

JORDAN TELECOM

INTERFERCNCCE MANGEMENT PLAN

27 April 2017

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1. Introduction

1.1 The local loop refers to the pairs of copper wire, between the user's premises External Termination Point (**ETP**) and the **JT** Main Distribution Frame (**MDF**). Local loop unbundling (**LLU**) refers to the process in which **JT** leases, wholly or in part, the local segment of its telecommunications network to Other Licensed Operators (**OLOs**).

1.2 Voiceband signals uses a limited frequency range.

1.3 Several other types of non-voice signals use technologies over the unshielded twisted pair cable including, but not limited to, digital data services, E1-carrier systems, and digital subscriber line (**xDSL**) transmission systems. In contrast to analogue voice service, data transmission often uses a much wider range of frequencies (**broadband** signals)

1.4 These broadband signals on one copper pair cause interference to other signals on other copper pairs in the same cable. This interference, called crosstalk, is caused by electromagnetic energy that couples into a metallic cable pair from transmission system technologies on other pairs in the same cable and has the potential to unacceptably degrade the performance of services/systems sharing the same cable, thereby compromising network integrity. The twisting of the insulated conductors into pairs minimizes this coupling, as does the twisting of the binder groups (bundles of pairs) in the cable. Despite these measures however, capacitive and inductive coupling still exist between pairs of a multi-pair loop cable.

1.5 Crosstalk can result in interference at:

- a) The near end, when one or more transmitters are co-located with a receiver (**NEXT**); and
- b) The far end, when a receiver's wanted signal (**disturbed system**) is interfered with by signals from other transmitters (**disturbing systems**) at the distant end of the cable (**FEXT**).

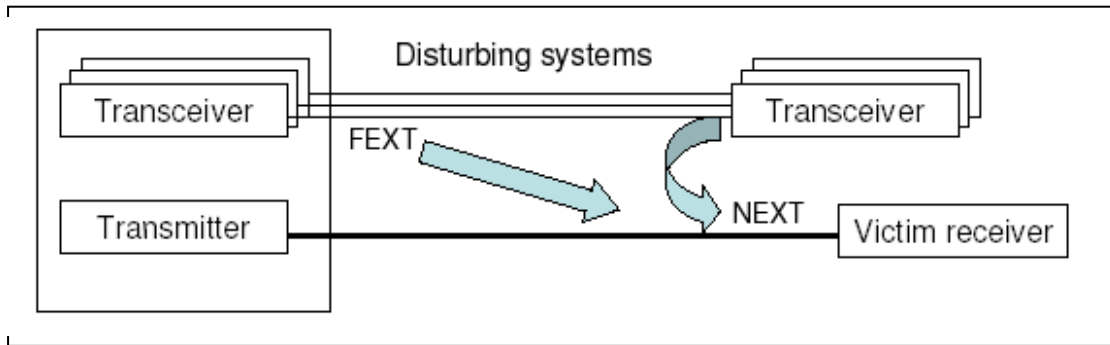


Figure 1. Crosstalk model for downstream systems

1.6 NEXT is typically more severe than **FEXT**, particularly when transmission takes place in both directions in a binder and there is an overlap in the frequency bands between the **upstream** and **downstream** signals.

1.7 Crosstalk depends on pair-to-pair exposure, signal frequency and signal strength (power), in particular crosstalk :

- a) Increases with closer pair proximity. Exposure or coupling is a measure of the proximity of metallic pairs at various points along a cable and the length over which pairs are in close proximity. The greater the exposure, the greater the total crosstalk.
- b) Increases with more pairs in a binder used .
- c) Increases with higher frequencies – high frequency energy has higher coupling than lower frequency energy. This is because as the signal frequency increases, the crosstalk coupling loss between the pairs of a cable decreases. Hence, for two signals of equal strength, the higher the frequency, the greater the crosstalk. Thus the higher the speed/capacity of the **xDSL** system, the greater the potential for inter-system interference. This is true for the fundamental crosstalk coupling through a small segment of the cable, and is also true for **NEXT**. However in the case of **FEXT**, which also includes the attenuation of the cable in the **FEXT** path, the **FEXT** ratio between the received signal and the received crosstalk at lower frequencies does increase with frequency, but at higher frequencies the attenuation path becomes more dominant and **FEXT** coupling decreases with frequency at higher frequencies.
- d) Increases with power – crosstalk is directly proportional to transmit (or disturbing) signal strength, so limiting transmit power lessens inter-service interference. Thus an effective means of controlling crosstalk interference is to limit the signal energy of some systems that are applied to cable pairs.

1.8 In an unbundled loop environment, where JT's local loop cable is being shared by Other Licensed Operators (OLOs), inter-system crosstalk must be controlled to ensure an acceptable level of protection of network integrity. Therefore, in order to ensure effective exploitation of the unbundled local loop, there is a requirement for all operators to abide by a set of agreed performance requirements by suitable selection of the type, quantity and disposition of xDSL systems to ensure their spectral compatibility.

1.9 Two broad spectral classes of transmission technologies are in common use today – symmetric and asymmetric. Each has different crosstalk features :

a) Spectrally symmetric systems (like **SHDSL**) cannot avoid near end cross talk from like systems because they use the same frequencies on the go and return channels. They must therefore be deployed to tolerate the impact of interference from crosstalk. Because of the **NEXT** impact, the working reach of symmetric technologies, in the presence of like systems, is less than the achievable reach of homogenous spectrally asymmetric deployments.

b) Spectrally asymmetric systems like **ADSL** have been specifically designed to avoid **NEXT** from other like systems by using different frequency ranges for the go and return paths. The result of this is generally longer range for the same downstream rate, but the cost of reduced upstream rate. The range advantage of asymmetric over symmetric technologies is achieved at the cost of increased susceptibility to **NEXT**.

1.10 There is insufficient bandwidth at the long range lower frequencies for symmetric technologies to practically split the usable spectrum to reduce self-**NEXT**, so some allowance for **NEXT** interference must be made and achievable reach traded off.

1.11 **NEXT** is the dominant form of interference that determines the design limit for asymmetric system when surrounded by other like symmetric systems. For an **SHDSL** system, other **SHDSL** systems are generally its worst disturbers. Replacing **SHDSL** disturbers with **ADSL** generally results in an improvement in performance.

1.12 Performance of spectrally symmetric technologies is very dependent on the **NEXT** coupling statistics of cables used.

1.13 In general, **spectral compatibility** is the capability of a transmission system technology on any cable pair to co-exist in the same cable as other systems of the same or different type without one causing undue harm to any other system operating in the same cable binder.

1.14 A loop transmission system technology is considered to be spectrally compatible with other loop transmission systems when it meets the signal power limits, the deployment guidelines and other criteria for the type of loop defined in this Interference Management Plan (**IMP**).

1.15 Impacts of symmetric systems on asymmetric systems in the same binder :

a) An increasing number of **ADSL** disturbers in a binder has a higher relative impact on **SHDSL** reach than the impact that a rising number of **SHDSL** systems has on **ADSL** reach;

b) The **ADSL** upstream performance is impacted more by rising numbers of **SHDSL** interferers because the upstream link is impacted by the **NEXT** effect of the **SHDSL** transmitters operating at the wire centre in the same frequency range as the **ADSL** upstream wire centre receiver(s);

c) The impact of **SHDSL** on **ADSL** upstream is still less in relative reach than the reach impact that **ADSL** has on **SHDSL** performance.

2. Objectives

2.1 Limits to an acceptable level the risk of interference between systems and services (including **POTS**) operated using a telephone line which is referred to as a Metallic Path Facility (**MPF**) at **JT** local loop.

2.2 Protects the integrity of **JT** Network when systems and services(including **POTS**) are operated using the **MPF**.

2.3 Facilitates the supply of innovative telecommunications services using the **MPF**.

- 2.4** Avoids the use of spectrum prior to the **IMP** working group decision of the most efficient use of that spectrum in the operation of systems using the **MPF**.

3. General principles

3.1 This Interference Management Plan (**IMP**) applies equally to **JT** and Other Licensed Operators(**OLOs**) that use **JT** local loop.

3.2 This **IMP** establishes performance requirements which systems must meet and only systems which meet the requirements of this **IMP** may be operated.

3.3 The user of the network (i.e. **OLO** and **JT**) shall be responsible for declaring compliance to this **IMP**.

3.4 Any pair in an access cable is to support any of the transmission systems allowed by this **IMP**, except for the deployed **HDB3** (like **E1**, **T1** carriers) systems which must be separated from other **xDSL** technologies by a cable unit or with pair number differing by 10 .

3.5

Any access cable could be utilized for **xDSL** technologies up to 100% of its capacity taking in consideration the restriction of **HDB3** systems deployment rule (principle 3.4).

3.6 Any changes to this **IMP** can adversely affect (e.g. in terms of reduced reach and reduced performance) the permitted transmission systems. Hence the mechanism for the control of changes to this **IMP** needs to be pre-defined so that users of this **IMP** can assess the risks associated with possible changes. For this reason this **IMP** will be under change control.

3.7 The **IMP** will be under the control of an **IMP** working group. This working group shall take decisions and actions based on consensus, i.e. all members of the **IMP** working group must work together to find an agreement

3.7.1 The **IMP** working group is a technical committee chaired and nominated by **JT**, the working group shall include a representative of the concerned Licensee. It serves as a platform for discussion of all issues with regard to the implementation of the **IMP**.

3.7.2 **IMP** working group shall ask the concerned **OLO** to nominate a technical representative to participate in working group discussion.

3.7.3 **IMP** working group may ask the concerned operator to submit any kind of supporting documents that is needed for the

implementation of IMP such as but not limited to certified compliance, laboratory compliance of systems, and operational compliance of systems

3.7.4 The **IMP** working group is to decide that a system is being operated in accordance with the requirements, the mandated **PSD** masks and the deployment limit of each of the deployed systems. There are three alternative ways by which compliance may be demonstrated. These ways are :

- (1) certified compliance with a listed international standard; or
- (2) laboratory compliance of systems; or
- (3) operational compliance of systems

Deployment rules that protect the deployed systems against unacceptable interference and unacceptable excess power will be mandated on new systems. Once a new system has met the rules successfully, as communicated and discussed in the IMP working group, **all operators** may deploy the system.

3.7.5 The **IMP** working group shall meet as required to review the implementation of the **IMP**. The invitation to meet should be done by the members of the working group.

3.7.6 In light of experience and technical developments, the **IMP** working group may decide on adjustments and changes of the **IMP**.

3.7.7 JT and **OLOs** inter-processes that are required for operations and maintenance should be discussed and adopted by the **IMP** working group. In case of alleged interference, it is required to efficiently and quickly identify the reason and find solutions to mitigate it.

3.7.8 In case no agreement can be reached by the working group, the IMP working group may raise the issue to TRC to decide on the matter.

3.8 In the event of an interference problem arising where reasonable suspicion falls on the **OLO** equipment, **OLO** is required to co-operate with **JT's** reasonable requests. Similarly, in the event that reasonable suspicion falls on **JT** equipment, **JT** is required to co-operate with **OLO's** reasonable request. In extreme circumstances **JT** reserves the right to initiate any appropriate remedial action.

3.9 Compliance of broadband **xDSL** technologies of **OLOs** with **JT** deployed systems (including **PSTN** services) that assures network integrity is expressed in mandated **PSD** masks and Deployment Limit for each technology.

3.10 JT Deployment Limit is calculated upon medium noise environment in 10 pair cable unit.

3.11 Deployment of more than one system type over the same **MPF** for a temporal period is not allowed unless its parameters do not exceed the masks stated in this **IMP**.

3.12 Legacy **HDSL** 160kbps , 592kbps , 784kbps ,1168kbps and **SDSL** technologies are not allowed to be deployed by **OLOs**.

3.13 Carrying **xDSL** services with other **broadband** services in the same internal cable at the customer premises (as local area network high frequency services) is not allowed when the individual copper pairs are unshielded.

3.14

Both JT and the OLO may ask for a test at the deployed system/s to confirm its/their compatibility with the deployment rules in case of occurrence of interference. Tests should be carried out in mutual agreement between the concerned operators

3.15 Longitudinal output voltage limit for all **NEs** must be $\leq -50\text{dBV}$ in any 4kHz band over a frequency range of 10kHz to 12040kHz

3.16 in case of introducing new systems by the OLOs, JT has the right to request tests , certificates any other documents that proves the compatibility of the new systems with the JT's network.

3.17 The attachments included in the Interference Management Plan describe JTC's networks. These attachments should serve as a guideline for the work of the IMP working group.

3.18 JT may introduce a new system in accordance with the procedures in clause 3.7, provided that JT informs the concerned Alternative Operators 6 weeks before the deployment of the new systems

4. Topology of LLU

4.1 When establishing an **LLU**, the **OLO** is connected through tie cables from **JT's** Handover Distribution Frame (**HDF**) to the **OLO's** rack. These tie cables provide the link between the **OLO's** rack and **JT's MPFs**. Tie cables are designated as either inward or return cables. The inward tie cable brings the **MPF** from the customer to the **OLO** space while the return cable takes the **POTS** service back to **JT** after the higher bandwidths have been removed by the **OLO's** splitter. Local loop unbundling can be classified into two main types :

- a) Full Unbundling (Access to Raw Copper) : Occurs when the copper pairs connecting a subscriber to the **MDF** are leased by **OLO** from **JT** (Figure 1). The Other Licensed Operator (**OLO**) takes total control of the copper pairs and can provide subscribers with all

services including voice. **JT** still maintains ownership of the unbundled loop and is responsible for maintaining it.

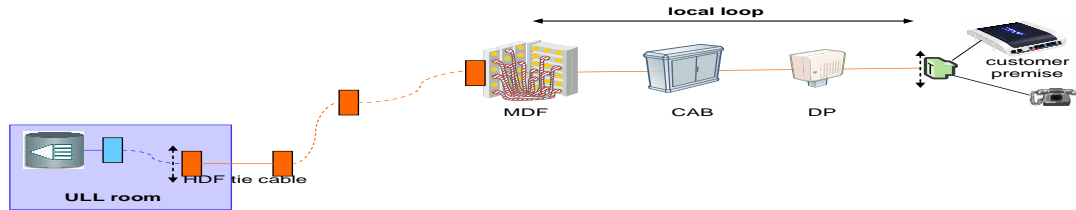


Figure 1. Full Unbundling

b) Line Sharing (Shared Access) allows **JT** to maintain control of the copper pair and continue providing some services to a subscriber while allowing Other Licensed Operators (**OLOs**) to lease part of the copper pair spectrum and provide services to the same subscriber (Figure 2). When Line Sharing is being deployed, then **OLO** gives the bottom 4kHz of the spectrum back to **JT** to use for telephony. This is done with a low pass filter commonly called a **splitter**. **JT** passes the shared access line to the **OLO** to extract the high frequencies through their **DSLAM**. The low frequencies are put into another pair and passed back to **JT** for onward connection to its telephone switch. The **OLO** will need to have two tie cables from **JT** to the **HDF**, one for inward pairs from the customer's Network Termination Point (**NTP**) and the other for return pairs to **JT's** telephony switch. Line sharing allows **JT** to continue to provide telephone service while **OLO** provides broadband (**ADSL**) services on the same copper pair. With line sharing, **OLO** uses the non-voice frequency of the loop.

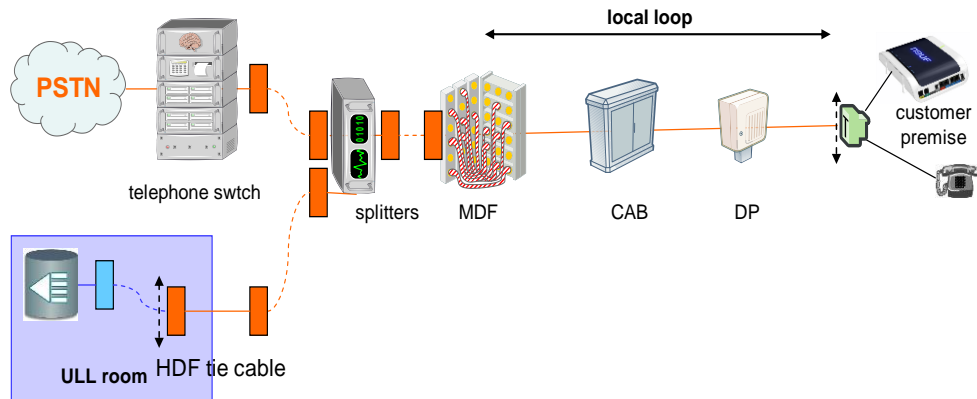


Figure 2. Line Sharing

5. Transmission characteristics of JT local loop access network

5.1 Physical characteristics of JT access copper cables

5.1.1 A subscriber loop consists of sections of twisted pairs cables of different gauges. These sections are either duct, buried or aerial and connected together by means of electrical joints, called splices, directly placed in the ground, in a manhole or on a pole.

5.1.2 The access network has a star topology with the feeder cable bundles going from the Main Distribution Frame (**MDF**) to the Cross Connection Cabinet (**CCC**). From the **CCC**, to Distribution Points (**DP**) and via drop wires to subscribers, the wire pairs are terminated in the individual customer sites. No **bridged taps** or loading coils are present in the outside local network.

5.1.3 Each cable consists of a number of copper conductors generally grouped in bundles or in layers.

5.1.4 A conductor is isolated by a layer of polyethylene.

5.1.5 Conductors have a 0.4 mm, 0.5mm, 0.6 mm, 0.8mm and 0.9 mm gauges .The average distribution of these conductors at **JT** local loop is illustrated in Table 1 :

Cable gauge(mm)	0.4	0.5	0.6	0.8	0.9
%	83	10.8	5.8	0.2	0.2

Table 1. Percentage of lines gauges in JT/LL

5.1.6 In plastic insulated cables used in the main and distribution, the conductors are surrounded by an aluminum screen surrounded by a polyethylene external sheath.

5.1.7 The plastic cables are longitudinally waterproof.

5.2 Electrical characteristics of JT access copper cables

5.2.1 (Table 2)gives some typical characteristics of the access network cables:

Diameter	Loop resistance (Ω /km)	Average kilometric capacity (nF/km)	Attenuation (dB/km@ 800Hz)	Attenuation (dB/Km@ 50kHz)	Attenuation (dB/Km@ 150kHz)	Attenuation (dB/Km @300 kHz)
0.4mm	270	55	2.0	8.8	12.5	14.5
0.5mm	180	50-55	1.3	6.0	9.0	11.0
0.6mm	120	38.5-46	1.0	4.5	7.0	9.0
0.8mm	70	38.5	0.7	3.0	5.0	6.7
0.9mm	55	38.5	0.6	2.5	4.5	6.0

Table 2. Characteristics of JT/ LL copper cables

5.2.2 Insulation resistance

The insulation resistance between 'a' and 'b' wires of a pair (without terminal equipment) or between wire 'a' or 'b' and earth is supposed to be at least 10M Ohms under 500VDC for period of 60 s , while the difference between their values should not exceed 20%.

5.2.3 Characteristic Impedance

Characteristic impedance of the cable is the ratio of the electric field strength to the magnetic field strength for waves propagating in the cable (Volts/m / Amps/m = Ohms). It is a function of frequency, cable geometry (size and spacing between the conductors) and the type of used dielectric. At broadband frequencies, any mismatching between the source's output impedance, the cable's characteristic impedance, and load's input impedance causes signal reflections.

Line impedance typical values are shown in (Table 3)

Frequency (kHz)	Impedance (Ohms)
1.6	600
6	300
32	150
64	120
200 and more	100

Table 3. Typical line impedance for certain frequencies

The impedance of Network Equipment (**NE**) and Customer Equipment (**CE**) transceivers is to be the same as cable characteristic impedance, with a tolerance of $\pm 20\%$, as measured at the central frequency of the usable spectrum.

5.2.4 Dielectric Loss Factor (DLF)

It is equivalent to a high value leakage resistance shunting the line. It depends on the insulating material.

Typical value for PE copper cables ≈ 0.00005

5.2.5 Propagation Velocity Factor(PVF)

Propagation Velocity Factor (**PVF**) is the propagation velocity of electromagnetic signal inside the copper conductor relative to light. It depends on the quantity and permittivity of the copper cable insulating material.

Typical value for PE copper cables ≈ 0.67

6. Deployment Limit

6.1 Deployment limit is the maximum permitted Attenuation in dB, at the reference frequency of the deployed **xDSL**, from **MDF** to the End User end **ETP** of the **MPF**.

6.2 Compliance of deployed **xDSL** technology is determined through calculating the attenuation of the access loop and compare it with the Deployment Limit using the following steps:

6.2.1. The attenuation (in dB at the relevant reference frequency for the deployed technology) of each cable segment is determined by calculation from the cable parameters and formulae mention in clause 6.2.2

6.2.2 The attenuations of all inline segments between the **MDF** and **ETP** are summed to give the Calculated Attenuation. The Calculated Attenuation of the access loop of n segments each with length l_i km at frequency f kHz is obtained from the sum of the attenuations of all inline segments in the **MPF** Loop:

$$\text{Calculated Attenuation}(f) = \sum_{i=1}^n l_i \times \text{Attenuation}_i(f) \quad (\text{dB}); \text{ and}$$

6.2.3 The Calculated Attenuation is then compared with the specified Deployment Limit for the deployed technology. The test for compliance with the Deployment Limit is that the Calculated Attenuation does not exceed the Deployment Limit D_k for the relevant deployed technology k at the specified reference frequency f_{ref} kHz for that class:

$$\text{Compliant if } \text{Calculated Attenuation}(f_{ref}) \leq D_k \quad (\text{dB})$$

6.3 There are four Deployment Limits over which it is permitted to deploy various technologies :

Line category	Attenuation at 300 kHz
Extra short	≤ 24 dB
short	$> 24, \leq 40$ dB
medium	$> 40, \leq 47$ dB
long	> 47 dB

Table 4. Deployment Limit

Line category	Examples of Permitted technologies
Extra short	ISDN-BR , ADSL,ADSL2plus Annex A&M, SHDSL 576kbps,1160kbps,2320kbps , ESHDSL 3840kbps, 5696kbps
short	ISDN-BR , ADSL,ADSL2plus Annex A, SHDSL 576kbps,1160kbps,2320kbps
medium	ISDN-BR , ADSL,ADSL2plus Annex A, SHDSL 576kbps,1160kbps
long	ISDN-BR , ADSL,ADSL2plus Annex A, SHDSL 576kbps

Table 5. Examples of technologies permitted within Deployment Limit

7. Spectral Mask for all Deployed broadband systems

The following mask define the maximum **PSD** of systems that are permitted to be deployed at **JT** copper loop access network.

7.1 Downstream mask from Exchange

This mask permits technologies such as **ISDN-BR**, **SHDSL**, **ESHDSL** up to 5.696Mbit/s, ADSL and ADSL2plus.

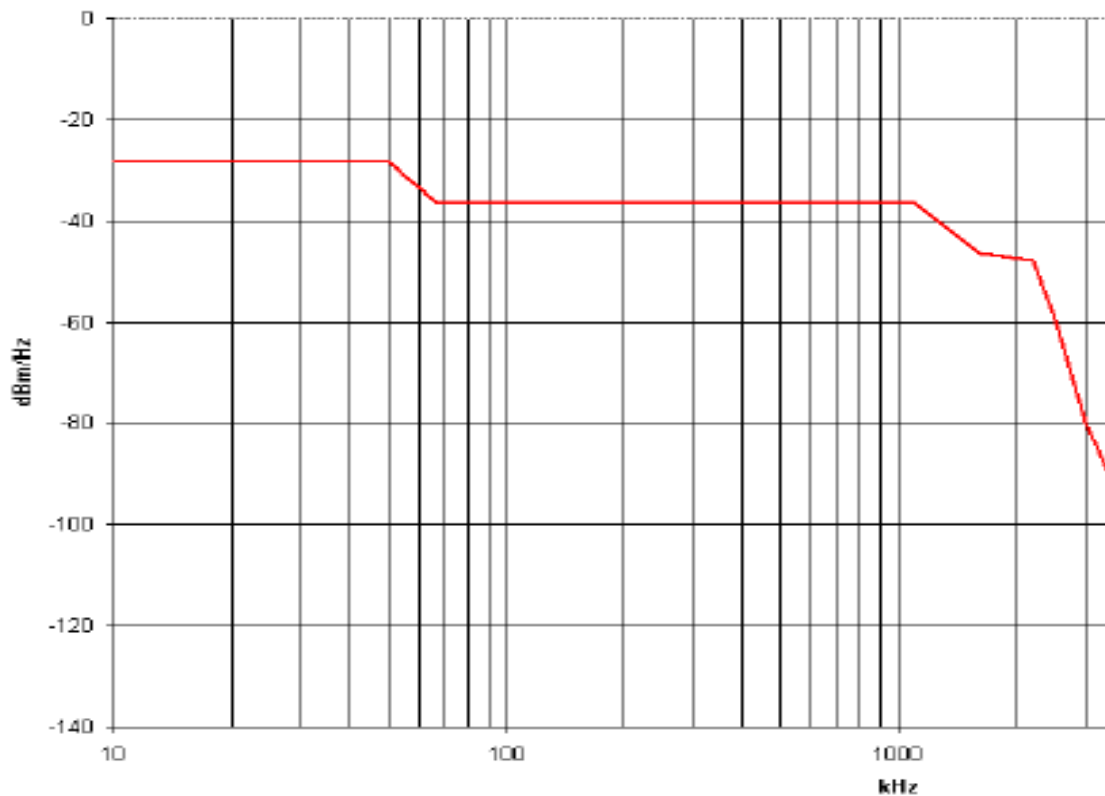


Figure 5. Downstream mask from the exchange.

7.2 Upstream mask from CE

The mask limit is dependant on the electrical distance between the **ETP** and the **MDF** for technologies using frequencies up to 12040kHz.

7.3 The maximum over all of the transmitted **PSD** templates in mW/Hz of all deployed technologies must be ≤ 0.05 mW.

8. Asymmetric DSL technologies

8.1 Introduction

Asymmetrical Digital Subscriber Line (**ADSL**) is a high-speed Internet access technology. **ADSL** can transmit both voice and data simultaneously over an existing, single copper pair .

An **ADSL** system consists of the following components:

- **ADSL** Transceiver Unit-Central Office (**ATU-C**)
- **ADSL** Transceiver Unit-Remote (**ATU-R**)
- Splitter – low pass filter for separating **POTS** from **ADSL**
- Digital Subscriber Line Access Multiplexer (**DSLAM**) – Multiplexes many **ADSL** copper lines into one fiber stream and includes the splitter and **ATU-C** in.

Traditional Plain Old Telephone Service (**POTS**) uses a narrow 4-kHz baseband frequency to transmit analog voice signals. **ADSL** increases the usable frequency range from 4 kHz to 1.1 MHz.

Frequency Division Multiplexing (**FDM**) then allows **ADSL** to create multiple frequency bands to carry **upstream** and **downstream** data simultaneously with the **POTS** signal over the same copper pair. The lower 4-kHz frequency range is reserved for **POTS**, the middle frequency band is used to transmit **upstream** data, and the larger, higher frequency band is used for **downstream** data. Discrete Multi-Tone (**DMT**) modulation divides the data bandwidth into 256 sub-channels, or tones, ranging from 25 kHz to 1.1 MHz. **Upstream** data transfer frequencies range from 25 kHz to 138 kHz, and **downstream** data transfer frequencies range from 138 kHz to 1.1 MHz. The remaining tones are used as guard bands for dividing the three frequency bands, and one pilot tone is used in each data stream, both **upstream** and **downstream**, for timing purposes. Each tone has a spacing of 4.3125 kHz and supports a maximum number of 15 bits, as limited by its Signal-To-Noise Ratio(**SNR**). Since the tones in higher frequencies are subject to higher attenuation and noise, the number of bits per tone is usually fewer than that in lower frequencies .

The combined **POTS** and **ADSL** signal is split in two distinct signals. The splitter is a passive, low-pass filter that always allows **POTS** to go through, guaranteeing uninterrupted voice service even if **ADSL** fails. The splitter also protects the **ADSL** signal from **POTS** transients signals. The second splitter output sends the combined **ADSL** and **POTS** signal to the

ATU-C/ATU-R, which contains a high-pass filter that screens out the **POTS** signal.

8.2 Other Asymmetrical **DSL** technologies (**ADSL2** , **ADSL2plus**,**ReADSL**,**VDSL**) add new features and functionalities and add support for new applications and services(reduce overall power consumption and improve the rate and reach of **ADSL**).

8.3 New ITU-ADSL Annexes

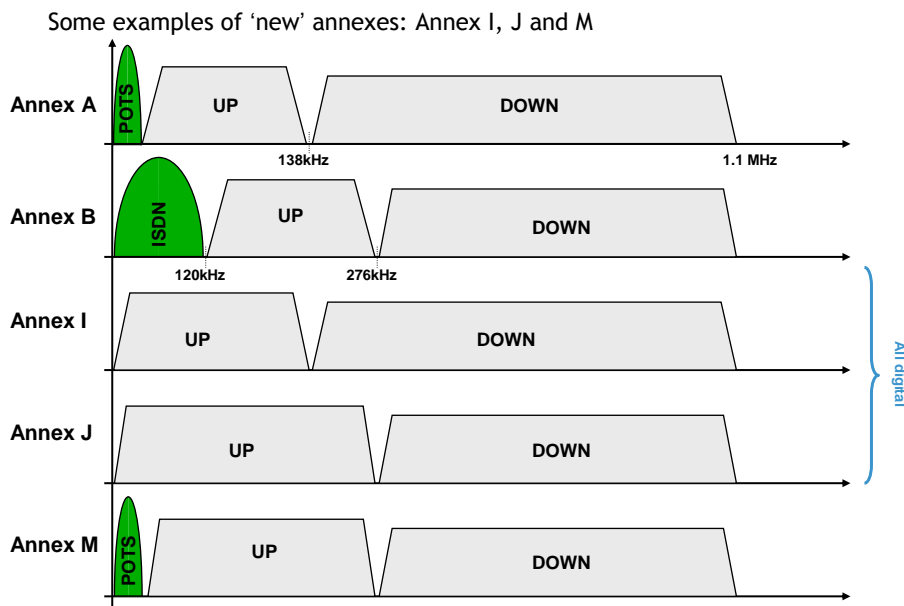


Figure 6. Annex I, J and M

8.4 Deployment limit for Asymmetric DSL technologies

Downstream speed	Max. Attenuation @300KHz(dB)
128 Kbps	70
512 Kbps	59
1024 Kbps	52
2048 Kbps	47
4 Mbps	40
8 Mbps	31
16 Mbps	24
24 Mbps	14.5

Table 6. Deployment Limit for ADSL technologies

8.5 JT Deployed Masks for Asymmetric DSL technologies

Version	Standard	Noise Margin/down stream(dB)	Noise Margin/up stream(dB)	Max PSD (dBm/Hz)/NE	Max PSD (dBm/Hz)/CE
ADSL Operational Modes (POTS)	ANSI T1.413 Issue 2; ITU-T G.992.1 Annex A	10	8	-40.0	-38.0
ADSL2 Operational Modes (POTS)	ITU-T G.992.3 Annex A/ITU G.992.4	10	8	-40.0	-38.0
ADSL2plus Operational Modes (POTS)	ITU-T G.992.5 Annex A	10	8	-40.0	-38.0
ReADSL Operational Modes (POTS)	ITU-T G.992.3 Annex L Mode 1	10	8	-37.0	-33.0

Table 7. JT Deployed Masks for ADSL technologies

8.6 No **ADSL** -systems with spectral overlap of upstream and downstream (Echo Canceling systems **EC**) are allowed on the loops. Only **ATU-C** 's with a **PSD** -mask for reduced **NEXT** (Frequency Division Duplex-**FDD**) are allowed on the loops.

8.7 The operation of any of the Spectrally Asymmetric systems listed in reverse mode (where the network end (**ATU-C**) equipment as defined in the relevant ITU G992 series recommendations is used to transmit in the reverse direction, that is towards the network), will cause unacceptable interference into the deployed **xDSL** technologies and It is strictly forbidden.

8.8 The power cutback mechanism for ADSL2 upstream and downstream transmission needs to be applied.

9. Symmetrical DSL technologies

9.1 Frequency spectrum of Symmetrical DSL

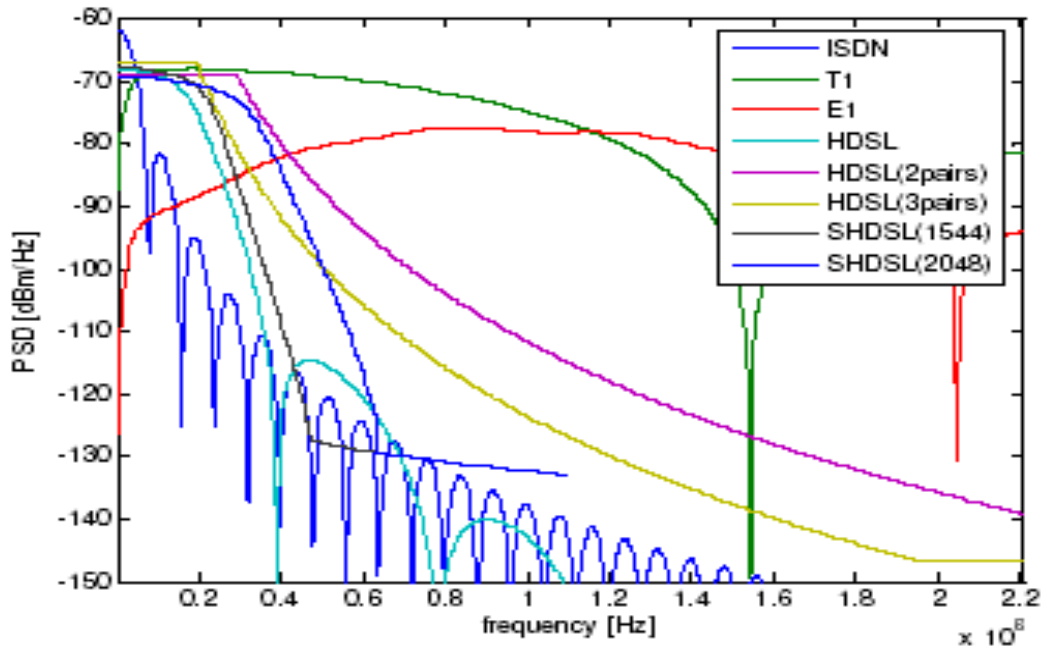


Figure 7. Symmetrical DSL spectrum

9.2 All Symmetrical technologies **use** Echo-Cancelling (**EC**) technique (Up & Down overlap, NEXT limited).

9.3 These technologies have No **POTS** overlay (Baseband, "NO splitter").

9.4 SHDSL replaces the legacy **HDSL** and **SDSL** to increase Spectral Compatibility with existing **DS** as illustrated in figure below

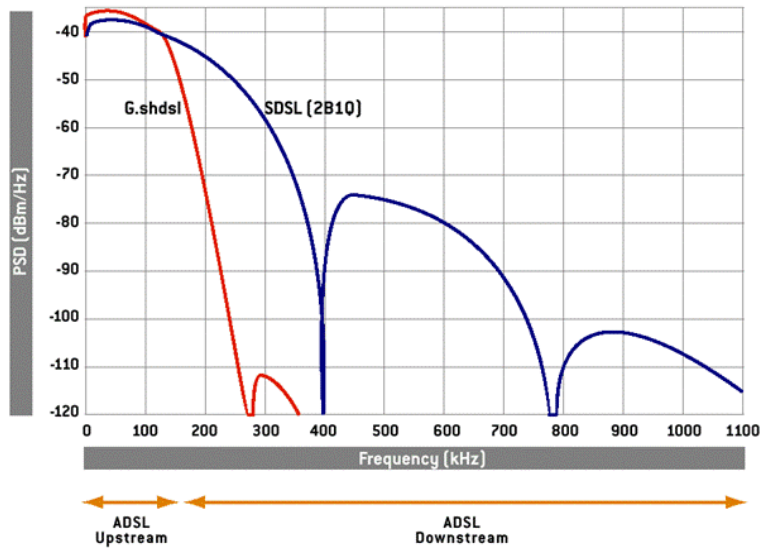


Figure 8. Compatibility of SHDSL with existing DS

9.5 SHDSL 32 TC-PAM (Annex F) has better spectrum efficiency (for the same bit rate) than **SHDSL 16 TC-PAM** (Annex A) and less impact on ADSL as shown in figure below :

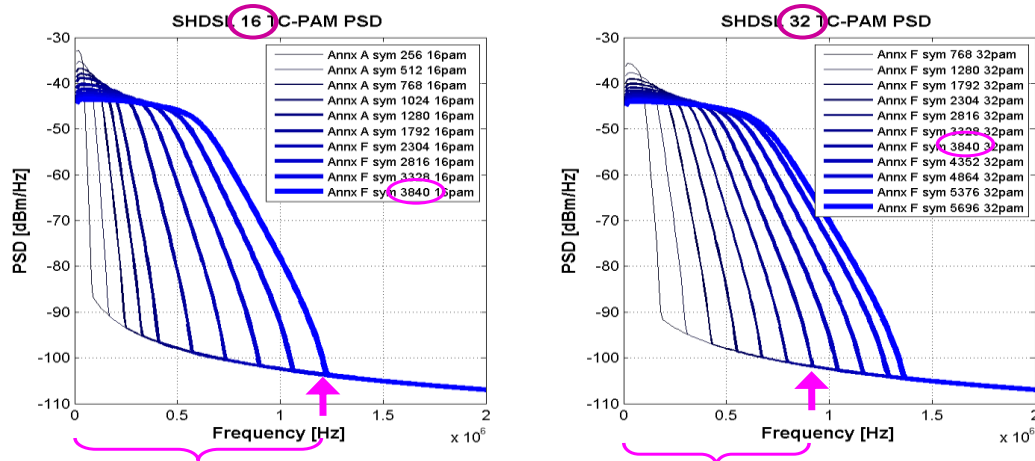


Figure 9. Comparison between SHDSL32 TC-PAM and 16 TC-PAM

9.6 Deployment Limit for Symmetric DSL technologies

name	Standard	Relevant Standard	Reference Frequency(kHz)	Max Attenuation @ Reference Frequency
ISDN-BR	2B1Q	ITU-T G.961	50	40
E1-HDB3	2048kbps	ITU-T G.703	1024	50
SHDSL 576kbps	16-TC-PAM	ITU-T G.991.2 and Annex B	150	55
SHDSL 1160 kbps	16-TC-PAM	ITU-T G.991.2 and Annex B	150	38
SHDSL 2320kbps	16-TC-PAM	ITU-T G.991.2 and Annex B	150	26
ESHDSL 3840kbps	16-TC-PAM	ITU-T G.991.2 and Annex F	150	19
ESHDSL 5696kbps	32-TC-PAM	ITU-T G.991.2 and Annex G	150	13

Table 8. Deployment Limit for Symmetric DSL technologies

10. Abbreviations

2B1Q	Two Binary One Quaternary (line code)
ATU-C	ADSL transceiver unit-central office
ATU-R	ADSL transceiver unit-remote
ADSL	Asymmetric Digital Subscriber Line
ADSL2	Asymmetric Digital Subscriber Line version 2
ADSL2plus	Extended bandwidth ADSL2
CCC	Cross Connect Cabinet
CE	Customer Equipment
DLF	Dielectric Loss Factor
DMT	Discrete Multi Tone
DP	Distribution Point
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EC	Echo Canceling
ESHDSL	Single-Pair High-Speed Digital Subscriber Line Extended rate
ETP	External Termination Point
FDD	Frequency Division Duplex
FDM	Frequency Division Multiplexing
FEXT	Far End Cross Talk
HDB3	High Density Bipolar of order 3 (line code)

HDSL	High bit rate Digital Subscriber Line
HDF	Handover Distribution Frame
IMP	Interference Management Plan
INP	Impulse Noise Protection
ISDN	Integrated Services Digital Network
LLU	Local Loop Unbundling
MDF	Main Distribution Frame
MPF	Metallic Path Facility
NEXT	Near End Cross Talk
NE	Network Equipment
OLO	Other licensed Operator
POTS	Plain Old Telephone Service
PSD	Power Spectral Density
PSTN	Public Switched Telephone Network
PVF	Propagation Velocity Factor
ReADSL	Reach extended ADSL2
SDSL	Symmetric Digital Subscriber Line
SHDSL	Single-pair High-speed Digital Subscriber Line
SNR	Signal to Noise Ratio
TCP-PAM	Trellis Coded Pulse Amplitude Modulation
VDSL	Very high speed Digital Subscriber Line

11. Definitions

Baseband

means frequency voice band .

Bridged Tap

means a length of un-terminated copper wire connected in parallel across another Wire.

Broadband

means frequencies above 20 kHz.

Cable Unit

is a group of twisted pairs that are wrapped together within a main, or distribution cable. For the purposes of this **IMP**, this group of twisted pairs is 10 pairs .

Calculated Attenuation

is the calculated sum of the attenuations in dB of all inline cable segments, excluding Bridged Taps, of the copper wires between specified end points at any given frequency.

Compliant System

means a system that complies with this **IMP**.

Distribution Point

means the point where the lead in cable is connected to the distribution cable.

Disturbed System

is the system that is subject to crosstalk interference from a disturbing system.

Disturbing System

is the system that acts as the cause of crosstalk interference into a disturbed system.

Downstream

means the direction from the **MDF** to the **ETP**.

External Termination Point

is the External Termination Point for telecommunications services at an End User's premises or, where there is no termination point external to the premises, either the first jack on the premises wiring or, alternatively, the building distribution frame.

Handover Distribution Frame

is the point where an **OLO** gains access to the **MPF** in an exchange **MDF**.

Legacy Systems

are systems of a type which were present in **JT** network before.

Metallic Path Facility

means a pair of twisted copper conductors between the relevant demarcation point at the End User's premises and the relevant demarcation point at a **JT** local exchange

Pair Separation

is the allocation of pairs of copper wires for two **xDSL** classes into separate cable units in unit cable or with pair number differing by 10

Plain Old Telephone Service

means a telecommunications service for the purpose of voice telephony (excluding **ISDN** and VoIP), **voice band** modem or facsimile.

SDSL

is an older variable rate **2B1Q** line coded system with similar characteristics to **HDSL**.

Spectrally Asymmetric

means using different **PSD** for transmission in each direction.

Spectrally Symmetric

means using the same **PSD** for transmission in each direction.

Splitter

low pass filter for separating **POTS** from **ADSL**

Upstream

means the direction from **ETP** to **MDF**

Voice Band

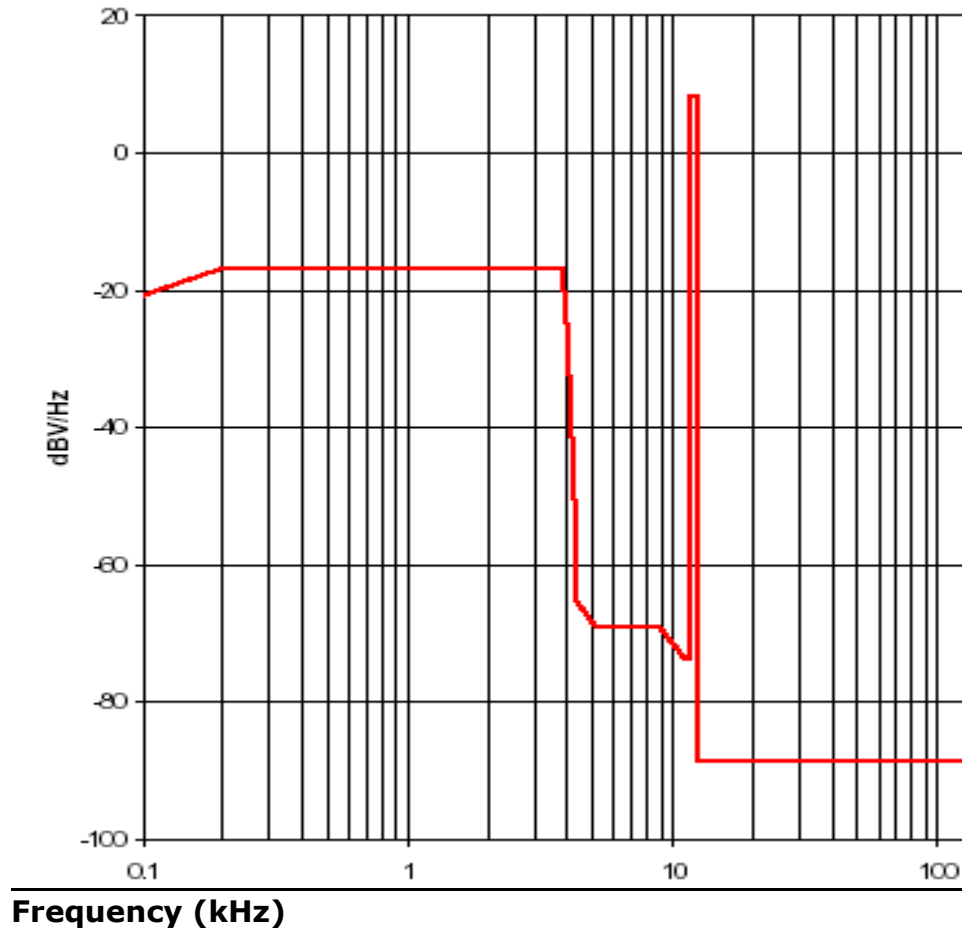
refers to those frequencies from DC to 4kHz.

xDSL

refers to different variations of a family of Digital Subscriber Line (**DSL**) technologies, such as **ADSL**, **ADSL2plus**, **HDSL**, **SHDSL**, **VDSL** and similar technologies that provide a high bandwidth digital connection over an **MPF**.

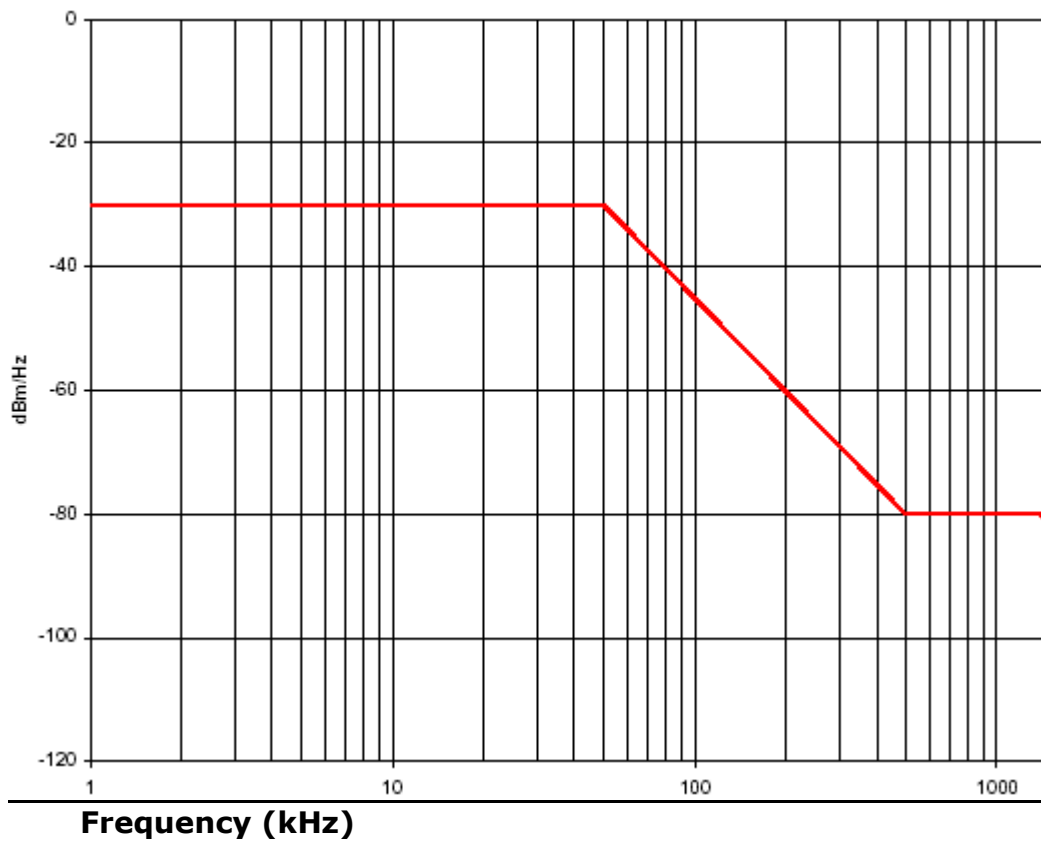
12. Annexes

Annex A . Spectrum Mask for POTS :



Frequency (kHz)
Figure 10. POTS mask

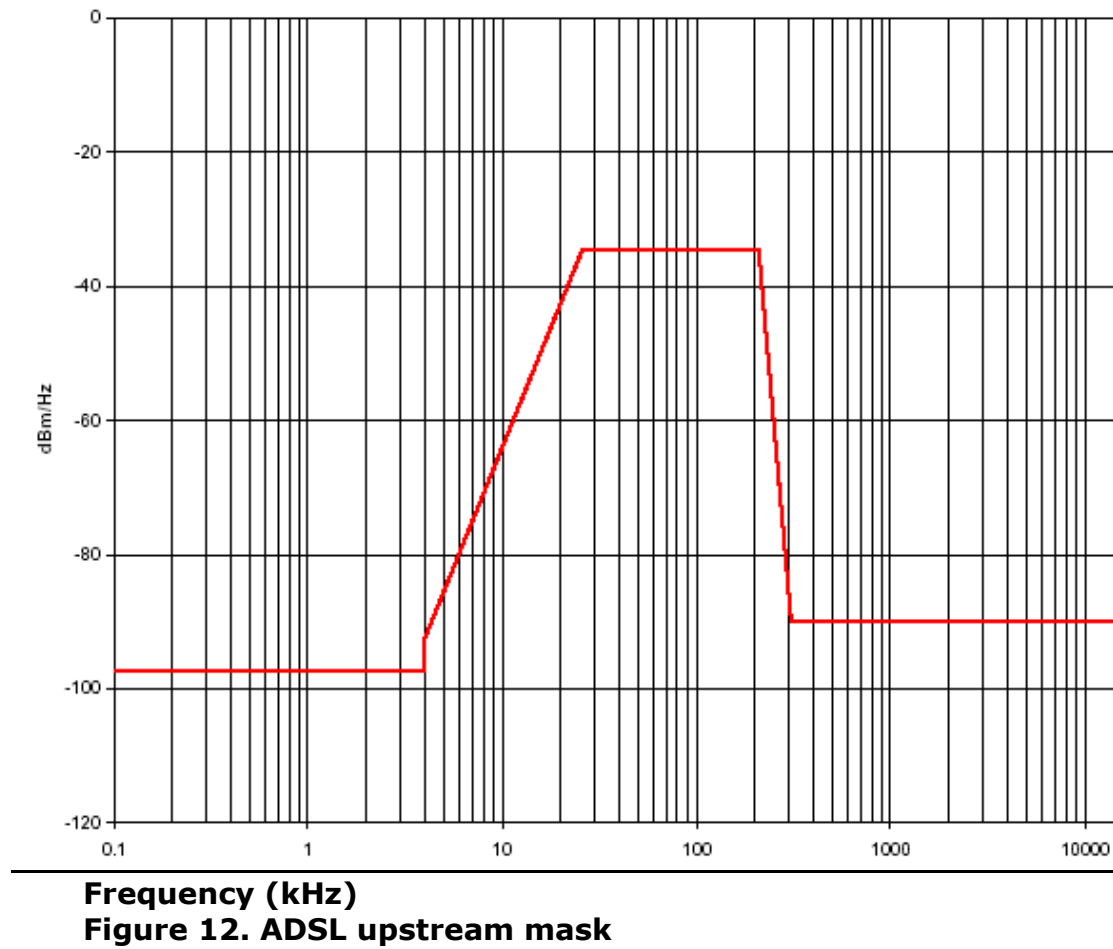
Annex B. Spectrum Mask for ISDN-BR(2B1Q)



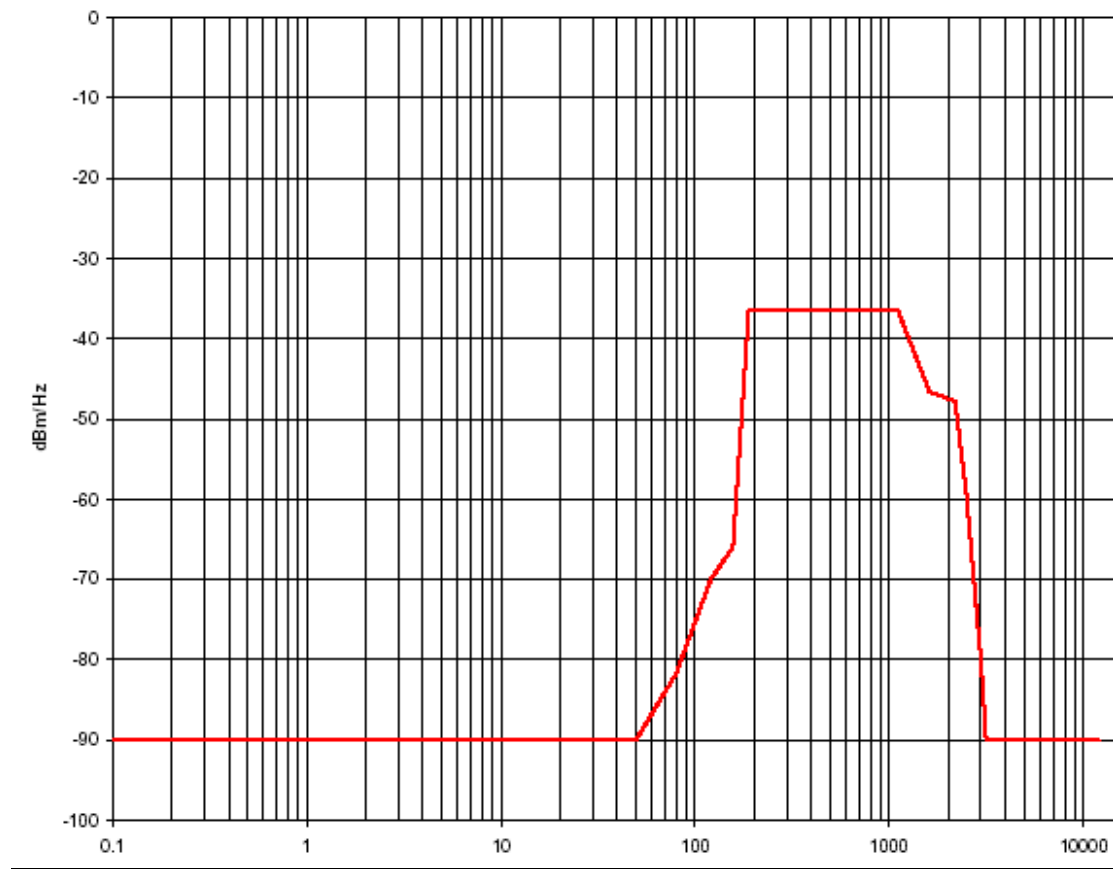
Frequency (kHz)
Figure 11. ISDN-BR mask

Direction	Upstream and downstream
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Annex C. Spectrum Mask for ADSL upstream (ITU-Annex B)



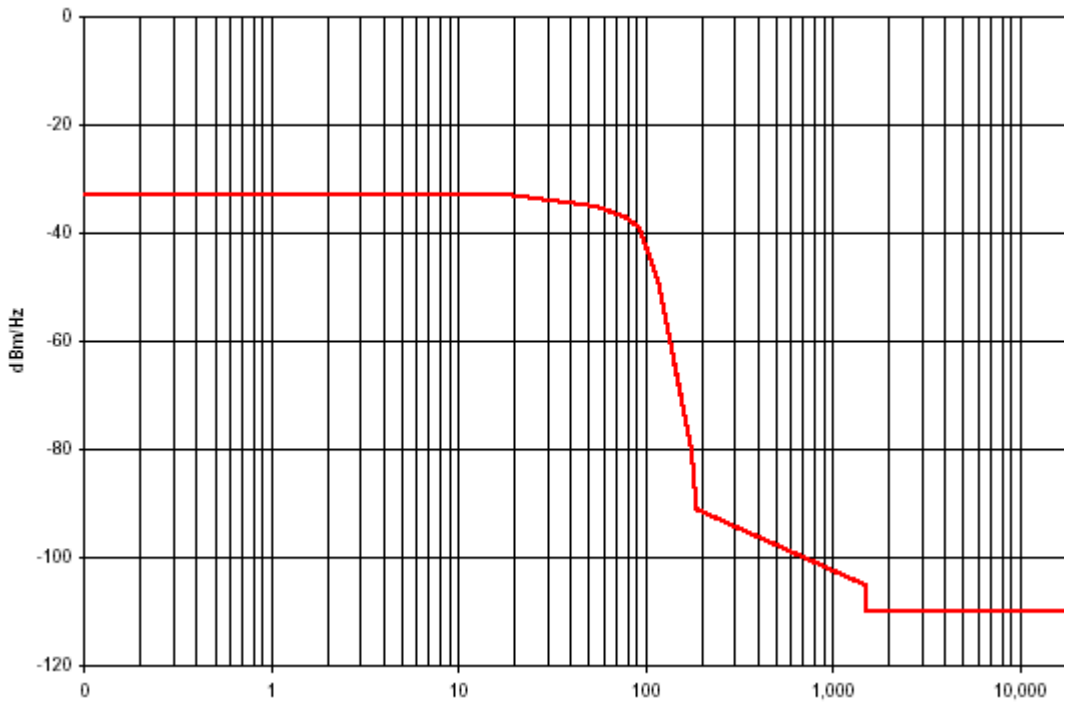
Annex D. Spectrum Mask for ADSL downstream (ITU-Annex B)



Frequency (kHz)

Figure 13. ADSL downstream mask

Annex E. Spectrum Mask for SHDSL 576kbps

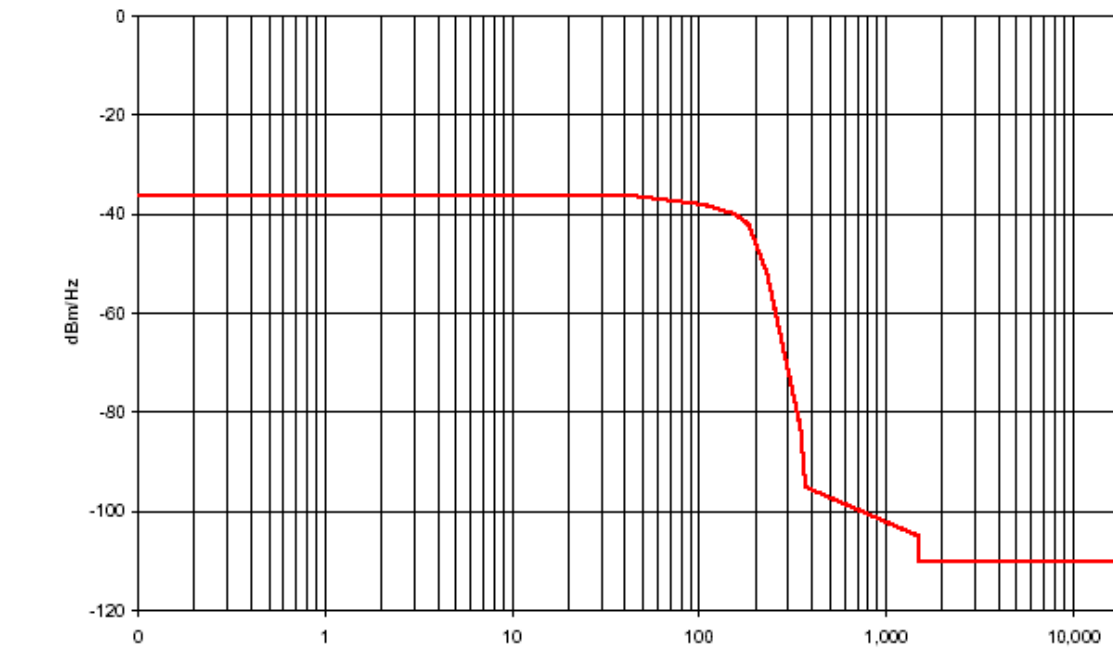


Frequency (kHz)

Figure 14. SHDSL 576kbps mask

Direction	Upstream and downstream
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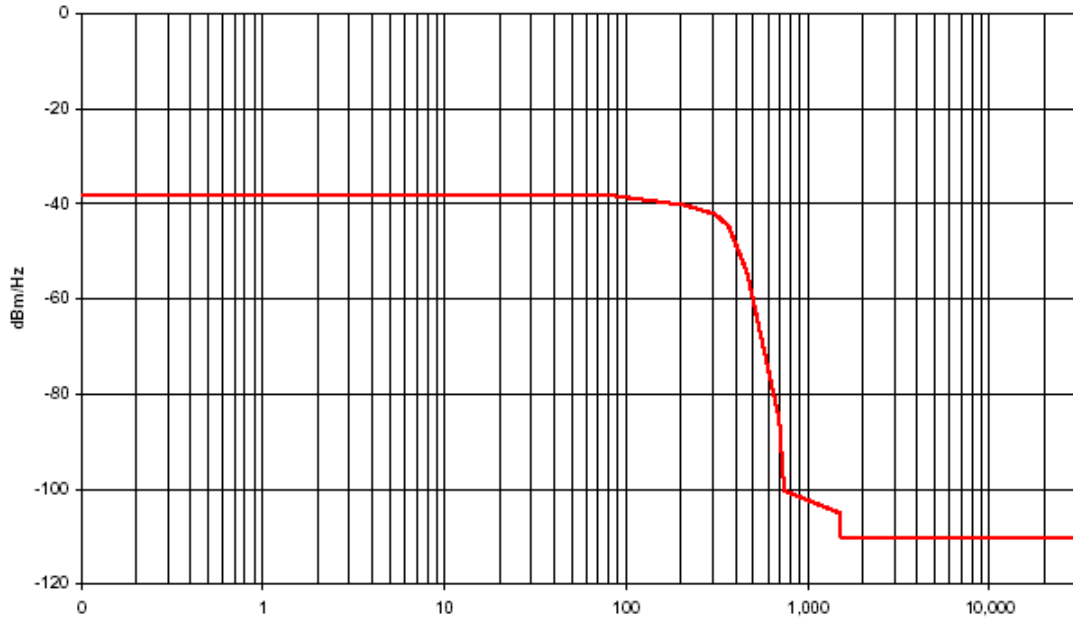
Annex F. Spectrum Mask for SHDSL 1160kbps :



Frequency (kHz)
Figure 15. SHDSL 1160kbps mask

Direction	Upstream and downstream
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Annex G. Spectrum Mask for SHDSL 2320kbps :



Frequency (kHz)

Figure 16. SHDSL 2320kbps mask

Direction	Upstream and downstream
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Annex H. Technical Specifications of the Splitter Interface

- 1.** The **POTS** splitter is fully compliant with the Recommendation in ITU-T992.1 Annex E Type 1 European.
- 2.** The **ISDN** splitter is fully compliant with the Recommendation found into ETSI TS 101 952-1 sub-part 3.
- 3.** Both splitters (**POTS** and **ISDN**) include a DC-blocking functionality.
9.1.1.1 The splitter does not include any High Pass Filter (HPF) Functionality.

Annex I. Spectrum Compatibility of xDSL systems with Voice Band Basis System

- 1.** The total power of any disturbing system in the frequency band $0 < f \leq 4\text{kHz}$ shall be less than -9dBm (600Ω).
- 2.** The spectrum for **Voice Band** system will be limited to 130 kHz (point $-30\text{ dBm}/600\text{ Ohm}$) in all the cases.
- 3.** The emission level is maximum $0\text{ dBm}/\text{ref } 600\text{ Ohm}$ in the 300Hz-3400 Hz
- 4.** The signal emitted out of the voice band (300Hz-3400Hz) must be limited to 3 Vpp.

13. References and relevant documents

13.1 General

ETSI TR 101 830-1 V1.2.1 (2001-08) :

Transmission and Multiplexing (TM); "Spectral Management on Metallic Access Networks; Part 1: Definitions and Signal Library".

ITU-T Rec. 0.153:

"Basic parameters for the measurement of error performance at bit rates below the primary rate".

CCITT Rec. 0.9:

"Measuring arrangements to assess the degree of unbalance about earth".

13.2 PSTN

ETSI-specification "EG 201 188 V1.1.1" :

"Public Switched Network (PSTN); Network Termination Point analog interface; Specification of physical and electrical characteristics at a 2-wire analog presented for short to medium length loop applications (1999-06)".

13.3 PSTN equipment

Requirement	Reference to requirements
Total signal voltage	ETSI TR 101 830-1 Subclause 7.1.1.
Peak amplitude	ETSI TR 101 830-1 Subclause 7.1.2.
Narrow-band signal power	ETSI TR 101 830-1 Subclause 7.1.3.
Unbalance about earth	ETSI TR 101 830-1 Subclause 7.1.4.
Reference impedance Zr	ETSI TR 101 830-1 Subclause 7.1.6.
Ringing signal	ETSI TR 101 830-1 Subclause 7.1.7. Frequency – The nominal frequency must be between 20 Hz and 55 Hz with a tolerance of +/- 5% Parasitic signals – The total power of the parasitic signals (harmonic included) created by the generator shall be 26 dB lower than the power of the nominal frequency wave
Metering signals	ETSI TR 101 830-1 Subclause 7.1.8.

13.4 ISDN

ETSI TS 102 080 V1.3.2. (2000-05) :

"Transmission and Multiplexing (TM); Integrated Services Digital Network (ISDN) basic rate access, Digital transmission system on metallic local lines".

9.1.2 ISDN (2B1Q)equipment

Requirements	Reference to requirements
Total signal power	TS102 080 Subclause A.12.3
Peak amplitude	TS102 080 Subclause A.12.1
Narrow-band signal power	ETSI TR 101 830-1 Subclause 8.1.3 TS102 080 Subclause B.12.4
Unbalance about earth	ETSI TR 101 830-1 Subclause 8.1.4 TS102 080 Subclause B.13.3
Feeding power (from the LT-port)	ETSI TR 101 830-1 Subclause 8.1.5

13.5 ADSL

ITU-T Recommendation G.992.1: "Asymmetrical Digital Subscriber Line (ADSL) Transceivers".

ANSI Standard T1.413-1998:

"Network and Customer Installation Interfaces –Asymmetrical Digital Subscriber Line (ADSL) Metallic Interface".

ETSI Technical specification TS 101 388 (V 1.3.1.):

"Transmission and Multiplexing ; Access transmission systems on metallic access cables ; Asymmetric Digital Subscriber Line (ADSL) –Coexistence of ADSL and ISDN-BA on the same pair ".

13.5.1 ADSL over POTS equipment : ANSI T1.413 Issue 2

Requirements	Reference to requirements
Total signal power (downstream only) < 100 mW = 20 dBm	ITU-T Recommendation G.992.1 Subclause A.1.2.3.1 downstream)
Total signal power (upstream only) < 18 mW = 12.5 dBm	ANSI T1.413 Issue 2, subclauses 7.15.1 and 7.15.3 ITU-T Recommendation G.992.1 Subclause A.2.4.3.1
Narrow-band signal power (downstream only)For ADSL with DMT with carriers spaced at 4.3125 kHz the carriers 33 –255	ANSI-T1.413 Issue 2 ANNEX F (ATU-C Transmitter PSD mask for reduced NEXT) ITU-T Recommendation G.992.1 Subclause A.1.3 (PSD – mask for Reduced NEXT)
Narrow-band signal power (upstream only) For ADSL with DMT with carriers spaced at 4.3125 kHz the carriers < 32	ANSI-T1.413 Issue 2 Subclause 7.14 ITU-T Recommendation G.992.1 Subclause A.2.4
Unbalance about earth (upstream AND downstream)	ANSI T1.413 Issue 2 Subclause 12.3.1 ITU –T Recommendation G.992.1 subclause A.4.3.1 Feeding

13.5.2 ADSL over ISDN equipment : ETSI TS 101 388

Requirements	Reference to requirements
Total signal power (downstream only) < 90 mW = 19.3 dBm	ETSI TS 101 388
Total signal power (upstream only) < 22.5 mW = 13.3 dBm	ETSI TS 101 388
Narrow-band signal power (downstream only) For ADSL with DMT with carriers spaced at 4.3125 kHz the carriers 56-255	Only FDD (Frequency Division Duplexed) systems allowed
Narrow-band signal power (upstream only) For ADSL with DMT with carriers spaced at 4.3125 kHz the carriers below 64	ETSI TS 101 388 Subclause 6.10 ITU-G992.1 Subclause B.2.2
Unbalance about earth (upstream AND downstream)	ITU -T Recommendation G.992.1 subclause A.4.3.1

13.6 SHDSL

ITU G.991.2: "Single pair High Speed Digital Subscriber Line (SHDSL) Transceivers".

13.7 ESHDSL

ITU-T G.991.2 , Annex G : " Single-Pair High-Speed Digital Subscriber Line Extended Rate".

13.8 ADSL2

ITU-T Recommendation ITU G.992.3 : " Asymmetrical Digital Subscriber Line Transceivers 2 (ADSL2) ".

13.9 ADSL2plus

ITU-T Recommendation ITU G.992.5 : "Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus) ".

13.10 ReADSL

ITU-T Recommendation ITU G.992.3 , Annex L : " Asymmetric Digital Subscriber Line (ADSL) transceivers – Reach extended ADSL2 "

Interference Management Plan