TITLE **Signal descriptions for various ADSL2plus variants.**

PROJECTS SpM-1

SOURCE: KPN, TNO

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STATUS for Decision

ABSTRACT Many operators in Europe are close to deploying ADSL2plus. Therefore, several regulators and involved operators are extending their (national) access rules to enable ADSL2plus systems to be deployed. ETSI can help them by providing adequate signal descriptions for SpM purposes, but the signal library of SpM part 1 does currently not include descriptions of ADSL2plus signals. This contribution provides a literal text proposal for inclusion into a revised “part 1”.

1. Introduction

Many operators in Europe are close to deploying ADSL2plus. Therefore, several regulators and involved operators are extending their (national) access rules to enable ADSL2plus systems to be deployed. ETSI can help them by providing adequate signal descriptions for SpM purposes, but the signal library of SpM part 1 does currently not include descriptions of ADSL2plus signals.

In this contribution, we propose literal text for several variants of ADSL2plus, for inclusion into a revised version of SpM “part 1” (TR 101 830-1). The PSD masks for ADSL2plus prescribed in the ITU-T Recommendation G.992.5 are used as basis for the signal definitions for ADSL2plus in the signal library of SpM part 1. On several details these mask were tailored to PSD masks which are directly usable for SpM questions.

Note that the PSD masks proposed in this contribution as fully based on the ITU-T Recommendation G.992.5, only small adaptations were performed. If significant deviations with the ITU-T standard are observed in this text, they were unintentional.

2. The proposed signal descriptions

The ADSL2plus standard [G992.5] contains, for Europe, five interesting variants described in 5 different annexes specifying 10 different ADSL2plus applications. Generally, the annexes differ in the used sub-carriers and their associate transmission power spectrum. Table 1 gives an overview of the different ADSL2plus annexes and their reference to the concerning clause in G992.5 for the PSD masks definition.

We elaborated the signal descriptions of 10 different ADSL2plus variants, resulting in the literal text proposal in chapter 4. The format is similar to the descriptions being available in SpM “part 1”, so most of it is self-explanatory.

Table 1: Overview of the different ADSL2plus Annexes and their references to the appropriate masks

Annex		ATU-C Downstream [G992.5]	ATU-R Upstream [G992.5]
ADSL2plus/A	POTS shared	A.1.2	A.2.2[1]
FDD.ADSL2plus/A	POTS shared	A.1.3	A.2.2[1]
ADSL2plus/B	ISDN shared	B.1.2	B.2.2[1]
FDD.ADSL2plus/B	ISDN shared	B.1.3	B.2.2[1]
ADSL2plus/I	All Digital Mode	I.1.2	I.2.2
FDD.ADSL2plus/I	All Digital Mode	A.1.3	I.2.2
ADSL2plus/J	All Digital Mode with extended upstream	I.1.2	J.2.2[2]
FDD.ADSL2plus/J	All Digital Mode with extended upstream	B.1.3	J.2.2[2]
ADSL2plus/M	POTS shared with extended upstream	A.1.2	M.2.2[3]
FDD.ADSL2plus/M	POTS shared with extended upstream	B.1.3	M.2.2[3]
Note 1: The ADSL1 ATU-R Mask is not valid for ADSL2plus because of a steeper slope at the upper edge			
Note 2: The SpM mask is based on the In-band Peak PSD (dBm/Hz) of J.2.2 ADLU-32 and the Frequency f1 (kHz) of J.2.2 ADLU-64			
Note 3: The SpM mask is based on the In-band Peak PSD (dBm/Hz) of M.2.2 EU-32 and the Frequency f1 (kHz) of M.2.2 EU-64			

3. Discussions on the need for Power cut back

There is one issue that has not been resolved in this proposal. That is the question whether *downstream* power cutback has to be included in ADSL2plus signal description for national access rules or not. There are good reasons to leave it out (as is currently the case in our literal text proposal) but there also good reasons to put it in.

Arguments against inclusion of PCB in SpM descriptions

- The ITU standard of ADSL2plus does not include a ***mandatory*** downstream power cut back requirement. Only when an implementation has power cut back on board the ITU standard describes how to exchange the associated parameters. So standard compliant ADSL2plus equipment may be unable to support power cut back.
- Downstream PCB might not be needed for state-of-the-art implementations and has no fundamental SpM purpose. It was (probably) only used in legacy systems to reduce the need for a high dynamic range of the receiver.

Arguments pro inclusion of PCB in SpM descriptions

- There are quite a large number of “legacy” systems (ADSL, SDSL) deployed in the field, and they have to meet a ***mandatory*** power cut back requirement. This is no problem if all disturbers use a similar PCB as well, but if new systems operate at full power, then the installed systems will suffer more from new systems the from legacy systems.
- PCB is mainly an issue at shorter loops, say for instance below 1.5 km, but this range is the most favourable range for taking advantage of the higher bitrate capabilities of ADSL2plus.

Discussion for TM6

So from a fundamental SpM point of view, there is no need for making downstream PCB a mandatory aspect of an access rule. However it is the discrepancy with legacy systems that causes the problem. We don’t have a strong opinion on this, but consider it essential that ETSI TM6 makes a principle decision if the activation of PCB in access rules for ADSL2plus is recommended by ETSI or not.Two options can be considered:

1. Apply the current ADSL1 PCB/PBO requirements also for the signal definition of ADSL2(+), and recommend to make that mandatory in national access rules.
    a. Advantage: it maintains the interest of legacy ADSL.
    b. Disadvantage: the ADSL1 PCB/PBO requirements have limitations. It only takes into account the received upstream power which works for ADSL1 but can result in a degradation of the ADSL2(+) downstream performance.
2. No PCB/PBO requirements on the signal definition of ADSL2(+), and add a note in SpM-1 that legacy deployments may sense a stronger reduction in capacity due to the absence of a mandatory PCB requirement.

a. Advantage: it does not conflict with the ADSL2(+) standard and it leaves the option open for the manufacturers to implement a more advanced solution.
b. It could harm ADSL1 that uses PCB/PBO

In our proposal there is chosen for the second option for the time being. The main argument to chose for the option to have no explicit requirements on the PCB/PBO for ADSL2(+) is that and it leaves the option open to implement a more advanced solution than is implement in ADSL1.

4. Cluster 4 signals (asymmetrical broad band)

This cluster summarizes asymmetrical signals that are generated by digital transmission equipment using a frequency spectrum up to 2.2 MHz, ADSL2plus.

4.1 "ADSL2plus/A" signals (EC, over POTS)

This category covers signals, generated by ADSL2plus transmission equipment with spectrum overlap, i.e. for which the downstream overlaps the upstream. These signals may share the same wire pair with POTS signals.
This clause is based on ITU-T [G.992.5]. A signal can be classified as an "ADSL2plus/A" signal if it is compliant with all clauses below.

4.1.1 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 a level of +20,4 dBm, measured within a frequency band from at least 4 kHz to 7 MHz.
Reference: ITU-T Recommendation G.992.5 [xx], clause A.1.2.2.

4.1.2 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 +12,5 dBm, measured within a frequency band from at least 4 kHz to 7 MHz.
Reference: ITU-T Recommendation G.992.5 [xx], clause A.2.2.2.

4.1.3 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 3 MHz. The definition and measurement method of peak amplitude is specified in clause 13.1.

NOTE: No ETSI deliverable specifies this parameter.

4.1.4 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***, shall not exceed the limits given in table 2, 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. Figure 1 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: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.1.4.

Reference: ITU-T Recommendation G.992.5 [G.992.5], clause A.1.2 reconstructed from PSD requirements.

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	A
4 kHz	600 Ω	-77,5 dBm	100 Hz	-97,5 dBm/Hz	
4 kHz	600 Ω	-72,5 dBm	100 Hz	-92,5 dBm/Hz	
25,875 kHz	100 Ω	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 104 kHz	100 Ω	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 622 kHz	100 Ω	-6,5 dBm	10 kHz	-46,5 dBm/Hz	
2 208 kHz	100 Ω	-7,8 dBm	10 kHz	-47,8 dBm/Hz	
2 500 kHz	100 Ω	-19,4 dBm	10 kHz	-59,4 dBm/Hz	
3 001.5 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
3 175 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
60 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	B
1 104 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	
1 622 kHz	100 Ω	0 dBm	100 kHz	-50 dBm/Hz	
2 208 kHz	100 Ω	-1,3 dBm	100 kHz	-51,3 dBm/Hz	
2 500 kHz	100 Ω	-12,9 dBm	100 kHz	-62,9 dBm/Hz	
3 001.5 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
3 175 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
3 175 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
4 545 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
7 225 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

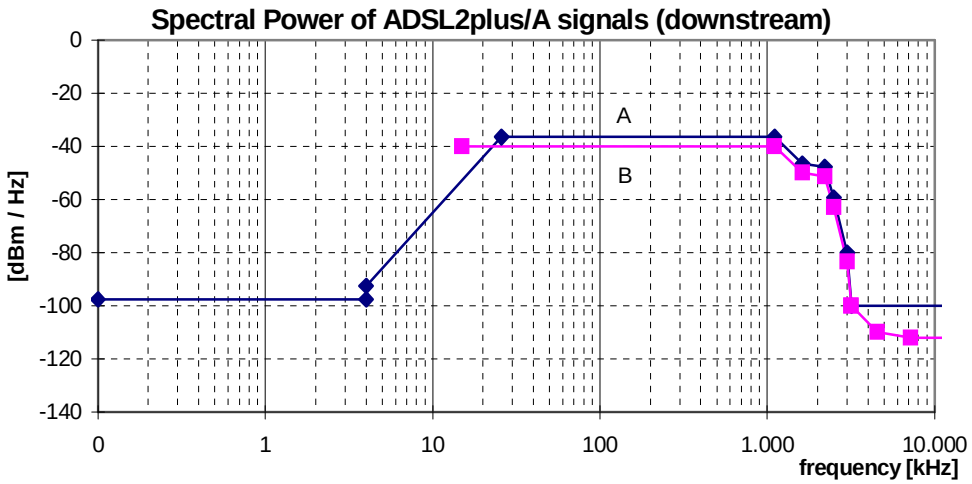

Figure 1: Spectral Power, for downstream ADSL2plus/A, as specified in table 2

Reference: ITU-T Recommendation G.992.5 [xx], clause A.1.2.

4.1.5 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 13, at any point in a frequency range between 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. Figure 10 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: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.1.5.
The ADSL1 ATU-R Mask is not valid for ADSL2plus because of a steeper slope at the edge 138 kHz.

Reference: ITU-T Recommendation G.992.5 [G.992.5], clause A.2.2 reconstructed from PSD requirements.

Table 3: 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	A
4 kHz	600 Ω	-77,5 dBm	100 Hz	-97,5 dBm/Hz	
4 kHz	600 Ω	-72,5 dBm	100 Hz	-92,5 dBm/Hz	
25,875 kHz	100 Ω	+5,5 dBm	10 kHz	-34,5 dBm/Hz	
138 kHz	100 Ω	+5,5 dBm	10 kHz	-34,5 dBm/Hz	
243 kHz	100 Ω	-53,2 dBm	10 kHz	-93,2 dBm/Hz	
686 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
5 275 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
60 kHz	100 Ω	+12 dBm	100 kHz	-38 dBm/Hz	B
138 kHz	100 Ω	+12 dBm	100 kHz	-38 dBm/Hz	
243 kHz	100 Ω	-46,7 dBm	100 kHz	-96,7 dBm/Hz	
686 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
1 411 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
1 411 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
1 630 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
5 275 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

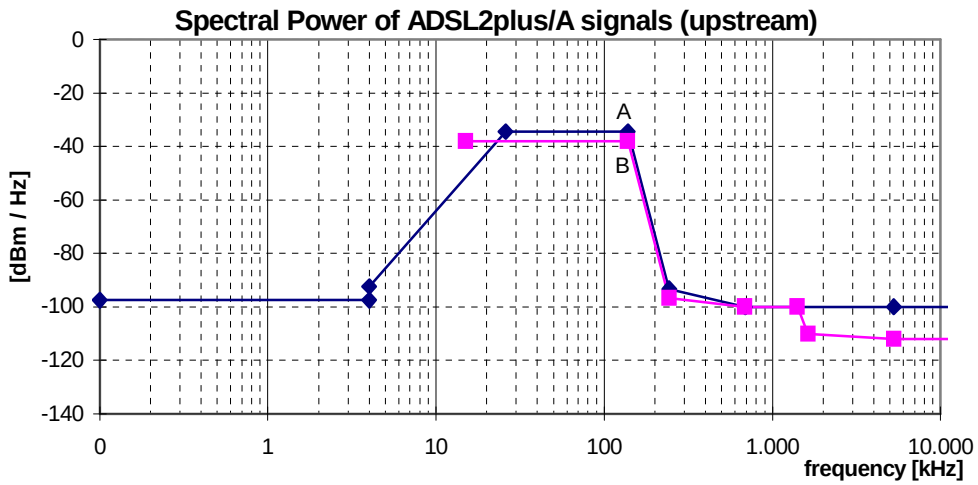

Figure 2: Spectral Power, for upstream ADSL2plus/A signals, as specified in table 3

4.1.6 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. Clause 11.1.6 describes and refers to the concerning sections. Table 4 gives the values for the LOV limits in case of

ADSL2plus while the LCL mask for ADSL2plus is given in figure 3. The LCL values of the associated break frequencies of this figure are given in table 5.

Table 4: Values for the LOV limits

	LOV	B	f_{min}	f_{max}	R_L	C_L
downstream	-46 dBV	10 kHz	5,1 kHz	3650 kHz	100 Ω	150 nF
upstream	-46 dBV	10 kHz	5,1 kHz	210 kHz	100 Ω	150 nF

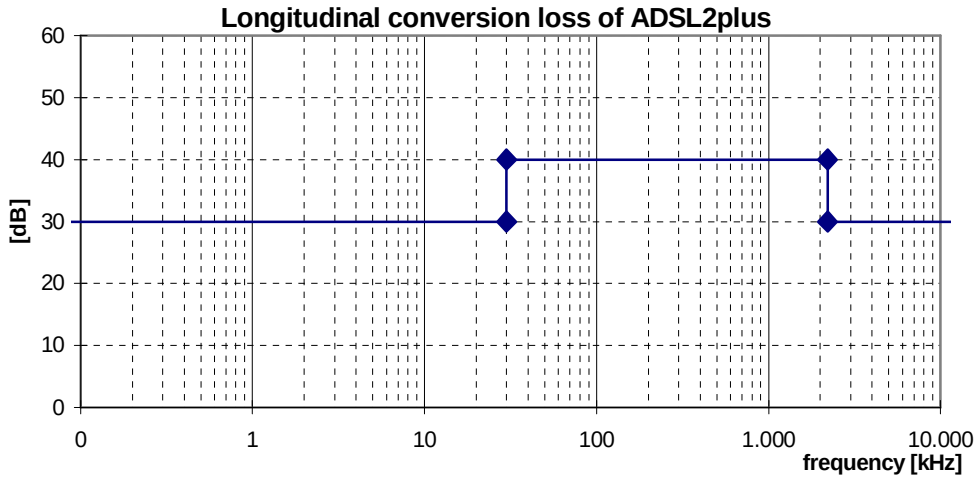

Figure 3: Minimum longitudinal conversion loss

Table 5: Frequencies and LCL values of the breakpoints of the LCL mask in figure 3

Frequency	LCL
< 30 kHz	30 dB
30 kHz	40 dB
2 208 kHz	40 dB
2 208 kHz	30 dB
30 MHz	30 dB

4.2 "FDD.ADSL2plus/A" signals (over POTS)

This category covers signals, generated by ADSL2plus transmission equipment, which uses Frequency Division Duplexing (FDD) to separate upstream and downstream. In this mode, the usable frequency band of downstream signals is narrower and not overlapping the upstream, but adjacent to it, to minimize self-NEXT. Therefore both downstream and upstream of "FDD.ADSL2plus/A" also fulfil the requirements of "ADSL2plus/A" (EC) signals, as described in a previous clause of the present document. These signals may share the same wire pair with POTS signals.
This clause is based on ITU-T [G992.5]. A signal can be classified as an " FDD.ADSLplus/A" signal if it is compliant with all clauses below.

4.2.1 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 a level of +19,9 dBm, measured within a frequency band from at least 4 kHz to 7 MHz.
Reference: ITU-T Recommendation G.992.5 [xx], clause A.1.3.2.

4.2.2 Total signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).

4.2.3 Peak amplitude (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).

4.2.4 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***, shall not exceed the limits given in table 6, 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. Figure 4 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: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.2.4.

Reference: ITU-T Recommendation G.992.5 [G.992.5], clause A.1.3 reconstructed from PSD requirements.

Table 6: 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	A
1 kHz	600 Ω	-77,5 dBm	100 Hz	-97,5 dBm/Hz	
1 kHz	600 Ω	-67,5 dBm	1 kHz	-97,5 dBm/Hz	
4 kHz	600 Ω	-67,5 dBm	1 kHz	-97,5 dBm/Hz	
4 kHz	100 Ω	-52,5 dBm	10 kHz	-92,5 dBm/Hz	
80 kHz	100 Ω	-32,5 dBm	10 kHz	-72,5 dBm/Hz	
137,9 kHz	100 Ω	-4,2 dBm	10 kHz	-44,2 dBm/Hz	
138 kHz	100 Ω	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 104 kHz	100 Ω	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 622 kHz	100 Ω	-6,5 dBm	10 kHz	-46,5 dBm/Hz	
2 208 kHz	100 Ω	-7,8 dBm	10 kHz	-47,8 dBm/Hz	
2 500 kHz	100 Ω	-19,4 dBm	10 kHz	-59,4 dBm/Hz	
3 001,5 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
3 175 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
170 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	B
1 104 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	
1 622 kHz	100 Ω	0 dBm	100 kHz	-50 dBm/Hz	
2 208 kHz	100 Ω	-1,3 dBm	100 kHz	-51,3 dBm/Hz	
2 500 kHz	100 Ω	-12,9 dBm	100 kHz	-62,9 dBm/Hz	
3 001,5 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
3 175 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
3 175 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
4 545 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
7225 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

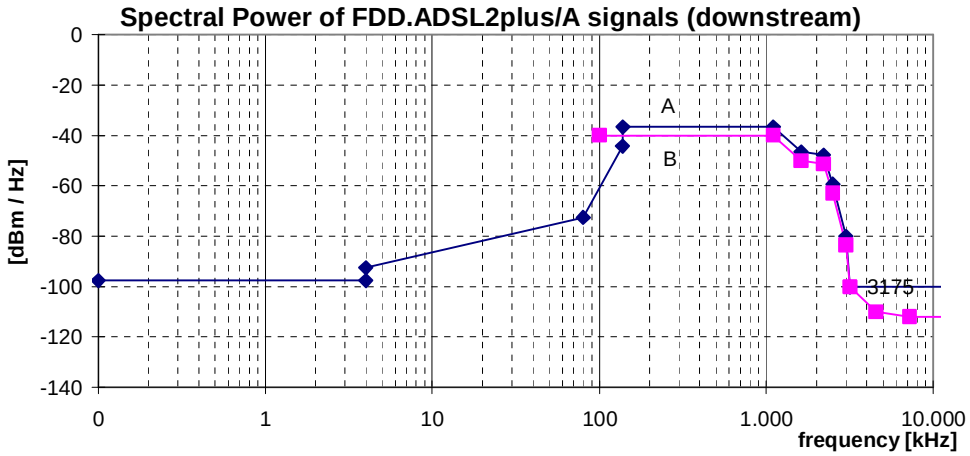

Figure 4: Spectral Power, for downstream FDD.ADSL2plus/A signals, as specified in table 6

4.2.5 Narrow-band signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).

4.2.6 Unbalance about earth (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).

4.3 "ADSL2plus/B" signals (EC, over ISDN)

This category covers signals, generated by ADSL2plus transmission equipment with spectrum overlap, i.e. for which the downstream overlaps the upstream. These signals may share the same wire pair with ISDN signals.
This clause is based on ITU-T [G.992.5]. A signal can be classified as an "ADSL2plus/B" signal if it is compliant with all clauses below.

4.3.1 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 a level of +19,9 dBm, measured within a frequency band from at least 4 kHz to 7 MHz.
Reference: ITU-T [G.992.5], clause B.1.2.2.

4.3.2 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 +13,3 dBm, measured within a frequency band from at least 4 kHz to 3 MHz.
Reference: ITU-T [G.992.5], clause B.2.2.2.

4.3.3 Peak amplitude (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).

4.3.4 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***, shall not exceed the limits given in table 7, 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. Figure 5 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.

Reference: ITU-T Recommendation G.992.5 [xx], clause B.1.2, reconstructed from PSD requirements.

NOTE: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.3.4.

Table 7: 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	100 Ω	-70 dBm	100 Hz	-90 dBm/Hz	A
1 kHz	100 Ω	-70 dBm	100 Hz	-90 dBm/Hz	
1 kHz	100 Ω	-60 dBm	1 kHz	-90 dBm/Hz	
4 kHz	100 Ω	-60 dBm	1 kHz	-90 dBm/Hz	
4 kHz	100 Ω	-50 dBm	10 kHz	-90 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	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 104 kHz	100 Ω	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 622 kHz	100 Ω	-6,5 dBm	10 kHz	-46,5 dBm/Hz	
2 208 kHz	100 Ω	-7,8 dBm	10 kHz	-47,8 dBm/Hz	
2 500 kHz	100 Ω	-19,4 dBm	10 kHz	-59,4 dBm/Hz	
3 001,5 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
3 175 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
100 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	B
1 104 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	
1 622 kHz	100 Ω	0 dBm	100 kHz	-50 dBm/Hz	
2 208 kHz	100 Ω	-1,3 dBm	100 kHz	-51,3 dBm/Hz	
2 500 kHz	100 Ω	-12,9 dBm	100 kHz	-62,9 dBm/Hz	
3 001,5 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
3 175 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
3 175 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
4 545 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
7 225 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

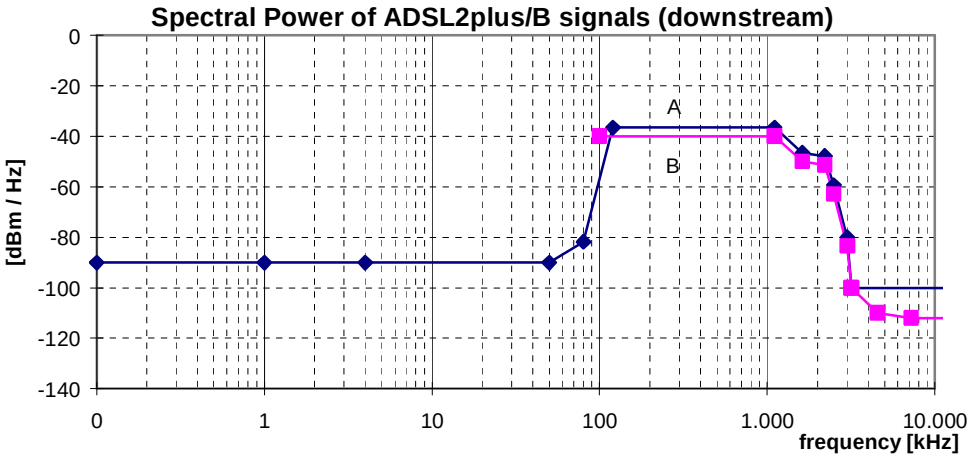

Figure 5: Spectral Power, for downstream ADSL2plus/B signals, as specified in table 7

4.3.5 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 15, 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. Figure 12 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: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.3.5.
The ADSL1 ATU-R Mask is not valid for ADSL2plus because of a steeper slope at the edge 276 kHz.

Reference: ITU-T Recommendation G.992.2 [xx], clause B.2.2 reconstructed from PSD requirements.

Table 8: 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	100 Ω	-70 dBm	100 Hz	-90 dBm/Hz	A
1 kHz	100 Ω	-70 dBm	100 Hz	-90 dBm/Hz	
1 kHz	100 Ω	-60 dBm	1 kHz	-90 dBm/Hz	
4 kHz	100 Ω	-60 dBm	1 kHz	-90 dBm/Hz	
4 kHz	100 Ω	-50 dBm	10 kHz	-90 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	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
120 kHz	100 Ω	+12 dBm	100 kHz	-38 dBm/Hz	B
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	
1 411 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
1 411 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
1 630 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
5 275 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

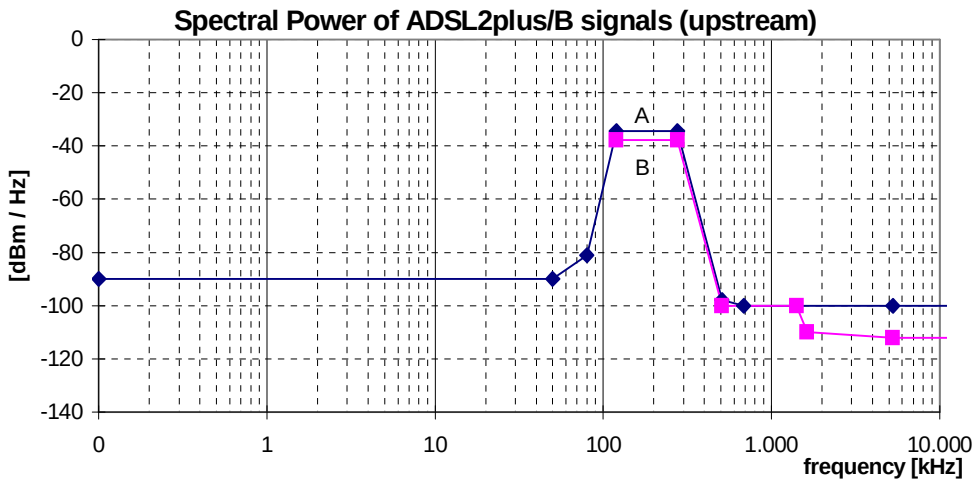

Figure 6: Spectral Power, for upstream ADSL2plus/B signals, as specified in table 8

4.3.6 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. Table 11 gives the values for the LOV limits in case of ADSL2+ while the LCL mask for ADSL2+ is given in figure 7. The LCL values of the associated break frequencies of this figure are given in table 12.

Table 9: Values for the LOV limits

	LOV	B	f_{min}	f_{max}	R_L	C_L
downstream	-46 dBV	10 kHz	5,1 kHz	3650 kHz	100 Ω	150 nF
upstream	-46 dBV	10 kHz	5,1 kHz	415 kHz	100 Ω	150 nF

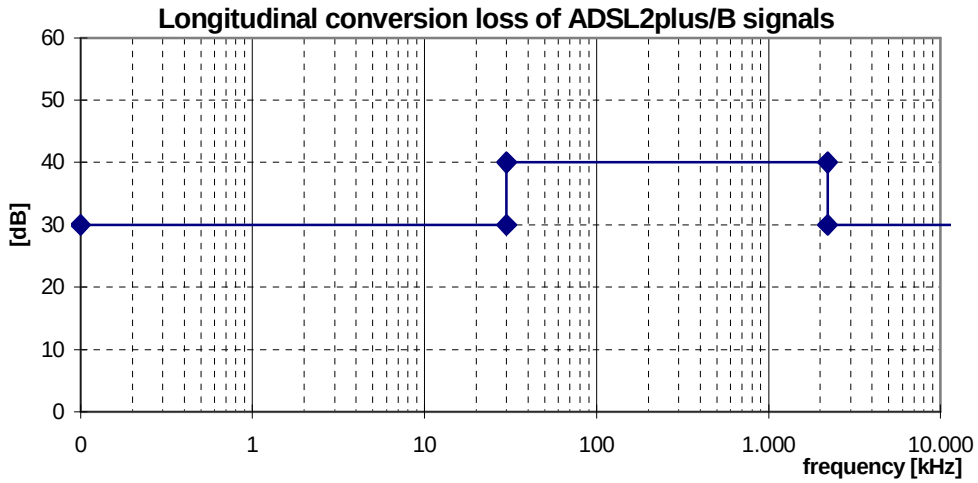

Figure 7: Minimum longitudinal conversion loss

Table 10: Frequencies and LCL values of the breakpoints of the LCL-mask in figure 7

Frequency	LCL
< 30 kHz	30 dB
30 kHz	40 dB
2 208 kHz	40 dB
2 208 kHz	30 dB
30 MHz	30 dB

4.4 "FDD.ADSL2plus/B" signals (over ISDN)

This category covers signals, generated by ADSL2plus transmission equipment which uses Frequency Division Duplexing (FDD) to separate upstream and downstream. In this mode, the usable frequency band of downstream signals is narrower to limit the overlap with the upstream to four DMT tones. This is to minimize self-NEXT. Therefore both downstream and upstream of " FDD.ADSL2plus/B" also fulfil the requirements of "ADSL2plus/B" (EC) signals, as described in a previous clause of the present document.
These signals may share the same wire pair with ISDN signals.
This clause is based on ITU [G.992.5]. A signal can be classified as an " FDD.ADSL2plus/B" signal if it is compliant with all clauses below.

4.4.1 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 a level of +19,3 dBm, measured within a frequency band from at least 4 kHz to 7 MHz.
If measurements of the upstream power indicates that downstream power back-off is necessary, as described for the downstream PSD, then the maximum total transmit power shall be reduced accordingly.
Reference: ITU-T [G.992.5], clause B.1.3.2.

4.4.2 Total signal power (upstream only)

The description of this signal characteristic equals that of " ADSL2plus/B " (EC).

4.4.3 Peak amplitude (upstream and downstream)

The description of this signal characteristic equals that of " ADSL2plus/B " (EC).

4.4.4 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***, shall not exceed the limits given in table 7, 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. Figure 5 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.
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause B.1.3, reconstructed from PSD requirements.

NOTE: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.4.4.

Table 11: 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	100 Ω	-70 dBm	100 Hz	-90 dBm/Hz	A
1 kHz	100 Ω	-70 dBm	100 Hz	-90 dBm/Hz	
1 kHz	100 Ω	-60 dBm	1 kHz	-90 dBm/Hz	
4 kHz	100 Ω	-60 dBm	1 kHz	-90 dBm/Hz	
4 kHz	100 Ω	-50 dBm	10 kHz	-90 dBm/Hz	
93,1 kHz	100 Ω	-50 dBm	10 kHz	-90 dBm/Hz	
209 kHz	100 Ω	-22 dBm	10 kHz	-62 dBm/Hz	
253,9 kHz	100 Ω	-8,5 dBm	10 kHz	-48,5 dBm/Hz	
254 kHz	100 Ω	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 104 kHz	100 Ω	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 622 kHz	100 Ω	-6,5 dBm	10 kHz	-46,5 dBm/Hz	
2 208 kHz	100 Ω	-7,6 dBm	10 kHz	-47,8 dBm/Hz	
2 500 kHz	100 Ω	-19,4 dBm	10 kHz	-59,4 dBm/Hz	
3 001,5 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
3 175 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
276 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	B
1 104 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	
1 622 kHz	100 Ω	0 dBm	100 kHz	-50 dBm/Hz	
2 208 kHz	100 Ω	-1,3 dBm	100 kHz	-51,3 dBm/Hz	
2 500 kHz	100 Ω	-12,9 dBm	100 kHz	-62,9 dBm/Hz	
3 001,5 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
3 175 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
3 175 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
3 750 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
4 545 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
7 225 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

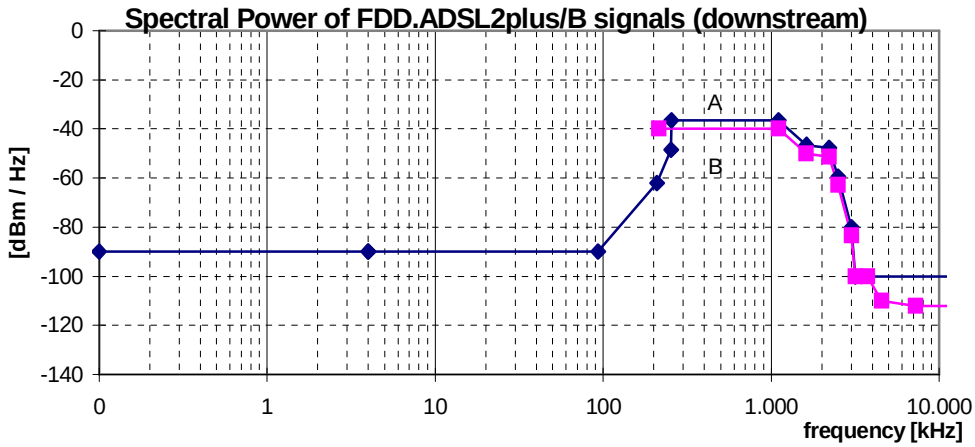

Figure 8: Spectral Power, for downstream FDD.ADSL2plus/B signals, specified in table 11

4.4.5 Narrow-band signal power (upstream only)

The description of this signal characteristic equals that of " ADSL2plus/B " (EC).

4.4.6 Unbalance about earth (upstream and downstream)

The description of this signal characteristic equals that of " ADSL2plus/B " (EC).

4.5 "ADSL2plus/I" signals (EC, All digital mode)

This category covers signals, generated by ADSL2plus transmission equipment with spectrum overlap, i.e. for which the downstream overlaps the upstream. These signals do not share the same wire pair with POTS or ISDN signals.
This clause is based on ITU [G.992.5]. A signal can be classified as an "ADSL2plus/I" signal if it is compliant with all clauses below.

4.5.1 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 a level of +20,4 dBm, measured within a frequency band from at least 4 kHz to 7 MHz.
Reference: ITU- T Recommendation G.992.5 [xx], clause I.1.2.2.

4.5.2 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 +13,3 dBm, measured within a frequency band from at least 4 kHz to 7 MHz.
Reference: ITU-T Recommendation G.992.5 [xx], clause I.2.2.2.

4.5.3 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 1 MHz. The definition and measurement method of peak amplitude is specified in clause 13.1.

NOTE: No ETSI deliverable does specify this parameter.

4.5.4 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***, shall not exceed the limits given in table 2, 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. Figure 1 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: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.1.4.

Reference: ITU-T Recommendation G.992.5 [G.992.5], clause I.1.2 reconstructed from PSD requirements.

Table 12: 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	-28,5 dBm	100 Hz	-48,5 dBm/Hz	A
1,5 kHz	600 Ω	-28,5 dBm	100 Hz	-48,5 dBm/Hz	
3 kHz	600 Ω	-16,5 dBm	100 Hz	-36,5 dBm/Hz	
25,875 kHz	100 Ω	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 104 kHz	100 Ω	+3,5 dBm	10 kHz	-36,5 dBm/Hz	
1 622 kHz	100 Ω	-6,5 dBm	10 kHz	-46,5 dBm/Hz	
2 208 kHz	100 Ω	-7,8 dBm	10 kHz	-47,8 dBm/Hz	
2 500 kHz	100 Ω	-19,4 dBm	10 kHz	-59,4 dBm/Hz	
3 001.5 kHz	100 Ω	-40 dBm	10 kHz	-80 dBm/Hz	
3 175 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
25 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	B
1 104 kHz	100 Ω	+10 dBm	100 kHz	-40 dBm/Hz	
1 622 kHz	100 Ω	0 dBm	100 kHz	-50 dBm/Hz	
2 208 kHz	100 Ω	-1,3 dBm	100 kHz	-51,3 dBm/Hz	
2 500 kHz	100 Ω	-12,9 dBm	100 kHz	-62,9 dBm/Hz	
3 001.5 kHz	100 Ω	-33,5 dBm	100 kHz	-83,5 dBm/Hz	
3 175 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
3 175 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
3 750 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
4 545 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
7 225 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

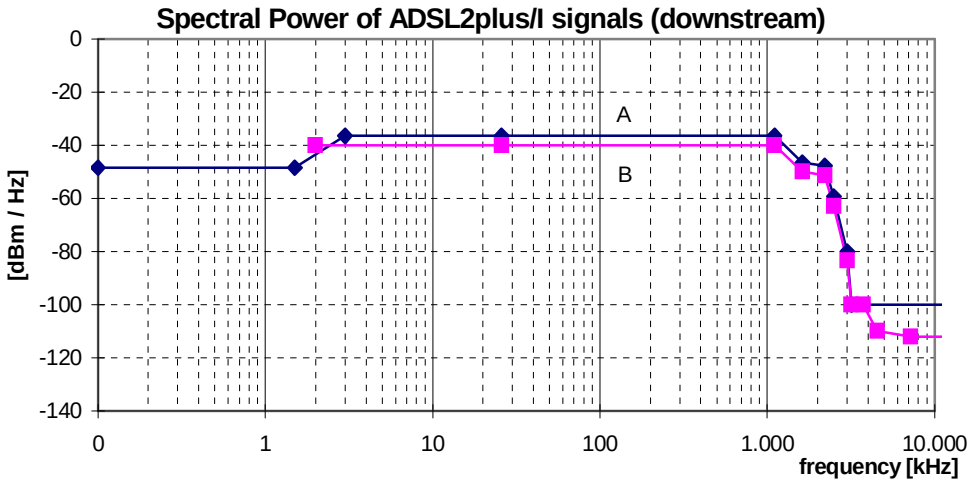

Figure 9: Spectral Power, for downstream ADSL2plus/I signals, as specified in table 12

Reference: ITU-T Recommendation G.992.5 [xx], clause I.1.2.

4.5.5 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 3, 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. Figure 2 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: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.1.5.

Reference: ITU-T Recommendation G.992.5 [G.992.5], clause I.2.2 reconstructed from PSD requirements.

Table 13: 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	-26,5 dBm	100 Hz	-46,5 dBm/Hz	A
1,5 kHz	600 Ω	-26,5 dBm	100 Hz	-46,5 dBm/Hz	
3 kHz	600 Ω	-14,5 dBm	100 Hz	-34,5 dBm/Hz	
10 kHz	100 Ω	+5,5 dBm	10 kHz	-34,5 dBm/Hz	
138 kHz	100 Ω	+5,5 dBm	10 kHz	-34,5 dBm/Hz	
243 kHz	100 Ω	-53,2 dBm	10 kHz	-93,2 dBm/Hz	
686 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
5 275 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
25 kHz	100 Ω	+12 dBm	100 kHz	-38 dBm/Hz	B
138 kHz	100 Ω	+12 dBm	100 kHz	-38 dBm/Hz	
243 kHz	100 Ω	-46,7 dBm	100 kHz	-96,7 dBm/Hz	
686 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
1 411 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
1 411 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
1 630 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
5 275 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

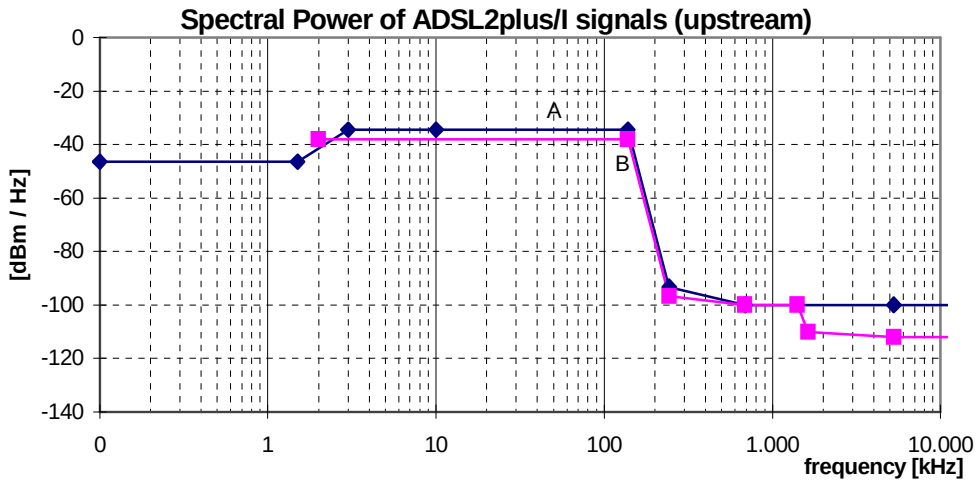

Figure 10: Spectral Power, for upstream ADSL2plus/I signals, as specified in table 13

4.5.6 Unbalance about earth (upstream and downstream)

The description of this signal characteristic equals that of "FDD.ADSL2plus/A" (EC).

4.6 "FDD.ADSL2plus/I" signals (All digital mode)

This category covers signals, generated by ADSL2plus transmission equipment, which uses Frequency Division Duplexing (FDD) to separate upstream and downstream. In this mode, the usable frequency band of downstream signals is narrower and not overlapping the upstream, but adjacent to it, to minimize self-NEXT. Therefore both downstream and upstream of "FDD.ADSL2plus/I" also fulfil the requirements of "ADSL2plus/I" (EC) signals, as described in a previous clause of the present document. These signals do not share the same wire pair with POTS or ISDN signals.
This clause is based on ITU-T [G992.5]. A signal can be classified as an "FDD.ADSL2plus/I" signal if it is compliant with all clauses below.

4.6.1 Total signal power (downstream only)

The description of this signal characteristic equals that of "FDD.ADSL2plus/A" (EC).
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause I.1.3.2.

4.6.2 Total signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/I" (EC).

4.6.3 Peak amplitude (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/I" (EC).

4.6.4 Narrow-band signal power (downstream only)

The description of this signal characteristic equals that of "FDD.ADSL2plus/A". Reference: ITU-T Recommendation G.992.5 [G.992.5], clause I.1.3. Note, there is one modification on the PSD mask, namely:

- For 0 < f < 4kHz, the PSD shall be below -97,5kHz (no extra limitation of max power in 0-4kHz band)

4.6.5 Narrow-band signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/I" (EC).

4.6.6 Unbalance about earth (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).

4.7 "ADSL2plus/J" signals (EC, all digital mode)

This category, “ADSL2plus/J”, covers signals, generated by ADSL2plus transmission equipment with spectrum overlap, i.e. for which the downstream overlaps the upstream and with extended upstream. These signals do not share the same wire pair with POTS or ISDN signals.
This clause is based on ITU-T [G.992.5]. A signal can be classified as an "ADSL2plus/J" signal if it is compliant with all clauses below.

4.7.1 Total signal power (downstream only)

The description of this signal characteristic equals that of "ADSL2plus/I" (EC).
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause J.1.2.2.

4.7.2 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 +13,4 dBm, measured within a frequency band from at least 4 kHz to 3 MHz.
Reference: ITU-T Recommendation [G.992.5], clause J.2.2.2.

4.7.3 Peak amplitude (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/I" (EC).

4.7.4 Narrow-band signal power (downstream only)

The description of this signal characteristic equals that of "ADSL2plus/I" (EC).
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause J.1.2.

4.7.5 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 8, at any point in the frequency range 100 Hz to 30 MHz. This table specifies the break points of these limits.
The ITU-T Recommendation G.992.5 [G.992.5], clause J.2.2 describes a family of 9 different upstream spectral mask called ADLU-32, ADLU-36,… ADLU-64. The passband is defined as the band from 3 kHz tot an upperbound frequency f1 which corresponds with the frequency spacing of the

highest DMT symbol used in the passband. E.g. mask ADLU-32 defines an upstream mask with a its passband up to DMT symbol 32 corresponding with a upperbound frequency of 138 kHz. The NBSP specification in table 8 is based on the In-band Peak PSD (dBm/Hz) of ADLU-32 while the Frequency f1 (kHz), Intercept Frequency f_int (kHz) and Intercept PSD Level PSD_int (dBm/Hz) are based on ADLU-64, ITU-T G.992.2 [xx], clause J.2.2, table J.3.
Limits for intermediate frequencies can be found by drawing a straight line between the break points on a logarithmic (Hz) - linear (dB) scale. Figure 6 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: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.1.5.

Reference: ITU-T Recommendation G.992.2 [xx], clause J.2.2 reconstructed from PSD requirements.

Table 14: 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	100 Ω	-26,5 dBm	100 Hz	-46.5 dBm/Hz	A
1,5 kHz	100 Ω	-26,5 dBm	100 Hz	-46,5 dBm/Hz	
3 kHz	100 Ω	-14,5 dBm	100 Hz	-34,5 dBm/Hz	
10 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	
493,41 kHz	100 Ω	-57,9 dBm	10 kHz	-97,9 dBm/Hz	
686 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
5275 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
25 kHz	100 Ω	+12 dBm	100 kHz	-38 dBm/Hz	B
276 kHz	100 Ω	+12 dBm	100 kHz	-38 dBm/Hz	
493,41 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
686 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
1 411 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
1 411 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
1 630 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
5 275 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

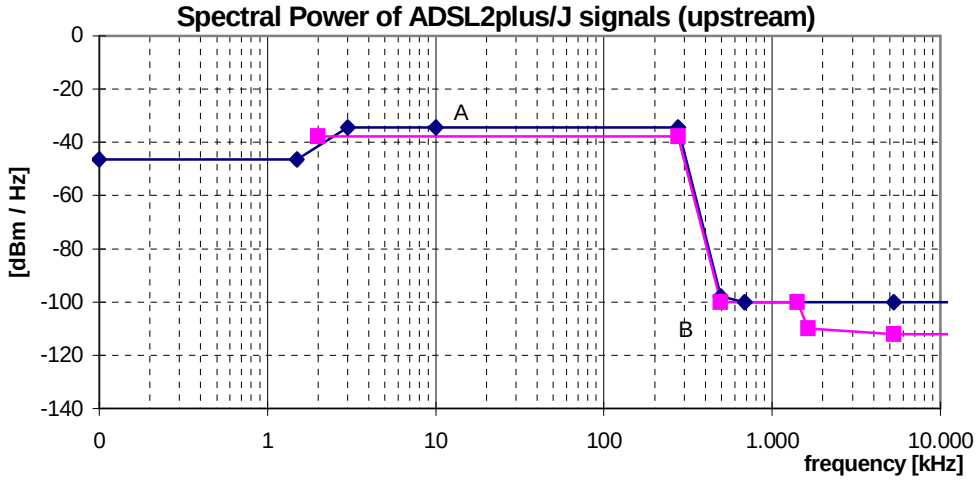

Figure 11: Spectral Power, for upstream ADSL2plus/J signals, as specified in table 14

4.7.6 Unbalance about earth (upstream and downstream)

The description of this signal characteristic equals that of "FDD.ADSL2plus/B" (EC).

4.8 "FDD.ADSL2plus/J" signals (all digital mode)

This category covers signals, generated by ADSL2plus transmission equipment, which uses Frequency Division Duplexing (FDD) to separate upstream and downstream, and uses an extended upstream. In this mode, the usable frequency band of downstream signals is narrower and not overlapping the upstream, but adjacent to it, to minimize self-NEXT. Therefore both downstream and upstream of "FDD.ADSL2plus/J" also fulfil the requirements of "ADSL2plus/J" (EC) signals, as described in a previous clause of the present document.
These signals do not share the same wire pair with POTS or ISDN signals.
This clause is based on ITU-T [G992.5]. A signal can be classified as an " FDD.ADSL2plus/J" signal if it is compliant with all clauses below.

4.8.1 Total signal power (downstream only)

The description of this signal characteristic equals that of "FDD.ADSL2plus/B".
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause J.1.3.2.

4.8.2 Total signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/J" (EC).

4.8.3 Peak amplitude (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/J" (EC).

4.8.4 Narrow-band signal power (downstream only)

The description of this signal characteristic equals that of "FDD.ADSL2plus/B".
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause J.1.3.

4.8.5 Narrow-band signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/J".
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause J.2.2.

4.8.6 Unbalance about earth (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/B" (EC).

4.9 "ADSL2plus/M" signals (EC, extended upstream)

This category covers signals, generated by ADSL2plus transmission equipment with spectrum overlap, i.e. for which the downstream overlaps the upstream, and use an extended upstream. These signals may share the same wire pair with POTS signals.
This clause is based on ITU-T [G.992.5]. A signal can be classified as an "ADSL2plus/M" signal if it is compliant with all clauses below.

4.9.1 Total signal power (downstream only)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).
Reference: ITU-T [G.992.5], clause M.1.2.2.

4.9.2 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 +12,5 dBm, measured within a frequency band from at least 4 kHz to 3 MHz.
Reference: ITU-T [G.992.5], clause M.2.2.2.

4.9.3 Peak amplitude (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/I" (EC).

4.9.4 Narrow-band signal power (downstream only)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).
Reference: ITU [G.992.5], clause M.1.2.

4.9.5 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 14, at any point in the frequency range 100 Hz to 30 MHz. This table specifies the break points of these limits.
The ITU-T Recommendation G.992.5 [G.992.5], clause M.2.2 describes a family of 9 different upstream spectral mask called EU-32, EU-36,… EU-64. The passband is defined as the band from 3 kHz tot an upperbound frequency f1 which corresponds with the frequency spacing of the highest DMT symbol used in the passband. E.g. mask EU-32 defines an upstream mask with a its passband up to DMT symbol 32 corresponding with a upperbound frequency of 138 kHz. The NBSP specification in table 14 is based on the In-band Peak PSD (dBm/Hz) of EU-32 while the Frequency f1 (kHz), Intercept Frequency f_int (kHz) and Intercept PSD Level PSD_int (dBm/Hz) are based on EU-64, ITU-T G.992.2 [xx], clause M.2.2, table M.3.
Limits for intermediate frequencies can be found by drawing a straight line between the break points on a logarithmic (Hz) - linear (dB) scale. Figure 11 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: The NBSP specification of this signal category has been split into two overlapping limits. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.1.5.

Reference: ITU-T Recommendation G.992.2 [xx], clause M.2.2 reconstructed from PSD requirements.

Table 15: 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	100 Ω	-77,5 dBm	100 Hz	-97.5 dBm/Hz	A
4 kHz	100 Ω	-77,5 dBm	100 Hz	-97,5 dBm/Hz	
4 kHz	100 Ω	-72,5 dBm	100 Hz	-92,5 dBm/Hz	
25,875 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	
493,41 kHz	100 Ω	-57,9 dBm	10 kHz	-97,9 dBm/Hz	
686 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
5275 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
30 000 kHz	100 Ω	-60 dBm	10 kHz	-100 dBm/Hz	
60 kHz	100 Ω	+12 dBm	100 kHz	-38 dBm/Hz	B
276 kHz	100 Ω	+12 dBm	100 kHz	-38 dBm/Hz	
493,41 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
686 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
1 411 kHz	100 Ω	-50 dBm	100 kHz	-100 dBm/Hz	
1 411 kHz	100 Ω	-40 dBm	1 MHz	-100 dBm/Hz	
1 630 kHz	100 Ω	-50 dBm	1 MHz	-110 dBm/Hz	
5 275 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	
30 000 kHz	100 Ω	-52 dBm	1 MHz	-112 dBm/Hz	

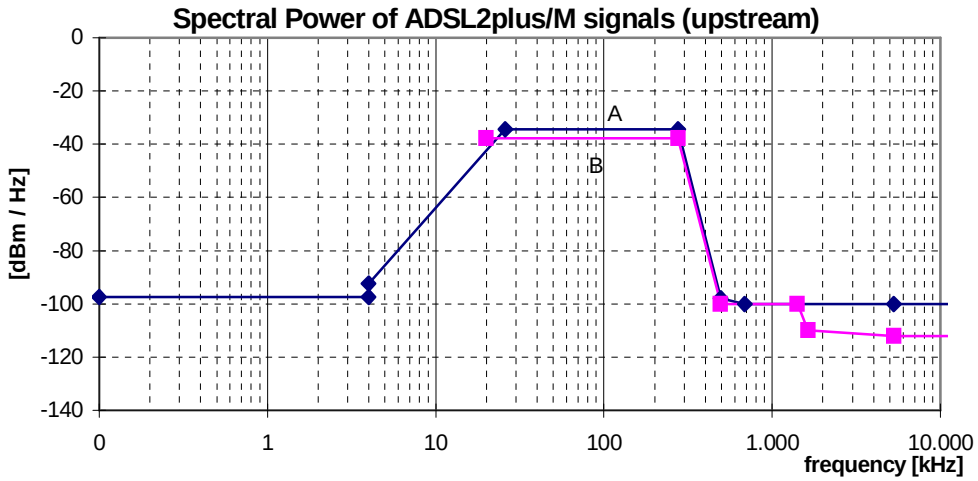

Figure 12: Spectral Power, for upstream ADSL2plus/M signals, as specified in table 15

4.9.6 Unbalance about earth (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/B" (EC).

4.10 "FDD.ADSL2plus/M" signals

This category covers signals, generated by ADSL2plus transmission equipment, which uses Frequency Division Duplexing (FDD) to separate upstream and downstream. In this mode, the usable frequency band of downstream signals is narrower and not overlapping the upstream, but adjacent to it, to minimize self-NEXT. Therefore both downstream and upstream of "FDD.ADSL2plus/M" also fulfil the requirements of "ADSL2plus/M" (EC) signals, as described in a previous clause of the present document.
These signals may share the same wire pair with POTS signals.
This clause is based on ITU [G992.5]. A signal can be classified as an " FDD.ADSL2plus/M" signal if it is compliant with all clauses below.

4.10.1 Total signal power (downstream only)

The description of this signal characteristic equals that of "FDD.ADSL2plus/B".
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause M.1.3.2.

4.10.2 Total signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/M" (EC).
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause M.2.2.2.

4.10.3 Peak amplitude (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/M" (EC).

4.10.4 Narrow-band signal power (downstream only)

The description of this signal characteristic equals that of "FDD.ADSL2plus/B".
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause M.1.3.

4.10.5 Narrow-band signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/M".
Reference: ITU-T Recommendation G.992.5 [G.992.5], clause M.2.2.

4.10.6 Unbalance about earth (upstream and downstream)

The description of this signal characteristic equals that of "ADSL2plus/B" (EC).

5. References

[1] ITU-T Recommendation G.992.5 (01/2005): “Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)”.