7	-59	-63.5	-67.5	-76.3	-84.8	-91.1	-80	-48.1	N/A
19	f	101.2	227.11	262	276	400	600	850	1104	1350	1622	1912	2033	2208	2248
	P	-92.5	-62	-52.1	-52.1	-55.7	-60.2	-64.9	-69.1	-78.1	-86.7	-91.5	-91.5	-80	-48.1
20	f	101.2	227.11	259	276	400	600	850	1104	1350	1622	1782	2033	2208	2248
	P	-92.5	-62	-52.9	-52.9	-56.6	-61.3	-66.2	-70.6	-79.8	-88.7	-91.5	-91.5	-80	-48.1
21	f	101.2	227.11	256	276	400	600	850	1104	1350	1622	1673	2033	2208	2248
	P	-92.5	-62	-53.7	-53.6	-57.5	-62.4	-67.5	-72.2	-81.5	-90.5	-91.5	-91.5	-80	-48.1
22	f	101.2	227.11	253.999	276	400	600	850	1104	1350	1594	2033	2208	2248	N/A
22	P	-92.5	-62	-54.3	-54.3	-58.3	-63.5	-68.8	-73.6	-83.2	-91.5	-91.5	-80	-48.1	N/A
23	f	101.2	227.11	251	276	400	600	850	1104	1350	1540	2033	2208	2248	N/A
	P	-92.5	-62	-55.1	-55	-59.2	-64.5	-70.1	-75.1	-84.8	-91.5	-91.5	-80	-48.1	N/A
24	f	101.2	227.11	249	276	400	600	850	1104	1350	1491	2031	2206	2246	N/A
	P	-92.5	-62	-55.7	-55.7	-60	-65.5	-71.3	-76.5	-86.3	-91.5	-91.5	-80	-48.1	N/A
25	f	101.2	227.11	247	276	400	600	850	1104	1350	1447	1911	2086	2126	N/A
	P	-92.5	-62	-56.3	-56.3	-60.8	-66.5	-72.5	-77.8	-87.8	-91.5	-91.5	-80	-47.8	N/A
26	f	101.2	227.11	244	276	400	600	850	1104	1350	1406	1807	1982	2022	2208
	P	-92.5	-62	-57	-57	-61.6	-67.5	-73.6	-79.2	-89.3	-91.5	-91.5	-80	-47.6	-48
27	f	101.2	227.11	242	276	400	600	850	1104	1369	1693	1868	1908	2208	N/A

IL		f_1 P_1	f_2 P_2	f_3 P_3	f_4 P_4	f_5 P_5	f_6 P_6	f_7 P_7	f_8 P_8	f_9 P_9	f_{10} P_{10}	f_{11} P_{11}	f_{12} P_{12}	f_{13} P_{13}	f_{14} P_{14}
	P	-92.5	-62	-57.6	-57.6	-62.3	-68.4	-74.7	-80.4	-91.5	-91.5	-80	-47.3	-48	N/A
28	f	101.2	227.11	240	276	400	600	850	1104	1334	1593	1768	1808	2208	N/A
	P	-92.5	-62	-58.2	-58.2	-63.1	-69.3	-75.8	-81.7	-91.5	-91.5	-80	-47	-48	N/A
29	f	101.2	227.11	238	276	400	600	850	1104	1301	1505	1680	1720	2208	N/A
	P	-92.5	-62	-58.8	-58.7	-63.8	-70.2	-76.8	-82.9	-91.5	-91.5	-80	-46.8	-48	N/A
30	f	101.2	227.11	236	276	400	600	850	1104	1270	1433	1608	1648	2208	N/A
	P	-92.5	-62	-59.3	-59.3	-64.5	-71	-77.9	-84	-91.5	-91.5	-80	-46.6	-48	N/A
31	f	101.2	227.11	234	276	400	600	850	1104	1240	1380	1555	1595	1622	2208
	P	-92.5	-62	-59.9	-59.9	-65.2	-71.9	-78.9	-85.2	-91.5	-91.5	-80	-46.1	-46.5	-48
32	f	101.2	227.11	232	276	400	600	850	1104	1205	1322	1497	1538	1622	2208
	P	-92.5	-62	-60.6	-60.6	-66	-73	-80.2	-86.7	-91.5	-91.5	-80	-45.1	-46.5	-48
33	f	101.2	227.11	230	276	400	600	850	1104	1172	1268	1443	1485	1622	2208
	P	-92.5	-62	-61.3	-61.3	-66.9	-74	-81.5	-88.2	-91.5	-91.5	-80	-44.2	-46.5	-48
34	f	101.2	227.11	276	400	600	850	1104	1141	1217	1392	1434	1622	2208	N/A
	P	-92.5	-62	-62	-67.8	-75.1	-82.7	-89.6	-91.5	-91.5	-80	-43.6	-46.5	-48	N/A
35	f	101.2	223	276	400	600	850	1104	1111	1169	1344	1387	1622	2208	N/A
	P	-92.5	-62.7	-62.7	-68.6	-76.2	-84	-91.1	-91.5	-91.5	-80	-42.4	-46.5	-48	N/A
36	f	101.2	219	276	400	600	850	1061	1122	1297	1341	1622	2208	N/A	N/A
	P	-92.5	-63.4	-63.4	-69.5	-77.2	-85.3	-91.5	-91.5	-80	-41.6	-46.5	-48	N/A	N/A
37	f	101.2	215	276	400	600	850	1009	1077	1252	1296	1622	2208	N/A	N/A
	P	-92.5	-64.1	-64.1	-70.4	-78.3	-86.6	-91.5	-91.5	-80	-41	-46.5	-48	N/A	N/A
38	f	101.2	211	276	400	600	850	962	1036	1211	1256	1622	2208	N/A	N/A
	P	-92.5	-64.8	-64.8	-71.2	-79.4	-87.9	-91.5	-91.5	-80	-39.9	-46.5	-48	N/A	N/A
39	f	101.2	207	276	400	600	850	919	996	1171	1217	1622	2208	N/A	N/A
	P	-92.5	-65.5	-65.5	-72.1	-80.5	-89.2	-91.5	-91.5	-80	-39	-46.5	-48	N/A	N/A
40	f	101.2	203	276	400	600	850	880	959	1134	1180	1622	2208	N/A	N/A
	P	-92.5	-66.2	-66.2	-73	-81.5	-90.4	-91.5	-91.5	-80	-38.3	-46.5	-48	N/A	N/A
41	f	101.2	199	276	400	600	843	921	1096	1143	1622	2208	N/A	N/A	N/A
	P	-92.5	-67	-66.9	-73.8	-82.6	-91.5	-91.5	-80	-37.4	-46.5	-48	N/A	N/A	N/A
42	f	101.2	196	276	400	600	803	857	1032	1079	1104	1622	2208	N/A	N/A
	P	-92.5	-67.6	-67.6	-74.7	-83.7	-91.5	-91.5	-80	-36.5	-36.5	-46.5	-48	N/A	N/A
43	f	101.2	192	276	400	600	768	800	975	1021	1104	1622	2208	N/A	N/A
	P	-92.5	-68.4	-68.4	-75.6	-84.8	-91.5	-91.5	-80	-36.7	-36.5	-46.5	-48	N/A	N/A
44	f	101.2	188	276	400	600	735	749	924	970	1104	1622	2208	N/A	N/A
	P	-92.5	-69.1	-69.1	-76.4	-85.8	-91.5	-91.5	-80	-36.5	-36.5	-46.5	-48	N/A	N/A
45	f	101.2	185	276	400	600	703	877	922	1104	1622	2208	N/A	N/A	N/A
	P	-92.5	-69.8	-69.8	-77.3	-86.9	-91.4	-80	-36.5	-36.5	-46.5	-48	N/A	N/A	N/A
>45	f	101.2	185	276	400	600	703	877	922	1104	1622	2208	N/A	N/A	N/A
	P	-92.5	-91.5	-91.5	-91.5	-91.5	-91.4	-80	-36.5	-36.5	-46.5	-48	N/A	N/A	N/A

NOTE 1: The label "N/A" denotes that a breakpoint is not used.

NOTE 2: The breakpoints for IL > 45 dB may be too restrictive for VDSL2, refinements are for further study.

In the special case that VDSL2 is deployed from the local exchange, the IL-value is zero. Figure 1 illustrates the limits of the spectral powers (measured in 10 kHz and in 100 kHz) as function of the frequency, according to the specifications in table 2 and table 3.

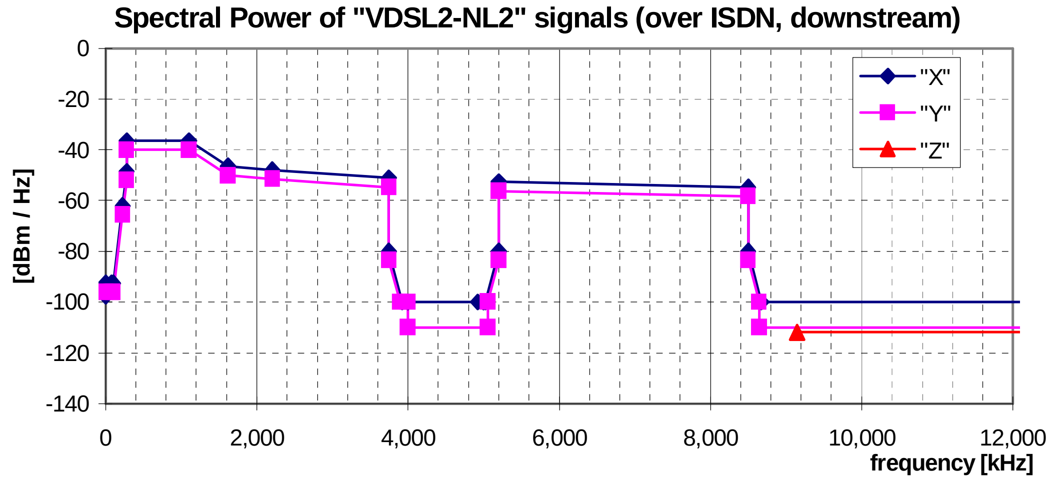

Figure 1: Spectral Power for "VDSL2-NL2" (over ISDN) signals, as specified in table 2 and table 3 for IL=0 dB.

When VDSL2 is deployed from the cabinet, shaping of the above spectral powers between 276 kHz and 2500 kHz can be significant. Figure 2 illustrates the limits of these spectral powers (measured in 10 kHz and in 100 kHz) for various IL-values. (for IL =10 dB, IL=20 dB and IL=40 dB).

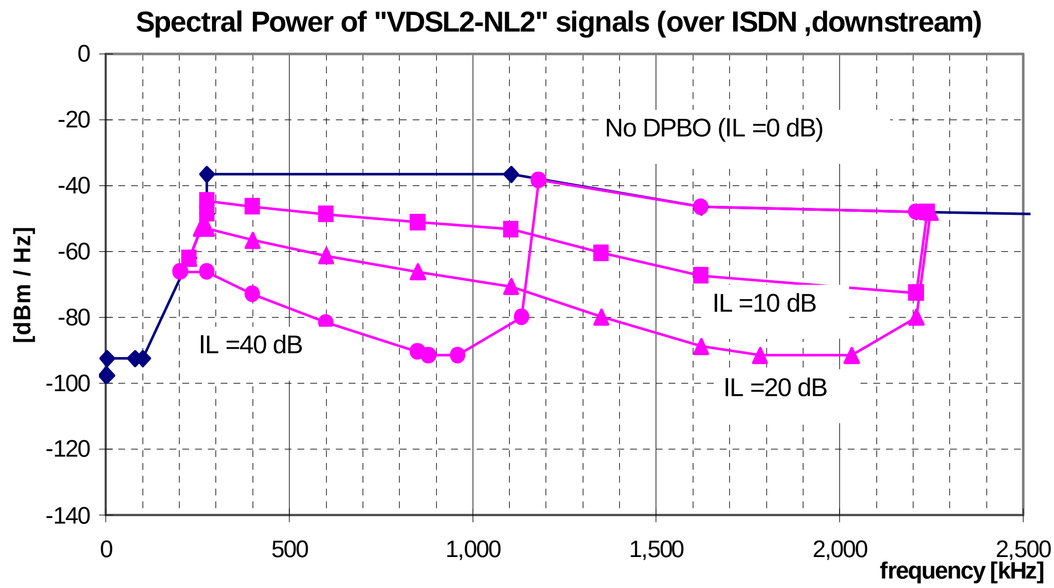

Figure 2: Spectral Power for "VDSL2-NL2" (over ISDN) signals, as specified in table 2 and table 3 in the frequency region where Downstream PSD Shaping has been applied.

2.1.5. Narrow-band signal power (upstream only)

To be compliant with this signal category, the Narrow-Band Signal Power (NBSP) into a resistive load impedance R, shall not exceed the limits given in table 4, at any point in the frequency range 100 Hz to 30 MHz. This table specifies the break points of these limits. Limits for intermediate frequencies can be found by drawing a straight line between the break points on a logarithmic (Hz) - linear (dB) scale below 3575 KHz and linear (Hz) - linear (dB) scale above 3575 KHz. Figure 3 illustrates the NBSP in a bandwidth-normalized way.

The NBSP is the average power ***P*** of a sending signal into a load resistance ***R***, within a *power* bandwidth ***B***. The measurement method of the NBSP is described in clause 13.2

NOTE 1: The NBSP specification in table 4 is reconstructed from the commonly used PSD specifications in [1] (similar to figure 3), and used here since it is much wider applicable. This enables a unified specification method. PSD specifications are adequate when signals are purely random in nature, but cannot cover harmonic components in a signal (would cause infinite high "PSD" levels at these harmonic frequencies). NBSP specifications cover both signal types.

NOTE 2: The NBSP specification of this signal category has been split into two overlapping limits: "X" and "Y". Both upper limits shall hold simultaneously. The 10 kHz bandwidth values represent the "maximum PSD values" from [1], and includes the pass band ripple. The 100 kHz bandwidth values represent the "average PSD values" in the passband to smooth out the spectral ripple of 3,5 dB. The 1 MHz bandwidth specification is equivalent to the sliding window specification being common for ADSL (see [3] and [5]).

Reference: ITU-T Recommendation G.993.2 [1], clause B2.4 reconstructed from PSD requirements.

Table 4: Break points of the narrow-band power limits

Centre frequency f	Impedance R	Signal Level P	Power bandwidth B	Spectral Power P/B	
0,1 kHz	600 Ω	-77,5 dBm	100 Hz	-97,5 dBm/Hz	“X”
4 kHz	600 Ω	-77,5 dBm	100 Hz	-97,5 dBm/Hz	
4 kHz	100 Ω	-52,5 dBm	10 kHz	-92,5 dBm/Hz	
50 kHz	100 Ω	-50 dBm	10 kHz	-90 dBm/Hz	
80 kHz	100 Ω	-41,8 dBm	10 kHz	-81,8 dBm/Hz	
120 kHz	100 Ω	5,5 dBm	10 kHz	-34,5 dBm/Hz	
276 kHz	100 Ω	5,5 dBm	10 kHz	-34,5 dBm/Hz	
508,8 kHz	100 Ω	-58 dBm	10 kHz	-98 dBm/Hz	
686 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
783 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
2825 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
3000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
3000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
3575 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
3750 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
3750 kHz	100 Ω	-11,2 dBm	10 kHz	-51,2 dBm/Hz	
5200 kHz	100 Ω	-12,7 dBm	10 kHz	-52,7 dBm/Hz	
5200 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
5375 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
6875 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
7050 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
7050 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
8325 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
8500 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
8500 kHz	100 Ω	-14,8 dBm	10 kHz	-54,8 dBm/Hz	
10000 kHz	100 Ω	-15,5 dBm	10 kHz	-55,5 dBm/Hz	
12000 kHz	100 Ω	-16,5 dBm	10 kHz	-56,5 dBm/Hz	
12000 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
12175 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
14350 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
14351 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
14526 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	

Centre frequency f	Impedance R	Signal Level P	Power bandwidth B	Spectral Power P/B	
50 kHz	100 Ω	-43,5 dBm	100 kHz	-93.5 dBm/Hz	"Y"
80 kHz	100 Ω	-35,3 dBm	100 kHz	-85.3 dBm/Hz	
120 kHz	100 Ω	12 dBm	100 kHz	-38 dBm/Hz	
276 kHz	100 Ω	12 dBm	100 kHz	-38 dBm/Hz	
508,8 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
686 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
783 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
2825 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
2999,999 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
3000 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
3575 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
3749,999 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
3750 kHz	100 Ω	-5,7 dBm	100 kHz	-54,7 dBm/Hz	
5199,999 kHz	100 Ω	-6,2 dBm	100 kHz	-56,2 dBm/Hz	
5200 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
5375 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
6875 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
7049,999 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
7050 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
8325 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
8499,999 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
8500 kHz	100 Ω	-8,3 dBm	100 kHz	-58,3 dBm/Hz	
10000 kHz	100 Ω	-9 dBm	100 kHz	-59 dBm/Hz	
11999,999 kHz	100 Ω	-10 dBm	100 kHz	-60 dBm/Hz	
12000 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
12175 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
14350 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
14351 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
14526 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
30000 kHz	100 Ω	-60 dBm	100 kHz	-110 dBm/Hz	
12675 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	"Z"
14350 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
14351 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
14526 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

NOTE 1: The PSD values between breakpoints shall be obtained by interpolation between adjacent breakpoints as follows:

- below *3575* kHz: on a dB / $\log_{10}(f)$ basis and
- above *3575* kHz: on a dB / f basis

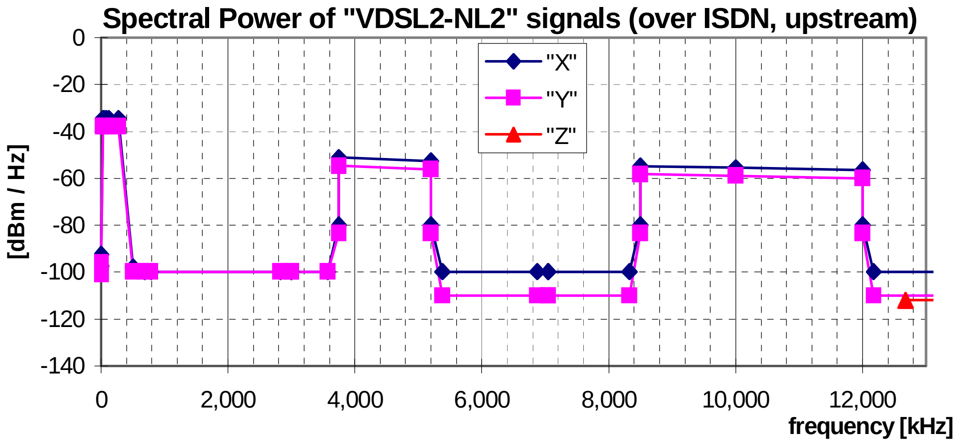

Figure 3: Spectral Power, for “VDSL2-NL2” (over ISDN) signals, as specified in table 4

2.1.6. Unbalance about earth (upstream and downstream)

To be compliant with this signal category, the balance of the signal that may flow through the LT-port or NT-port shall exceed minimum requirements, under the condition that the local loop wiring and its termination is well balanced. This can be verified by a Longitudinal Output Voltage (LOV) and a Longitudinal Conversion Loss (LCL) measurement at the source of that signal, as specified in clause 13.3.2 and 13.3.3. The minimum LOV and LCL requirements hold for what can be observed at the ports of the Local Loop Wiring, when the Local Loop Wiring is replaced by an artificial impedance network described in,clause 13.3.2 and 13.3.3.
The differential termination impedance for LOV and LCL measurements shall be chosen equally to the design impedance R_T = 100 Ω of the Signal Source under test.
The observed LOV shall have an rms voltage of below the value specified in table 5, measured in a *power* bandwidth B, centred over any frequency in the range from f_{min} to f_{max}, and averaged in any one second period. Compliance with this limitation is required with a longitudinal terminating impedance having value $Z_L(\omega) = R_L + 1 / (j\omega \times C_L)$ for all frequencies between f_{min} to f_{max}. Clause 13.3.2 defines an example measurement method for longitudinal output voltage.
The observed LCL shall be higher than the lower limits given in figure 4. The LCL values of the associated break frequencies of this figure are given in table 6. Clause 13.3.3 in defines an example measurement method for longitudinal conversion loss. To be compliant with this signal category, this requirement shall be met for both the switched-on and switched-off mode of the signal source.
Reference: TS 101 270-1, clauses 8.3.3 and E.3.2 [2].

Table 5: Values for the LOV limits

	LOV	B	f_{min}	f_{max}	R_L	C_L
downstream	-46 dBV	10 kHz	5,1 kHz	1 825 kHz	100 Ω	150 nF
upstream	-46 dBV	10 kHz	5,1 kHz	210 kHz	100 Ω	150 nF

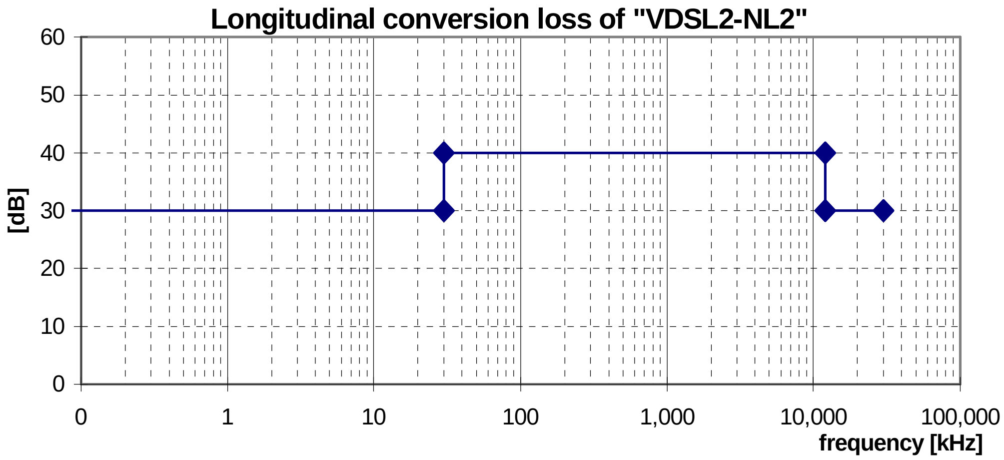

Figure 4: Minimum longitudinal conversion loss

Table 6: Frequencies and LCL values of the breakpoints of the LCL mask in figure 4

Frequency	LCL
< 30 kHz	30 dB
30 kHz	40 dB
12 MHz	40 dB
12 MHz	30 dB
30 MHz	30 dB

END OF LITERAL TEXT PROPOSAL

3. Conclusions and proposal to ETSI-TM6

In this contribution, we presented a full signal description of VDSL2 for use “over ISDN”, tailored to the Dutch access network. This signal description has been published as part of the subloop reference offer in the Netherlands, and its limits are mandatory for gaining access to the sub-loop in the Netherlands.

We propose to add this “VDSL2-NL2” signal description to the library of descriptions in ETSI SpM-1, starting with opening a second study point.

As said before, by the inclusion of the “VDSL2-NL1” and “VDSL2-NL2” signal descriptions in SpM-1, ETSI will by no means impose anybody to make use of these limits. Using it is purely an issue of national concern and national regulation.

Furthermore we invite other operators to propose similar VDSL2 signal descriptions, tailored to their own need, also for inclusion in SpM-1.

4. References

[1] ITU-T Recommendation G993.2: “Very High Speed Digital Subscriber Line 2 (VDSL2)”, Pre- published, Geneva, February 2006

[2] ETSI TS 101 270-1 (V1.4.1): "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional requirements".

[3] ETSI TS 101 388 (V1.3.1): "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Asymmetric Digital Subscriber Line (ADSL) - European specific requirements [ITU-T Recommendation G.992.1 modified]".

[4] ITU-T Recommendation G.992.1: "Asymmetric digital subscriber line (ADSL) transceivers".

[5] ETSI 063t07, "Description of “VDSL2-NL1” signals, for spectral management purposes in the Netherlands".