ETSI WG TM6

(ACCESS TRANSMISSION SYSTEMS ON METALLIC CABLES)

Permanent Document

TM6(05)05 – rev 2

Living List for Spectral Management SpM - part 1 revision of TR 101 830-1

This document is the living list of current issues connected with ETSI's spectral management report TR 101 830, part 1 (*Definitions and signal library*).
This work item is focussed on the revision of "Part 1", to add new signal descriptions such as for enhanced SDSL and ADSL2plus. A target date for "working group approval" is scheduled for nov 2005. The issues related to the creation of "Part 2" or "Part 3", are beyond the scope of this living list.

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Rapporteur/Editor	**Rob F.M. van den Brink**	
(on behalf of KPN)	TNO Telecom	tel: +31.15.2857059
	PO-Box 5050	fax: +31.15.2857349
	2600 GB Delft	e-mail: R.F.M.vandenBrink@telecom.tno.nl

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

SP	Title	Owner	Status
1-1	Alignment of “definitions” with ETSI SpM-2 and SpM-3	Rob van den Brink (KPN/TNO)	PA
1-2	Refinement of references in text on “DC Power feeding”	Rob van den Brink (KPN/TNO)	PA
1-3	Signal description for enhanced SDSL	Bernd Heise, Infineon	PA
1-4	Signal description for various ADSL2plus variants	Rob van den Brink (KPN/TNO)	Under study
1-5			
1-6			
1-7			
1-8			

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

Part 1 study points

SP 1-1. Alignment of “definitions” with ETSI SpM-2 and SpM-3

During the creation of SpM “part 2” and “part 3”, various definitions have been enhanced or added, to enable a consistent terminology. It is desired that “part 1” adopts this list, so that all three parts contain the same list of definitions. This study point is mainly a formality, to enable formal agreements on these definitions.

Related Contributions:

- *m01p20a10, may 2005, Draft of SpM part 2 - Rapporteur*

SP 1-2. Refinement of references in text on “DC power feeding”

In a liason statement, ETSI “TC Safety” has informed TM6 about a change in the standards on safety requirements. This has (minor) consequences for the references being used in clause 7 on “DC power feeding”, and in clause 8 on POTS signals. This study point is mainly a formality, to enable official agreement on these definitions, since “TC Safety” has already provided the required corrections.

Related Contributions:

- *051t06, feb 2005, Liason statement to TM6 regarding TR 101 830-1 – Chairman TC Safety*

SP 1-3. Signal description for enhanced SDSL

The SDSL standard has been extended with annex E describing enhance SDSL variants, using PSDs that are wider then common for SDSL. To facilitate loop providers with correct signal descriptions for granting these signals access to the local loop wiring, an additional description is to added to the current signal library.

Related Contributions:

- *051t27, feb 2005, Additional signals for SpM1 – Infineon*

SP 1-4. Signal description for various ADSL2plus variants

Various new ADSL variant have been defined by ITU Recommendations. To facilitate loop providers with correct signal descriptions for granting these signals access to the local loop wiring, an additional description is to added to the current signal library.

Related Contributions:

- *052t18, June 2005, Signal descriptions of various ADSL2plus variants – KPN, TNO*

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 1, but are still in the "under study" status. If agreement is achieved, they will be moved into the Draft

ED. NOTE. The full title should include the text “access networks;”

SDSL

[1] ETSI TS 101 524, **v1.2.1**: "Transmission and Multiplexing (TM); Access transmission system on metallic access cables; Symmetrical single pair high bitrate Digital Subscriber Line (SDSL)". Nov 2001.

[2] ITU-T Recommendation G.991.2 (2001-02): "Single-Pair High-Speed Digital Subscriber Line (SHDSL) transceivers".

ADSL

[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".

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

VARIOUS

[5] CENELEC EN 60950 - 1: "Information technology equipment – Part 1: General Requirements".

[6] CENELEC EN 60950 - 21: "Information technology equipment – Safety - Part 21: Remote Power Feeding"

[7] CENELEC CLC/prTR 62102 (2004): Electrical safety - Classification of interfaces for equipment to be connected to information and communications technology networks.

[8] CENELEC CLC/prTS 62367 (2004): Safety aspects for xDSL signals on circuits connected to telecommunication networks (DSL: Digital Subscriber Line).

~~[9] ETSI EG 201 212 (V1.2.1): "Electrical safety; Classification of interfaces for equipment to be connected to telecommunication networks".~~ (withdrawn)

~~[10] ITU-T Recommendation K.50 (2000-02): "Safe limits of operating voltages and currents for telecommunication systems powered over the network".~~ (not used anymore)

ED. NOTE. Spelling conventions: “crosstalk” and “bitrate” without a space in-between

Text portion proposed for inclusion into clause 3

3 DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

ED. NOTE The list below is intended as a full replacement of the definitions that are currently published in “part 1”

For the purposes of the present documents on spectral management, the following terms and definitions apply:

Local Loop Wiring: Part of a metallic access network, terminated by well-defined ports, for transporting signals over a distance of interest. This part includes mainly cables, but may also include a main distribution frame (MDF), street cabinets, and other distribution elements. The local loop wiring is usually passive only, but may include active splitter-filters as well.

Loop provider: Organization facilitating access to the local loop wiring. (NOTE: In several cases the loop provider is historically connected to the incumbent network operator, but other companies may serve as loop provider as well.)

Network operator: Organization that makes use of a local loop wiring for transporting telecommunication services. (NOTE: This definition covers incumbent as well as competitive network operators.)

Access Port: An Access Port is the physical location, appointed by the loop provider, where signals (for transmission purposes) are injected into the local loop wiring.

NT-access port (or NT-port for short): is an access port for injecting signals, designated as "NT-port".
NOTE: Such a port is commonly located at the customer premises, and intended for injecting "upstream" signals.

LT-access port (or LT-port for short): is an access port for injecting signals, designated as "LT-port".
NOTE: Such a port is commonly located at the central office side, and intended for injecting "downstream" signals.

Transmission technique: electrical technique used for the transportation of information over electrical wiring.

Transmission equipment: equipment connected to the local loop wiring that uses a transmission technique to transport information.

Transmission system: A set of transmission equipment that enables information to be transmitted over some distance between two or more points.

Upstream transmission: transmission direction from a port, labelled as NT-port, to a port, labelled as LT-port. This direction is usually from the customer premises, via the local loop wiring, to the central office side.

Downstream transmission: transmission direction from port, labelled as LT-port, to a port, labelled as NT-port. This direction is usually from the central office side via the local loop wiring, to the customer premises.

Noise margin: the ratio (P_{n2}/P_{n1}) by which the received noise power P_{n1} may increase to power P_{n2} until the recovered signal no longer meets the predefined quality criteria. This ratio is commonly expressed in dB.

Signal margin: the ratio (P_{s1}/P_{s2}) by which the received signal power P_{s1} may decrease to power P_{s2} until the recovered signal no longer meets the predefined quality criteria. This ratio is commonly expressed in dB.

Max data rate: the maximum data rate that can be recovered according to predefined quality criteria, when the received noise is increased with a chosen noise margin (or the received signal is decreased with a chosen signal margin).

Performance: is a measure of how well a transmission system fulfils defined criteria under specified conditions. Such criteria include reach, bitrate and noise margin.

Access Rule: Mandatory rule for achieving access to the local loop wiring, equal for all network operators who are making use of the same network cable that bounds the crosstalk in that network cable.

Deployment Rule: Voluntary rule, irrelevant for achieving access to the local loop wiring and proprietary to each individual network operator. (NOTE: A deployment rule reflects a network operator's own view about what the maximum length or maximum bitrate may be for offering a specific transmission service to ensure a chosen minimum quality of service.)

Spectral management rule: A generic term, incorporating (voluntary) deployment rules, (mandatory) access rules and all other (voluntary) measures to maximize the use of local loop wiring for transmission purposes.

Spectral management: The art of making optimal use of limited capacity in (metallic) access networks. This is for the purpose of achieving the highest reliable transmission performance and includes:

- Designing of deployment rules and their application.
- Designing of effective access rules.
- Optimised allocation of resources in the access network, e.g. access ports, diversity of systems between cable bundles, etc.
- Forecasting of noise levels for fine-tuning the deployment.
- Spectral policing to enforce compliance with access rules.
- Making a balance between conservative and aggressive deployment (low or high failure risk).

Spectral compatibility: A generic term for the capability of transmission systems to operate in the same cable.
NOTE: The precise definition is application dependent and has to be defined for each group of applications.

Cable management plan (CMP): A list of selected access rules dedicated to a specific network. This list may include associated descriptions and explanations.

Cable fill: (or degree of penetration): number and mixture of transmission techniques connected to the ports of a binder or cable bundle that are injecting signals into the access ports.

Signal Category: is a class of signals meeting the minimum set of specifications identified in clause 6.
NOTE: Some signal categories may distinct between different sub-classes, and may label them for instance as signals for "downstream" or for "upstream" purposes.

PSD mask: The absolute upper bound of a PSD, measured within a specified resolution band.
NOTE: The purpose of PSD masks is usually to specify maximum PSD levels for stationary signals.

PSD template: The expected average PSD of a stationary signal.
NOTE: The purpose of PSD templates is usually to perform simulations. The levels are usually below or equal to the associated PSD masks

Power back-off: is a generic mechanism to reduce the transmitter's output power.
NOTE: It has many purposes, including the reduction of power consumption, receiver dynamic range, crosstalk, etc.

Power cut-back: is specific variant of power back-off, used to reduce the dynamic range of the receiver. It is characterized by a frequency independent reduction of the in-band PSD.
NOTE: It is used, for instance, in ADSL and SDSL.

EC: The abbreviation EC normally means Echo Cancelled.
NOTE: This abbreviation is used within the context of ADSL to designate ADSL systems with spectral overlap of downstream and upstream signals. In this context, the usage of the abbreviation "EC" was only kept for historical reasons. The usage of the echo cancelling technology is not only limited to spectrally overlapped systems, but can also be used by FDD systems.

Victim modem: a modem, subjected to interference (such as crosstalk from all other modems connected to other wire pairs in the same cable) that is being studied in a spectral management analysis. This term is intended solely as a technical term, defined within the context of these studies, and is not intended to imply any negative judgement.

Disturber: a source of interference in spectral management studies coupled to the victim wire pair. This term is intended solely as a technical term, defined within the context of these studies, and is not intended to imply any negative judgement.

> ED. NOTE. The editorial consequences for the rest of the text include:
>
> (a) replace "degree of penetration" by "cable fill"

Text portion proposed for inclusion into clause 7

7 CLUSTER 0 SIGNALS (DC POWER FEEDING)

This cluster summarizes maximum DC feeding voltages and currents, used for remote powering of transmission equipment (including POTS, ISDN and xDSL ~~HDSL and SDSL~~). The DC power-feeding limits are supplementary to the AC signal descriptions in the succeeding clusters 1 to 5. By referring to both kinds of signal descriptions, the simultaneous use of AC signals and DC power feeding over the same wire pair can be enabled.
Feeding voltages and currents are to be limited for reasons like:

- General safety requirements, including any additional network related safety requirements and/or network protection requirements specified by the loop provider.
- Interoperability and/or prevention of damage to equipment and devices (system related reasons)

7.1 ”Class A” TNV power Feeding (from LT-port)

This category covers feeding voltages and currents that will not exceed the requirements relevant for safety, as can be found in ~~ETSI [9] and~~ Cenelec [7,5] safety standards for TNV-3 circuits.

TNV-3 circuits have an operating voltage limit defined as a combination of the maximum DC-voltage and the peak AC-voltage, and may be subjected to overvoltages from the telecommunication network. TNV-3 circuits may be touched by users on a limited area of contact.

To be compliant with this signal class, the combination of the DC power feeding and AC peak signal shall not exceed limits calculated from the formula: (U_{DC}/120V+$U_{AC,peak}$/70,7V ≤ 1), and all requirements in ~~[9] and~~ [5] for TNV-3 circuits.
However in this context attention is drawn to CENELEC [8] for xDSL signals.

~~Reference: EG 201 212 [9].~~ (withdrawn)
Reference: CENELEC EN 60950 - 1 [5].
Reference: CENELEC CLC/TR 62102 [7].
Reference: CENELEC CLC/TS 62367 [8].

7.2 "Class B" RFT Power Feeding (from the LT-port)

This category covers feeding voltages and currents that will not exceed the requirements relevant for safety as can be found in ~~ITU [10]~~ CENELEC [6] safety standards for RFT circuits (**R**emote **F**eeding **T**elecommunication). RFT circuits are subdivided into current limited circuits (RFT-C) and voltage limited circuits (RFT-V). The circuits may be subjected to overvoltages from the telecommunication network, and access to the conductors is restricted to service personnel.

To be compliant with "***class B.1" RFT-C Power Feeding***, the feeding current shall not exceed 60mA DC for any feeding voltage value, and all other requirements in [6] [~~10~~] for RFT-C circuits.

To be compliant with "***class B.2.1" RFT-V Power Feeding***, the steady state open circuit voltage from each conductor to earth shall not exceed 140 V d.c., and all other requirements in [6] [~~10~~] for RFT-V circuits.

To be compliant with "***class B.2.2" RFT-V Power Feeding***, the steady state open circuit voltage from each conductor to earth shall not exceed 200 V d.c. if the short circuit current is limited to 10 mA d.c, and all other requirements in [6] [~~10~~] for RFT-V circuits.

Reference: CENELEC EN 60950 - 21 [6].
~~Reference [10]: ITU-T Recommendation K.50.~~

Text portions proposed for inclusion into clause 8

8 CLUSTER 1 SIGNALS (VOICE BAND)

8.1 "POTS" signals (voice band lines 300 Hz to 3400 Hz)

8.1.5 Feeding Power (from the LT-port)

Power feeding is no integral part of this signal category, although it is not uncommon for POTS services. To enable power feeding in combination with this signal category, refer to Class A ~~one of the power feeding classes summarized~~ in clause 7. However, when ringing signals are present, the requirements in EN60950-1 [5] annex M has to be followed.

Reference: CENELEC EN 60950 - 1 [5].
Reference: CENELEC EN 60950 - 21 [6].
Reference: CENELEC CLC/TR 62102 [7].
Reference: CENELEC CLC/TS 62367 [8].

Text portions proposed for inclusion into clause 10

10 CLUSTER 3 SIGNALS (SYMMETRICAL BROADBAND)

10.7 "SDSL::Fn" Signals

This category covers signals, generated by multi-rate SDSL transmission equipment on one or up to four wire pairs, up to 2320 kb/s. This clause is based on ETSI SDSL standard [1] and on ITU ~~draft~~ Recommendation G.991.2 [2], but is not applicable to "enhanced" SDSL variants specified in annex E of [1]. The line code modulation used in these standards is Ungerboeck Coded Pulse Amplitude Modulation (UC-PAM), also known as Trellis Coded PAM (TC-PAM), and uses 16 levels per symbol (16 UC-PAM).

> ED. NOTE. The text highlighted in red is proposed for a change, to make a clear distinction between "basic" SDSL and "enhanced" SDSL. The rest of the text remains unchanged, except for the following addition:

The principal frequency frequency F_N in this signal category does not exceed the value of 771 kHz

10.X "e-SDSL::Fn" signals (enhanced SDSL)

This category covers signals, generated by multi-rate SDSL transmission equipment on one or up to four wire pairs, up to 5696 kb/s per wire pair, as specified in annex E of ETSI SDSL standard [1]. This signal description is an extension to the "SDSL::Fn" signal description in a previous clause.

The phrase "Fn" is a placeholder for a number that is used as parameter F_N in the signal definition, representing the principal frequency. This is explained in the previous clause for "SDSL::Fn" signals. The principal frequency F_N does not exceed the value of 1426 kHz for "e-SDSL::Fn" signals. Enhanced SDSL addresses both the 16 UC-PAM and 32 UC-PAM variants specified in annex E of [1], The principal frequency of the PSD generated by 32 UC-PAM is lower than for 16 UC-PAM when used for transporting at the same bitrate.

Table 1 gives several examples on how to use the naming convention for specifying the actual parameter value F_N. It also illustrates some (informative) bitrates that can be transported within these signal limits, when using the associated (informative) modulation parameters. These are examples only, other system implementations may use the same signal limits in a different way.

Table 1: Example on how the naming convention relates to the actual parameter value F_N that is used in the clauses below to specify the signal limits of this signal category. The actual bitrates and modulation parameters are implementation dependent, and informative only

Signal category	F_N [kHz]		Symbol Rate [kbaud]	Bit/symbol	Line Bitrate [kbit/s]
16 UC-PAM:					
e-SDSL::771	770,67		770.67	3	2312
e-SDSL::1027	1026,67		1026,67	3	3080
e-SDSL::1286	1285,53		1285,53	3	3856
32 UC-PAM:					
e-SDSL::768	768,00		768,00	4	3072
e-SDSL::964	964,00		964,00	4	3856
e-SDSL::1026	1026,00		1026,00	4	4104
e-SDSL::1282	1282,00		1282,00	4	5128
e-SDSL::1426	1426,00		1426,00	4	5704

10.X.1 Total Signal Power

To be compliant with this signal category, the mean signal power into a resistive load of 135 Ω shall not exceed a level of P_{max}, measured within a frequency band from at least 100 Hz to ($2 \times F_N$). Table 2 summarizes values of P_{max} for the various e-SDSL signals:

Table 2: Power limits

For 16 UC-PAM modulation: +13,5 ± 0.5 dBm for "e-SDSL::Fn" signals, when F_N < 685 kHz +14,5 ± 0.5 dBm for "e-SDSL::Fn" signals, when $F_N \geq$ 685 kHz
For 32 UC-PAM modulation: +13,5 ± 0.5 dBm for "e-SDSL::Fn" signals, when F_N < 672 kHz +14,5 ± 0.5 dBm for "e-SDSL::Fn" signals, when 672 kHz < $F_N \geq$ 685 kHz

Reference: TS 101 524 [1], clauses 9.4.1 and E.4
Reference: ITU-T Recommendation G.991.2 [2], clauses B.4.1 and B.4.2.

10.X.2 Peak amplitude

These definitions are identical as specified for “SDSL:Fn” signals.

10.X.3 Narrow-band signal power (NBSP)

These definitions are identical as specified for “SDSL:Fn” signals, with the addition that F_N can have values up to 1426 kHz.

10.X.4 Unbalance about earth

These definitions are identical as specified for “SDSL:Fn” signals.

10.X.5 Feeding Power (from the LT-port)

Power feeding is no integral part of this signal category, although it is not uncommon for e-SDSL services. To enable power feeding in combination with this signal category, refer to one of the power feeding classes summarized in clause **7**.

Text portions proposed for inclusion into clause 11

11. CLUSTER 4 SIGNALS (ASYMMETRICAL BROAD BAND)

11.5. "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 [4]. A signal can be classified as an "ADSL2plus/A" signal if it is compliant with all clauses below.

11.5.1. 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 [4], clause A.1.2.2.

11.5.2. 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 +12,5 dBm, measured within a frequency band from at least 4 kHz to 7 MHz.

Reference: ITU-T Recommendation G.992.5 [4], clause A.2.2.2.

11.5.3. 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 3 MHz. The definition and measurement method of peak amplitude is specified in clause 13.1.

NOTE: No ETSI deliverable specifies this parameter.

11.5.4. 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 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 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: “X” and “Y”. 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 [4], clause A.1.2 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	"X"
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	"Y"
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	

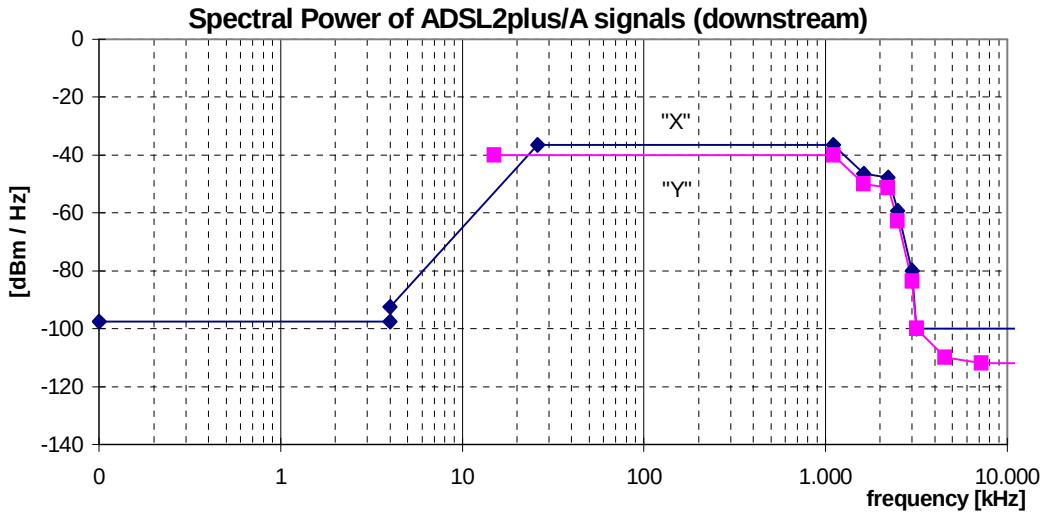

Figure 1: Spectral Power, for downstream ADSL2plus/A, as specified in table 3.

11.5.5. 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 4, 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 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: “X” and “Y”. 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 [4], clause A.2.2 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	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	“Y”
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	

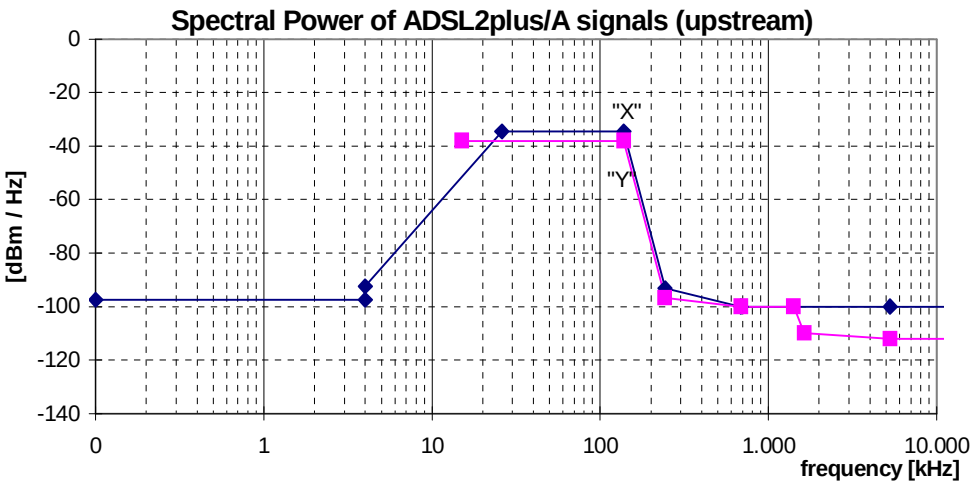

Figure 2: Spectral Power, for upstream ADSL2plus/A signals, as specified in table 4.

11.5.6. 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 5 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 6.

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	3650 kHz	100 Ω	150 nF
upstream	-46 dBV	10 kHz	5,1 kHz	210 kHz	100 Ω	150 nF

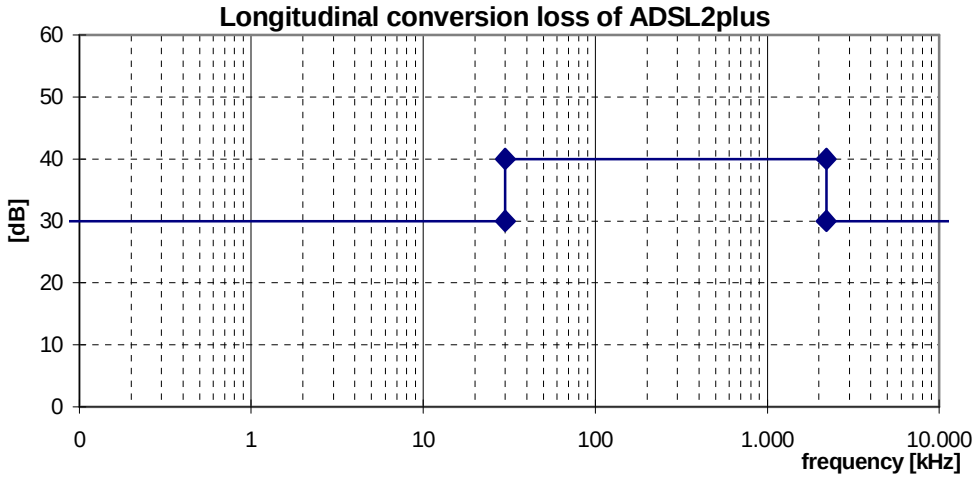

Figure 3: Minimum longitudinal conversion loss

Table 6: 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

11.6. "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 G.992.5 [4]. A signal can be classified as an "FDD.ADSLplus/A" signal if it is compliant with all clauses below.

11.6.1. 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 [4], clause A.1.3.2.

11.6.2. Total signal power (upstream only)

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

11.6.3. Peak amplitude (upstream and downstream)

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

11.6.4. 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 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: “X” and “Y”. 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 [4], clause A.1.3 reconstructed from PSD requirements.

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	600 Ω	-77,5 dBm	100 Hz	-97,5 dBm/Hz	“X”
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	“Y”
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	

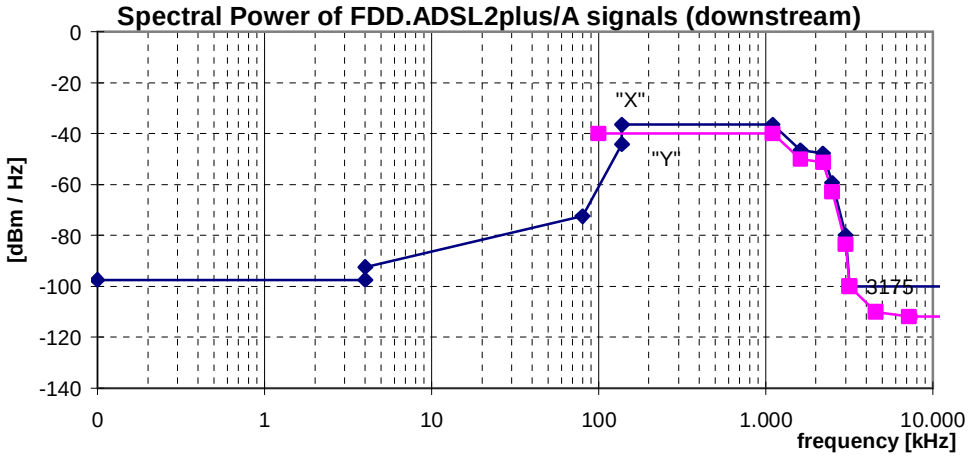

Figure 4: Spectral Power, for downstream FDD.ADSL2plus/A signals, as specified in table 7.

11.6.5. Narrow-band signal power (upstream only)

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

11.6.6. Unbalance about earth (upstream and downstream)

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

11.7. "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 [4]. A signal can be classified as an "ADSL2plus/B" signal if it is compliant with all clauses below.

11.7.1. 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 [4], clause B.1.2.2.

11.7.2. 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 +13,3 dBm, measured within a frequency band from at least 4 kHz to 3 MHz.

Reference: ITU-T G.992.5 [4], clause B.2.2.2.

11.7.3. Peak amplitude (upstream and downstream)

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

11.7.4. 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 8, 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.

NOTE: The NBSP specification of this signal category has been split into two overlapping limits: "X" and "Y". 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 [4], clause B.1.2, 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	"X"
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	"Y"
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	

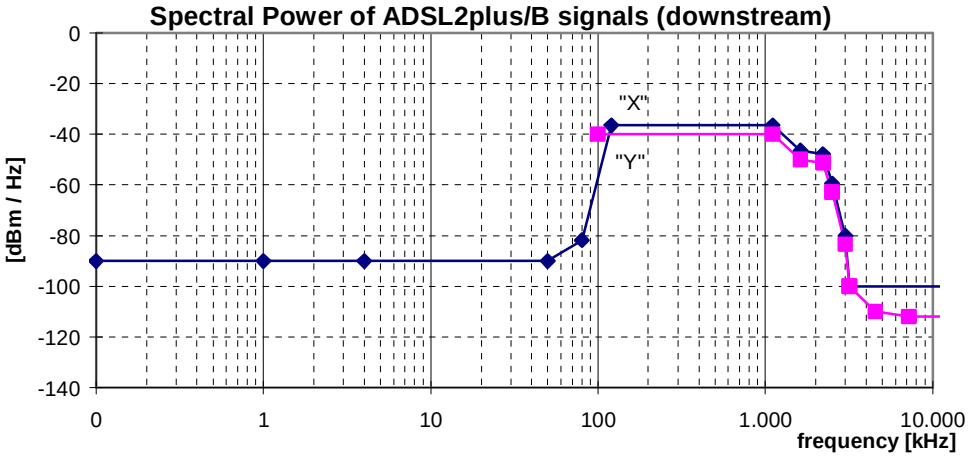

Figure 5: Spectral Power, for downstream ADSL2plus/B signals, as specified in table 8.

11.7.5. 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 9, 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: “X” and “Y”. 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 276 kHz.

Reference: ITU-T Recommendation G.992.5 [4], clause B.2.2 reconstructed from PSD requirements.

Table 9: 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	"X"
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	"Y"
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	

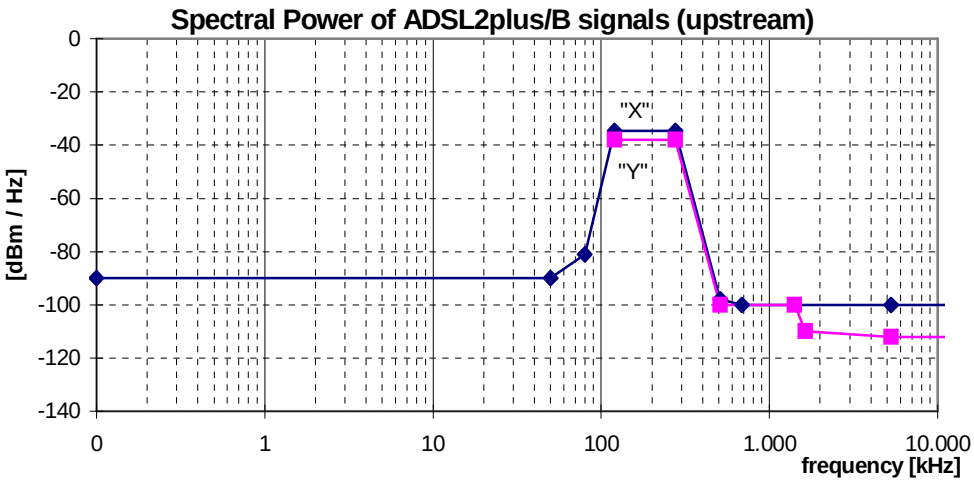

Figure 6: Spectral Power, for upstream ADSL2plus/B signals, as specified in table 9.

11.7.6. 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. 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. Table 10 gives the values for the LOV limits in case of ADSL2plus while the LCL mask for ADSL2plus is given in figure 7. The LCL values of the associated break frequencies of this figure are given in table 11.

Table 10: 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

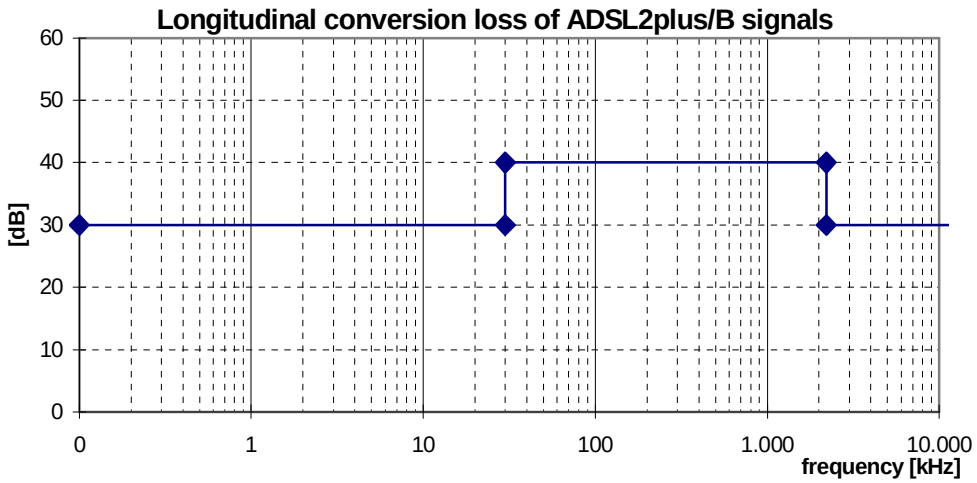

Figure 7: Minimum longitudinal conversion loss.

Table 11: 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

11.8. "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-T G.992.5 [4]. A signal can be classified as an "FDD.ADSL2plus/B" signal if it is compliant with all clauses below.

11.8.1. 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 [4], clause B.1.3.2.

11.8.2. Total signal power (upstream only)

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

11.8.3. Peak amplitude (upstream and downstream)

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

11.8.4. 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 12, 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 8 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 [4], clause B.1.3, reconstructed from PSD requirements.

NOTE: The NBSP specification of this signal category has been split into two overlapping limits: “X” and “Y”. The reason for this split is the same as described in the NBSP descriptions for ADSL, e.g. clause 11.1.4.

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	100 Ω	-70 dBm	100 Hz	-90 dBm/Hz	“X”
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	“Y”
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	

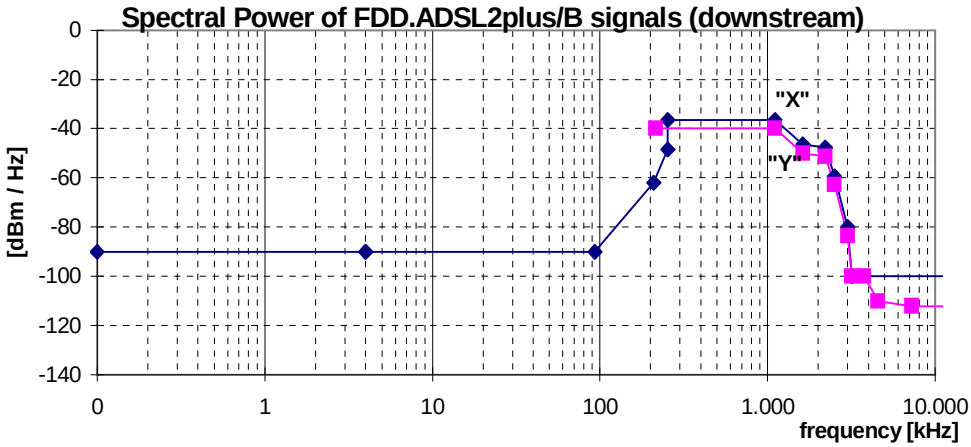

Figure 8: Spectral Power, for downstream FDD.ADSL2plus/B signals, specified in table 12.

11.8.5. Narrow-band signal power (upstream only)

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

11.8.6. Unbalance about earth (upstream and downstream)

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

11.9. "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-T G.992.5 [4]. A signal can be classified as an "ADSL2plus/I" signal if it is compliant with all clauses below.

11.9.1. 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 [4], clause I.1.2.2.

11.9.2. 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 +13,3 dBm, measured within a frequency band from at least 4 kHz to 7 MHz.

Reference: ITU-T Recommendation G.992.5 [4], clause I.2.2.2.

11.9.3. 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.

11.9.4. 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 13, 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 9 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: "X" and "Y". 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 [4], clause I.1.2 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	-28,5 dBm	100 Hz	-48,5 dBm/Hz	"X"
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	"Y"
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	

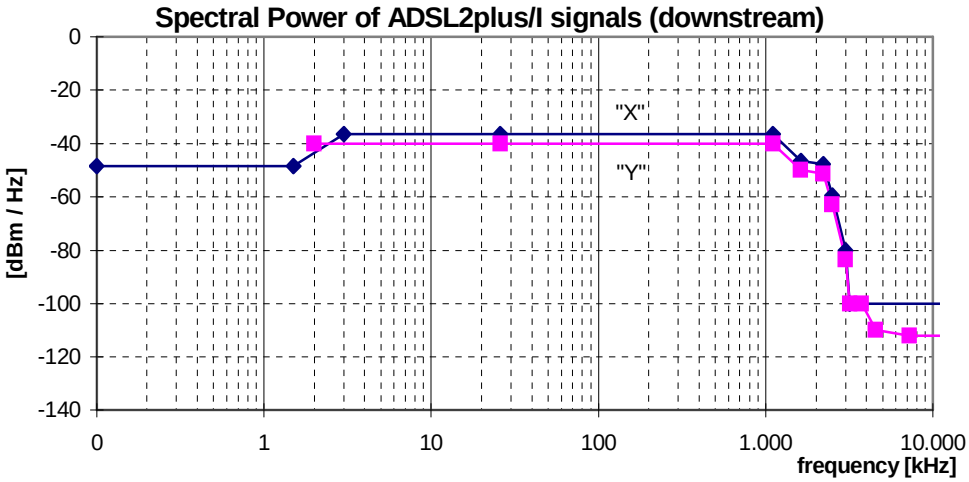

Figure 9: Spectral Power, for downstream ADSL2plus/I signals, as specified in table 13.

11.9.5. 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. 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: “X” and “Y”. 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 [4], clause I.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	600 Ω	-26,5 dBm	100 Hz	-46,5 dBm/Hz	"X"
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	"Y"
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	

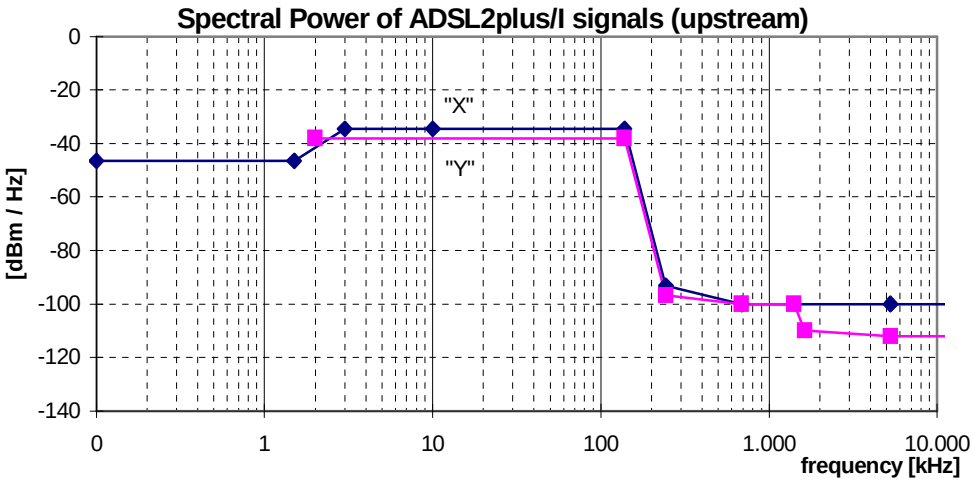

Figure 10: Spectral Power, for upstream ADSL2plus/I signals, as specified in table 14.

11.9.6. Unbalance about earth (upstream and downstream)

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

11.10. "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 [4]. A signal can be classified as an "FDD.ADSL2plus/I" signal if it is compliant with all clauses below.

11.10.1. 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 [4], clause I.1.3.2.

11.10.2. Total signal power (upstream only)

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

11.10.3. Peak amplitude (upstream and downstream)

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

11.10.4. 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 [4], 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)

11.10.5. Narrow-band signal power (upstream only)

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

11.10.6. Unbalance about earth (upstream and downstream)

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

11.11. "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 [4]. A signal can be classified as an "ADSL2plus/J" signal if it is compliant with all clauses below.

11.11.1. Total signal power (downstream only)

The description of this signal characteristic equals that of "ADSL2plus/I" (EC).
Reference: ITU-T Recommendation G.992.5 [4], clause J.1.2.2.

11.11.2. 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 [4], clause J.2.2.2.

11.11.3. Peak amplitude (upstream and downstream)

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

11.11.4. 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 [4], clause J.1.2.

11.11.5. 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 16, 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 [4], 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 16 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.992.5 [4], 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 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: “X” and “Y”. 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 [4], clause J.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	-26,5 dBm	100 Hz	-46.5 dBm/Hz	“X”
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	“Y”
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	

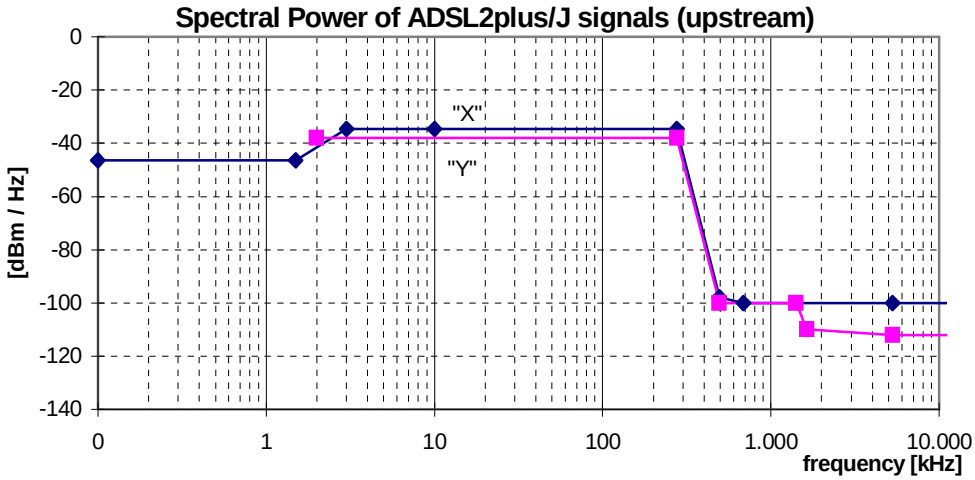

Figure 11: Spectral Power, for upstream ADSL2plus/J signals, as specified in table 15.

11.11.6. Unbalance about earth (upstream and downstream)

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

11.12. "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 [4]. A signal can be classified as an "FDD.ADSL2plus/J" signal if it is compliant with all clauses below.

11.12.1. Total signal power (downstream only)

The description of this signal characteristic equals that of "FDD.ADSL2plus/B".
Reference: ITU-T Recommendation G.992.5 [4], clause J.1.3.2.

11.12.2. Total signal power (upstream only)

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

11.12.3. Peak amplitude (upstream and downstream)

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

11.12.4. 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 [4], clause J.1.3.

11.12.5. Narrow-band signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/J".
Reference: ITU-T Recommendation G.992.5 [4], clause J.2.2.

11.12.6. Unbalance about earth (upstream and downstream)

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

11.13. "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 [4]. A signal can be classified as an "ADSL2plus/M" signal if it is compliant with all clauses below.

11.13.1. Total signal power (downstream only)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).
Reference: ITU-T G.992.5 [4], clause M.1.2.2.

11.13.2. 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 [4], clause M.2.2.2.

11.13.3. Peak amplitude (upstream and downstream)

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

11.13.4. Narrow-band signal power (downstream only)

The description of this signal characteristic equals that of "ADSL2plus/A" (EC).
Reference: ITU G.992.5 [4], clause M.1.2.

11.13.5. 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 16, 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 [4], 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 15 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.992.5 [4], 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 13 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: “X” and “Y”. 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 [4], clause M.2.2 reconstructed from PSD requirements.

Table 16: 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	"X"
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	"Y"
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	

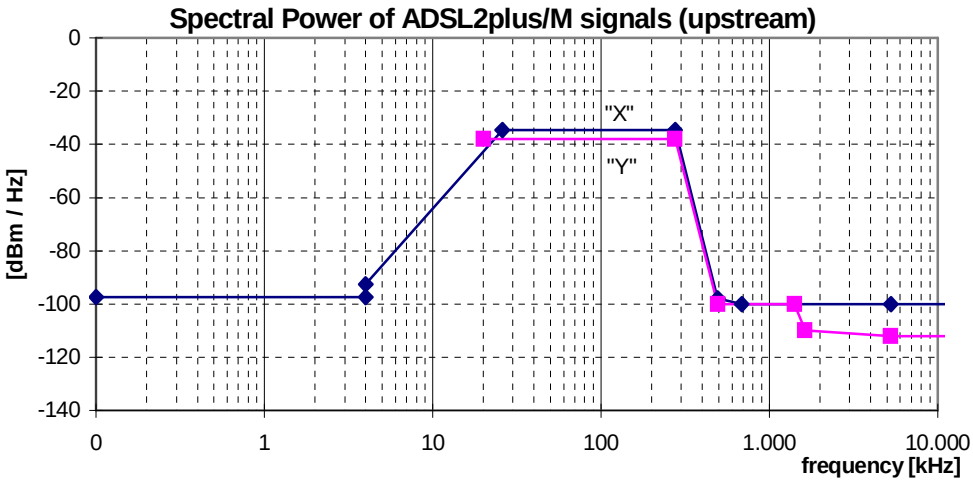

Figure 13: Spectral Power, for upstream ADSL2plus/M signals, as specified in table 16.

11.13.6. Unbalance about earth (upstream and downstream)

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

11.14. "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 [4]. A signal can be classified as an "FDD.ADSL2plus/M" signal if it is compliant with all clauses below.

11.14.1. Total signal power (downstream only)

The description of this signal characteristic equals that of "FDD.ADSL2plus/B".
Reference: ITU-T Recommendation G.992.5 [4], clause M.1.3.2.

11.14.2. Total signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/M" (EC).
Reference: ITU-T Recommendation G.992.5 [4], clause M.2.2.2.

11.14.3. Peak amplitude (upstream and downstream)

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

11.14.4. 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 [4], clause M.1.3.

11.14.5. Narrow-band signal power (upstream only)

The description of this signal characteristic equals that of "ADSL2plus/M".
Reference: ITU-T Recommendation G.992.5 [4], clause M.2.2.

11.14.6. Unbalance about earth (upstream and downstream)

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

End of literal text proposals

Hidden definitions (do not delete!!):
Clause 11.1.4
Clause 11.1.5
Clause 11.1.6

Clause 13.1
Clause 13.2
Clause 13.3