



Proximus Raw Copper and Shared Pair Products

Annex C Technical Specifications

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Our reference: MSO & Servicing version

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1. Preliminary remark

1. In order to safeguard the integrity of local access lines and maintain an acceptable performance of higher bandwidth services, Beneficiaries must notify their acceptance of and willingness to comply with the Proximus technical requirements before they can be supplied with the raw copper and shared pair products.
2. Conformity with the Proximus technical requirements is essential for all if the performance and reach of higher bandwidth services is to be maximised, and failure to comply is a serious matter.
3. Each equipment connected to the Access Network pairs has to comply with the principles of the R&TTE Directive or of any Directive replacing the latter.
4. In addition equipment has to conform to other relevant standards such as those governing product safety and EMC [ETSI EN 300 386 V1.2.1].
5. This document contains a detailed description of the requirements that equipment must meet to be suitable for use on unbundled local loops, without any guarantee of speed and/or quality of data transmission. Reference is made to international standards.
6. Note that the Spectrum Management issues are discussed in the Task Group Spectrum Management set up by the BIPT; evolution in the requirements and rules are always possible by decision of BIPT.
7. Proximus has also to comply with these requirements without limitations nor exceptions pursuant to the regulatory framework.

2. Transmission properties of the access network

2.1 Generalities

8. A subscriber loop consists of sections of twisted pairs cables of different gauges. All the sections are buried and connected together by means of electrical joints, called splices, directly placed in the ground or sometimes in a manhole.

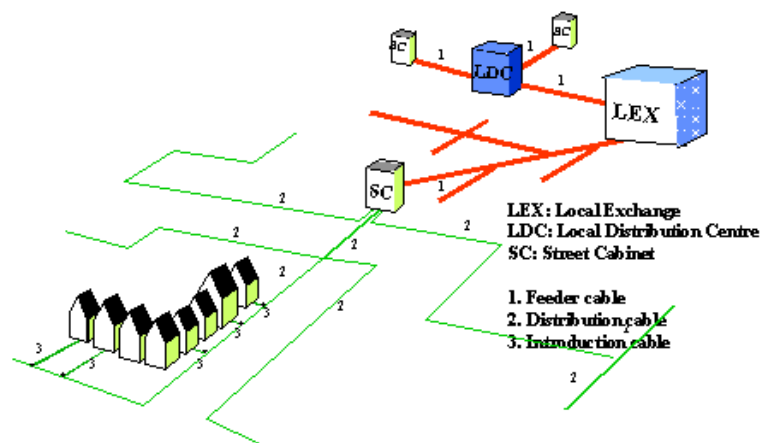


Fig. 1

9. In the ideal situation, the Access Network has a star configuration with the feeder cable bundles going from the main distribution frame to the street cabinet. From the street cabinet, via distribution cables and drop wires, the wire pairs are terminated in the individual customer sites. The reality shows that cable arrangements lead sometimes to a meshed structure in the feeding network. No bridged taps (stubs) are present in the outside local network.
10. Each telecom cable consists of a number of copper conductors generally grouped in quads; these quads can be arranged in bundles or in layers, depending on the type of cable.
11. Definition:
We will consider 2-wire circuits realized by using unloaded twisted copper pairs. These will bind the two ends via infrastructure telephony cables. These circuits don't contain any separating, coupling, correcting, amplifying ... elements. They are usually made of different conductor sections with different characteristics.

2.2 Physical characteristics of the cables

12. A conductor can be isolated by a layer of paper (in the old generation cables) or synthetic material, usually polyethylene.
13. Most of the conductors have a 0.5 mm or 0.6 mm diameter; distant customers however need to be connected via conductors of 0.8 and 1.0 mm; 2000 pairs cables going out of the central office are sometimes made of 0.4 mm conductors.
14. In paper insulated cables, the conductors are surrounded by a lead sheath, generally protected by armouring and polyethylene sheath.
15. In plastic insulated cables used in the distribution network, the conductors are surrounded by a polyethylene sheath.
16. In plastic insulated cables used in the feeding network, the conductors are surrounded by an aluminium screen, a polyethylene internal sheath, an armouring and a polyethylene external sheath.
17. The plastic cables are in the majority of the cases longitudinally waterproof.

2.3 Electrical characteristics of the cables

18. The table below gives some typical characteristics of the access network cables [figures given by the cable manufacturers or by measurements in the field]:

Diameter	LR	KC	A800	A40.000	A150.000	A300.000
0.4 mm	275	55	2.0	7.5	12.5	14.5
0.5 mm	180	50-55	1.3	6	9	11
0.6 mm	123	38.5-46	1.0	4	6.5	9
0.8 mm	69	38.5	0.7	2.5	5	6

LR = Loop Resistance in Ohm/km

KC = average Kilometric Capacity in nF/km (it depends on the type of cable)

A800 = Attenuation measured at 800 Hz in dB/km

A40.000 = Attenuation measured at 40.000 Hz in dB/km

A150.000 = Attenuation measured at 150.000 Hz in dB/km

A300.000 = Attenuation measured at 300.000 Hz in dB/km

19. NB: the attenuation values are conditional. A loop is made of several pieces of cables and then additional attenuation and reflections due to the splices and the different cable gauges will occur.

2.4 Insulation resistance

20. The insulation resistance between the 'a' and 'b' wires of a pair (without terminal equipment) or between wire and earth is supposed to be at least 750 kOhms. Values measured less than this may as far as the provisioning and repair is concerned, be reported as a fault. For the lines of type 2, a value lower than 1 MOhm may be reported as a fault if the Beneficiary establishes in good faith the relation between a resistance lower than 1 MOhm and the problem observed.

2.5 Measurements

21. Proximus line parameters measurements are performed with a metallic line test measurement system.

3. Pair selection rules

22. The number of broadband systems that can be deployed within an access cable is not limited. Adding a lot of broadband systems within a cable nevertheless leads to a general decrease of the performance, compared with the situation where only a few high frequency systems are deployed.
23. In order to maintain a good performance level for the xDSL services, Proximus is applying some pair selection rules. The purpose is to keep the new xDSL technologies at a distance of the existing and disturbing technologies.
24. The only rules to be considered are the following: a line type 2 or type 3 will not be located in the same quad than or in the adjacent quad of an existing 2 Mbits system.
25. The pair selection rules do not offer any guarantees as to the potential bitrate in any access cable or on any specific copper pair.
26. The principle of "pair selection rules" is presently applicable but not necessarily applicable in the long term.

4. References

27. In case a new version of the references below is published, the reader must always refer to the most recent version.

28. When a reference is made to an international standard document and ETSI document and when a list of values is given (if the country particularities are foreseen), the Belgian value must always be taken.

29. This list is given for information purpose only, unless otherwise explicitly mentioned.

4.1 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
EN 60950 (CENELEC):	Safety of information technology equipment including electrical business equipment
ITU-T Rec. O.153:	Basic parameters for the measurement of error performance at bit rates below the primary rate
CCITT Rec. O.9:	Measuring arrangements to assess the degree of unbalance about earth (Blue book vol IV)
Directive 1999/5/CE:	Directive du Parlement Européen et du Conseil du 9 mars 1999 concernant les équipements hertziens et les équipements terminaux de télécommunications et la reconnaissance mutuelle de leur conformité (1999/5/CE) publiée au journal officiel des Communautés européennes du 07.04.1999
ITU-T Recommendation G.997.1:	Physical layer management for digital subscriber line (DSL) transceivers

4.2 PSTN

ETS 300 001:	European Telecommunication Standard. Attachments to the Public Switched Telephone Network (PSTN) ; General requirements for equipment connected to an analogue subscriber interface in the PSTN (Edition 3 1996-03) (Belgian part)
ETSI-specification "EG 201 188 V1.1.1":	Public Switched Network (PSTN); Network Termination Point (NTP) analog interface; Specification of physical and

electrical characteristics at a 2-wire analog presented NTP for short to medium length loop applications (1999-06)

Proximus – User to Network Interface (UNI) Specification:

“Analog Subscriber Line Signalling (Basic Call)” (ref.: BGC_D_48_9807_30_02_E.DOC)

<http://www.proximus.com>

4.3 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”

4.4 ADSL

ETR 328:

Transmission and Multiplexing (TM); Asymmetric Digital Subscriber Line (ADSL); Requirements and performance

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”

4.5 SHDSL

ETSI TS 101 524:

Transmission and Multiplexing (TM) ; Access transmission system on metallic access cables; Symmetrical single pair high bitrate Digital Subscriber Line (SDSL)

ITU G.991.2:

Single pair High Speed Digital Subscriber Line (SHDSL)
Transceivers

4.6 **ADSL2**

ITU-T Recommendation ITU
G.992.3 :

"Asymmetrical Digital Subscriber Line
Transceivers 2 (ADSL2)"

4.7 **ADSL2plus**

ITU-T Recommendation ITU
G.992.5 :

"Asymmetric Digital Subscriber Line (ADSL)
transceivers – Extended bandwidth ADSL2
(ADSL2plus)"

4.8 **VDSL2**

ITU-T Recommendation G.993.2:

Very high speed digital subscriber line
transceivers 2 (VDSL2)

ITU-T Recommendation G.993.5:

Self-FEXT cancellation (vectoring) for use with VDSL2
transceivers

5. Common technical specifications for the equipment to be connected to the loop

5.1 VDSL2

30. VDSL2 as defined in sections 6.12 (VDSL2 from LEX) and 10.6 (VDSL2 from LDC) shall respect the following deployment rules that are only applicable if at least one Beneficiary operates VDSL2 from the same LEX/LDC:
31. Upstream bands U1 and U2 may not be used in situations where the UPBO mechanism may fail to protect the upstream transmission of other VDSL2 lines.
32. VDSL2 partitioning of the frequency spectrum into non-overlapping frequency bands, each of which is allocated for either upstream or downstream transmission, shall respect the 998 or 998ADE17 or 998ADE35 band plans defined in annex B of ITU-T Recommendation G.993.2 and its amendment 1.
33. This implies that limit masks B8-1, B8-2, B8-3, B8-4, B8-5, B8-6, B8-7, B8-10, B8-11, B8-12, B8-17, B8-20, B8-21 and B8+22 of table B-3 of ITU-T Recommendation G.993.2 amendment 1 are allowed for transmission.
34. When spectral compatibility with VDSL systems in the same cables is needed, it shall be possible to limit the downstream transmit PSD level in order not to exceed -61dBm/Hz in template value (or -57.5 in peak values as defined in G.993.2).
35. VDSL2 Upstream Power Back Off, as defined in §7.2.1.3 of ITU-T Recommendation G.993.2, shall be applied for upstream bands U1 and U2. The UPBO configuration parameters may be function of equipment location and it shall be possible to adapt it to match the network evolutions. The parameters in question will be communicated by Proximus when asked.
36. Stubs in the customer premises internal cabling (i.e. star configuration or pairs connected in parallel to connect the different rooms of a household) may make the Upstream Power Back Off mechanism fail to perform correctly. In such conditions one VDSL2 line could disturb the other VDSL2 lines by sending too high upstream power. Therefore upstream bands U1 and U2 are not allowed if at customer premises there is not one direct path without any stub between the introduction point and the VDSL2 NT (modem). As illustrated in the figure below, in case of POTS or ISDN overlay, this condition requires that a centralized splitter shall be used (= no distributed splitters for full spectrum VDSL2).

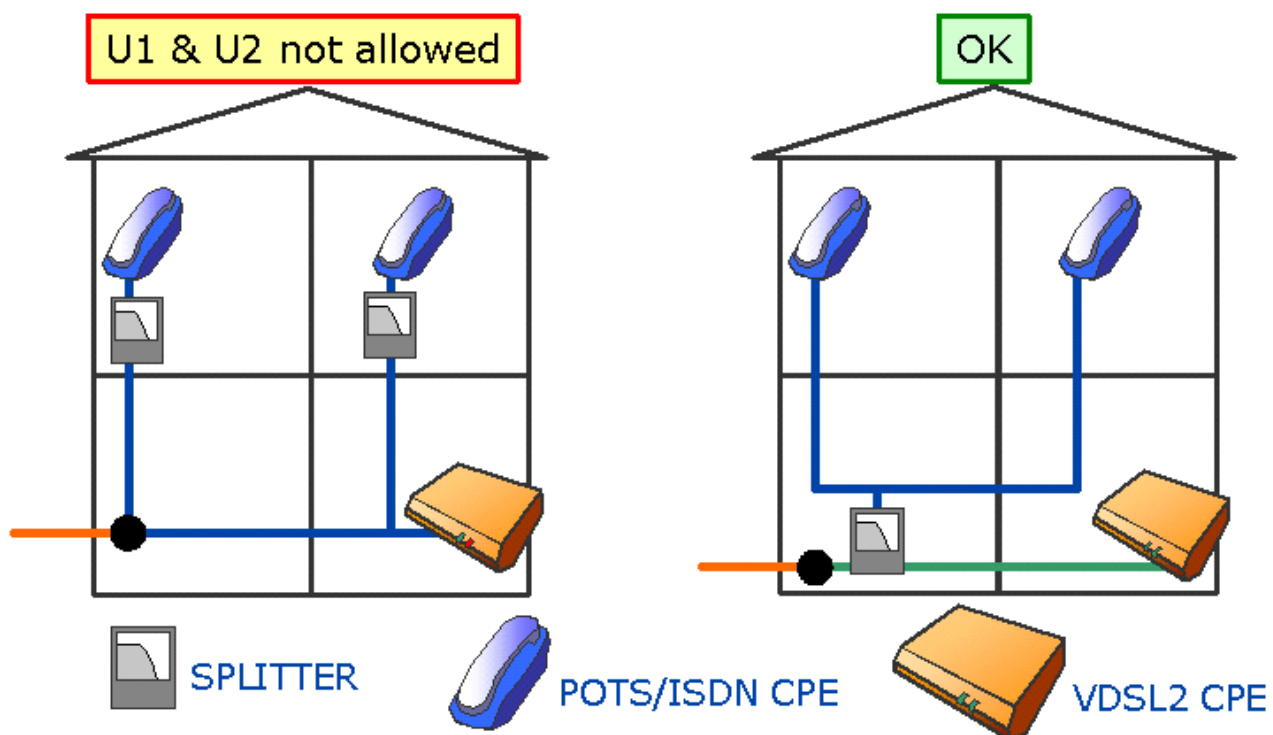


Figure 2: "Customer premises internal cabling"

The figure below depicts a distribution cable where direct and return pairs are present:

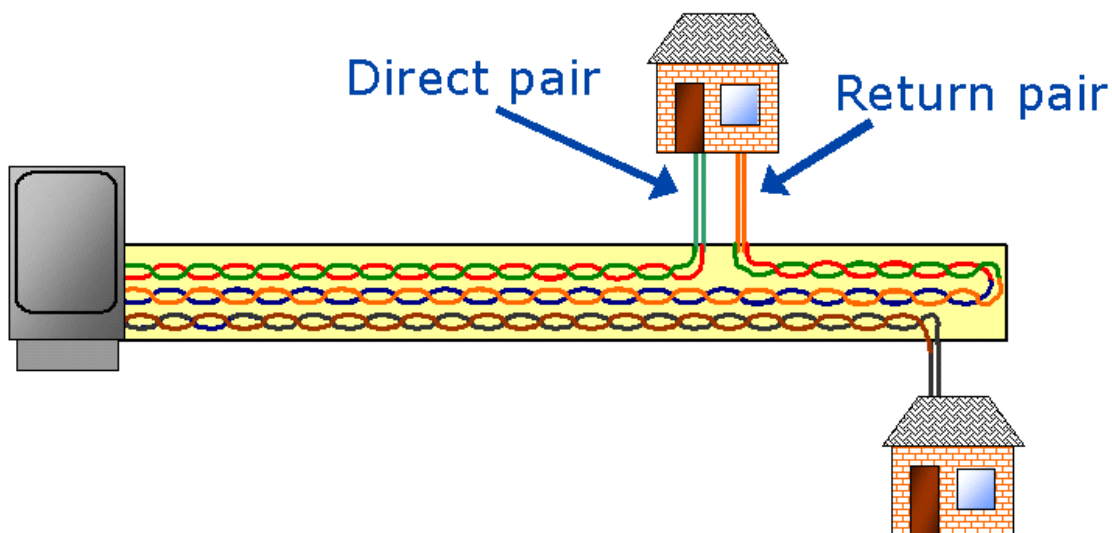


Figure 3: "return pair"

37. Pairs that have a section over the return, as depicted in Figure 3, are not compatible with the Upstream Power Back Off mechanism. A VDSL2 system that would be connected over such pair will transmit at higher upstream level in the bands U1 and U2, if they were enabled, compared to lines situated over the direct path. This will result in the fact that a VDSL2 line may be seriously disturbed in the upstream bands U1 and U2, if this line is situated further from the DSLAM than another VDSL2 line that goes over the return in the same cable. Therefore upstream bands U1 and U2 are not allowed over pairs that go over the return.
38. The figure below depicts a ring topology in the distribution network:

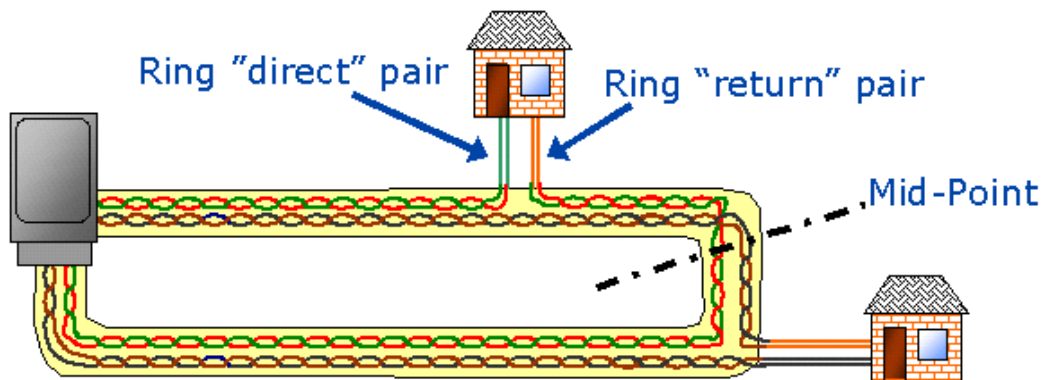


Figure 4: "ring topology"

39. In case of ring topologies, as depicted in Figure 4, the presence of opposite streams may seriously impact the downstream and upstream performances of all VDSL2 lines in the cable. Therefore Proximus shall define an optimum mid-point of the ring and the use of frequencies above f_{max} , where f_{max} is to be set in the range between 2208kHz and 3750kHz, shall not be allowed for VDSL2 lines over pairs that cross over the ring mid-point.

6. Technical specifications for the equipment to be connected to the Raw Copper Loop

6.1 General requirements

40. The attention of the reader is drawn to the following points:

- The systems must be insensitive to the crossing of the wires in a pair.
- The direct current must be always limited to 120 mA.
- If a ringing voltage is to be used, when generating the signal, it must be assured that the signal is a sine and that zero – detection of the signal is applied.

Insulation

41. Different lines will always be isolated from each other. The insulation resistance will be greater than 10 MOhm under 200 VDC. This also applies for the insulation between the emission and reception

circuits. This requirement is withdrawn when considering multi-line equipment using a centralised feeding for the disposal of direct current on the line. In this case, the line interfaces of this equipment must be symmetrical towards the earth.

Signalisation and Remote feeding

42. The conformity towards the "connection to telecommunication networks" (EN 60950) aspect will be established by the delivery of a document testifying the conformity of the equipment for the considered application.
43. When a numbering signaling by loop opening is used, this one will have a rhythm of maximum 10 ± 1 Hz.
44. The internal impedance of the ringing current generator must be 400 Ohm minimum.

6.2 Requirements for PSTN equipment to be connected to the Raw Copper Loop

45. The document ETSI TR 101 830-1 V1.1.1 and the Proximus User to Network Interface (UNI) specifications have to be considered as references. When both are mentioned, the Proximus UNI is **the** document where the specifications have to be found, due to the Proximus network specificity, whereas the ETSI document will give a general overview and eventually some additional pieces of information.

Requirements	Requirements or 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. Proximus – User to Network Interface (UNI) Specification: "Analog Subscriber Line Signalling (Basic Call)" Subclause 5.4
Feeding power (from the LT-port)	ETSI TR 101 830-1 Subclause 7.1.5. Proximus – User to Network Interface (UNI) Specification: "Analog Subscriber Line Signalling (Basic Call)" Subclause 5.1 and Subclause 5.2
Reference impedance Z_r	ETSI TR 101 830-1 Subclause 7.1.6.
Ringing signal	ETSI TR 101 830-1 Subclause 7.1.7. Proximus – User to Network Interface (UNI) Specification: "Analog Subscriber Line Signalling

	(Basic Call)" Subclause 8.1.1, Subclause 8.1.2, Subclause 8.1.4 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.

Except for voice band, the paragraph 4.4.3. of ETS 300 001 (Belgian values) applies.

6.3 Requirements for equipment delivering signals for which the binary rate is smaller or equal to 64 kbit/s

46. The major points are the following:

47. Impedance

The line interface impedance, at the different transmission rates and/or with the different coding types or transmitted signals types, will preferably be adapted to the line characteristic impedance at the central frequency of the modem usable spectrum.

48. Line impedance typical values:

Frequency (kHz)	Impedance (Ohms)
1.6	600
6	300
32	150
64	120

200 and more	100
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49. The impedance of the transceivers and the receivers will be the same, with a tolerance of $\pm 20\%$, as measured at the central frequency of the usable spectrum. The measurement needs to be done for each of the impedances as different options are foreseen.

50. Symmetry

The symmetry of the input and output interface with the earth will be in accordance with the following values:

- From 10 Hz to F (Hz): ≥ 48 dB
- From F (Hz) to F1 (Hz) : 48 dB – 10 dB/decade

51. where:

- F = the highest frequency of the spectrum, measured at the -10 dB point below the level of the spectrum usable component of the spectrum with the highest level.
- F1 = the highest frequency of the measured spectrum, including the harmonics; the components below -60 dBm/600 Ohm will be ignored.

52. Spectrum of the transmitted frequencies

The spectrum will be limited to 130 kHz (point -30 dBm/600 Ohm) in all the cases.

53. Emission level

The emission level is maximum 0 dBm/ref 600 Ohm in the 300Hz-3400Hz frequency range.

54. The signal emitted out of the voice band (300Hz-3400Hz) must be limited to 3 Vpp.

6.4 Requirements for equipment for the transmission of signals using ISDN basic access line code

6.4.1 ISDN 2B1Q signals

55. This category covers signals, generated by ISDN transmission equipment on a single pair, based on 2B1Q line coding. This subclause is based on the ETSI reports on ISDN equipment. A signal can be classified as an ISDN 2B1Q signal if it is compliant with all subclauses below.

56. The equipment must in particular be compliant with the ETSI TS 102 080 (V1.3.2.). In order to be compliant with the spectral management rules, the paragraph 8.1. of the recommendation ETSI ETR 101 830-1 V1.1.1 needs to be matched.

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 A.12.4
Unbalance about earth	ETSI TR 101 830-1 Subclause 8.1.4 TS102 080 Subclause A.13.3.1
Feeding power (from the LT-port)	ETSI TR 101 830-1 Subclause 8.1.5 EN60950

6.4.2 ISDN MMS43 signals

57. This category covers signals, generated by ISDN transmission equipment on a single pair, based on MMS43 (also called 4B3T) line coding. This subclause is based on the ETSI reports on ISDN equipment. A signal can be classified as an ISDN MMS43 signal if it is compliant with all subclauses below.

58. The equipment must in particular be compliant with the ETSI TS 102 080 (V1.3.2.). In order to be compliant with the spectral management rules, the paragraph 8.2. of the recommendation ETSI ETR 101 830-1 V1.1.1 needs to be matched.

Requirements	Reference to requirements
Total signal power	ETSI TR 101 830-1 Subclause 8.2.1
Peak amplitude	TS102 080 Subclause B.12.1

Narrow-band signal power	ETSI TR 101 830-1 Subclause 8.2.3 TS102 080 Subclause B.12.4
Unbalance about earth	ETSI TR 101 830-1 Subclause 8.2.4 TS102 080 Subclause B.13.3
Feeding power (from the LT-port)	ETSI TR 101 830-1 Subclause 8.2.5 EN 60950

6.5 Requirements for ADSL over POTS equipment to be connected to the Raw Copper Loop

59. This clause summarizes asymmetrical signals that are generated by digital transmission equipment up to 8 Mbit/s, including ADSL. Asymmetrical means a bitrate in the downstream direction and a significantly lower bitrate in the upstream direction.

60. Generally, the applied technology must comply with the following recommendations:

- ITU-T 992.1
- ANSI T1.413 Issue 2

61. Further, in order to comply with the spectral management rules, the equipment shall match the following requirements:

- No ADSL – systems with spectral overlap of upstream and downstream (Echo Cancelling systems) are allowed on the loops. Only ATU-C's with a PSD mask for reduced NEXT (FDD) are allowed on the loops.
- The power cutback mechanism for the upstream transmission, as described in ITU-T 992.1, needs to be applied.
- It is strictly forbidden to reverse the transmission direction. ADSL systems are designed to maximize self-compatibility when all 'downstream' signals in one cable flow in the same direction. This for the reasons explained in ETSI TR 101 830-1 V1.1.1 clause 5.2 / Note 1.

62. In this case, the following naming convention is used in the present document:

- **Downstream** signal limits are mandatory for signals that are injected into an LT-port of the Local Loop Wiring. LT-ports are located at the central office side of the local loop wiring.
- **Upstream** signal limits are mandatory for signals that are injected into an NT-port of the local loop wiring. NT-ports are located at the customer side.

63. These ADSL-signals may share the same wire pair with POTS-signals.

64. The following clauses are based on ANSI and ITU reports on ADSL-equipment. A signal can be classified as an ADSL over PSTN – signal if it is compliant with all subclauses below:

General Requirements	Reference to requirements
Total signal power (downstream only) < 100 mW = 20 dBm	ANSI T1.413 Issue 2, subclauses 6.15.1 and 6.15.3 ITU-T Recommendation G.992.1 subclause A.1.2.3.1
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 power (from the LT-port)	Not applicable

65. The requirements for any PSTN equipment operating in the frequency band below ADSL on the same wire pair appear from the PSTN requirement.

6.6 Requirements for ADSL over ISDN equipment to be connected to the Raw Copper Loop

66. This category covers signals, generated by ADSL transmission equipment. These signals share the same wire pair with ISDN-signals.

67. Generally, the applied technology must comply with the following recommendations:

- ITU-T 992.1
- ETSI TS 101 388

68. Further, in order to comply with the spectral management rules, the equipment shall match the following requirements:

- No ADSL-systems with spectral overlap of upstream and downstream (Echo Cancelling systems) are allowed on the loops. Only ATU-C's with a PSD mask for reduced NEXT (FDD) are allowed on the loops.
- In accordance with ETSI TS 101 388 §4.2.2.1, tones above 254 kHz are used for downstream transmission, and thus shall not be used for upstream transmission.
- The power cutback mechanism for the upstream transmission, as described in ITU-T 992.1, needs to be applied.
- It is strictly forbidden to reverse the transmission direction. ADSL systems are designed to maximize self-compatibility when all 'downstream' signals in one cable flow in the same direction. This for the reasons explained in ETSI TR 101 830-1 V1.1.1 clause 5.2 / Note 1.
- Note that the ISDN-lines in Belgium are operating with 4B3T line coding.

69. In this case, the following naming convention is used in the present document:

- **Downstream** signal limits are mandatory for signals that are injected into an LT-port of the Local Loop Wiring. LT-ports are located at the central office side of the local loop wiring.
- **Upstream** signal limits are mandatory for signals that are injected into an NT-port of the local loop wiring. NT-ports are located at the customer side.

70. The following clauses are based on ETSI and ITU reports on ADSL-equipment. A signal can be classified as an ADSL over ISDN – signal if it is compliant with all subclauses below:

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
Feeding power (from the LT-port)	Not applicable

71. The requirements for any ISDN basic access equipment operating in the frequency band below ADSL on the same wire pair appear from the ISDN requirements.

6.7 Specific requirements for spectral compatibility between ADSL over POTS and ADSL over ISDN

72. Additionally, the ATU-C ADSL above POTS must be capable to apply 'tone suppression' in the downstream part, in order to have the possibility to reduce additional NEXT (Near End Cross Talk) from a part of the downstream tones on a part of the upstream tones of an adjacent ADSL over ISDN transmission system.
73. Example: the ADSL above POTS downstream could be forced to start above carrier 40, to allow ADSL above ISDN upstream to be able to use all carriers below 40 without ADSL downstream NEXT.
74. The location of the masking frequency for ADSL over POTS downstream will be in the range of carrier 32 to 56.
75. A new PSD mask applies here, which is generated by applying the wider mask of the relevant PSDs defined under sections 6.5 and 6.6 above, and by additionally masking the carriers of the DMT transmission in the passband.

6.8 Specific requirements for SHDSL equipment to be connected to the Raw Copper Loop

76. The equipment must be conforming to the relevant ITU G.991.2 and ETSI Technical specifications.
77. Only SHDSL equipment with Line code PAM16 and Symmetrical PSD – ANNEX B (European version) is allowed to be connected to the Raw Copper Loop.

6.9 Specific requirements for ADSL2

78. ADSL2 systems complying with recommendation ITU G.992.3 (Asymmetrical Digital Subscriber Line Transceivers 2 (ADSL2)), and to one of the annex A (ADSL2 over POTS), annex B (ADSL2 over ISDN), annex L (Reach Extended ADSL2 – READSL2) or M (ADSL2 extended upstream) of the recommendation ITU G.992.3 are authorized for use from the Central Office (LEX) on local loops (raw copper or shared pair) except for copper pairs that pass via KVDs served by ROPs which are flagged as being opened for ADSL2 services or which have vectoring in ADSL(2+) frequencies activated.
79. The systems shall comply with the following rules:
 - It is strictly forbidden to reverse the transmission direction.
 - In this case, the following naming convention is used:
 - Downstream signal limits are mandatory for signals that are injected into an LT-port of the local loop wiring. LT-ports are located at the central office side of the local loop wiring.
 - Upstream signal limits are mandatory for signals that are injected into an NT-port of the local loop wiring. NT-ports are located at the customer side.
 - These ADSL2 signals may share, accordingly, the same wire pair with POTS or ISDN BA signals.

- ADSL2 over POTS Downstream passband PSD shall respect PSD mask defined by ITU-T G.992.3 §A.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements 8.10).
- ADSL2 over POTS Upstream PSD shall respect PSD mask defined by ITU-T G.992.3 §A.2.2 ATU-R upstream transmit special mask (supplements 8.10).
- ADSL2 over ISDN Downstream passband PSD shall respect PSD mask defined by ITU-T G.992.3 §B.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements 8.10).
- ADSL2 over ISDN Upstream PSD shall respect PSD mask defined by ITU-T G.992.3 §B.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements 8.10). In accordance with ITU-T G.992.3 §B.1.3, tones above 254kHz are used for downstream transmission, and thus shall not be used for upstream transmission.
- ADSL2 annex L Downstream pass band PSD shall respect PSD mask defined by ITU-T G.992.3 §L.1.3 ATU-C downstream transmit spectral mask for non-overlapped spectrum reach-extended operation (supplements clause 8).
- ADSL2 annex L Upstream Masks shall respect one of the PSD mask defined into ITU-T G.992.3 §L.2.2 (known as mode 1) or ITU-T G.992.3 §L.2.3 (known as mode 2).
- ADSL2 annex M Downstream pass band PSD shall respect PSD mask defined by ITU-T G.992.3 §M.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements 8.10).
- ADSL2 annex M Upstream PSD shall respect PSD mask defined by ITU-T G.992.3 §M.2.2 ATU-R upstream transmit special mask (supplements 8.10).
- The spectral mask EU-64 defined by ITU-T G.992.3 table M.3 is not allowed.
- ADSL2 annex M is not allowed for local loops with attenuation at 800Hz exceeding 3,5dB.
- ADSL2 annex L is not allowed for local loops with attenuation at 800Hz less than 5,8dB.
- ADSL2 from LEX/LDC is not allowed on local loops which pass via a street cabinet where "ADSL from ROP" is activated.

80. Further, ADSL2 systems shall also comply with the same restrictions as outlined for ADSL in § 5.7.

6.10 Specific requirements for ADSL2plus

81. ADSL2+ systems complying with recommendation ITU G.992.5 (Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2+)) and with one of the annex A (ADSL2+ over POTS), B (ADSL2+ over ISDN) or M (ADSL2+ extended upstream) of the recommendation ITU G.992.5 are authorized for use from the Central Office (LEX) on local loops (raw copper or shared pair).

82. The systems shall comply with the following rules:

- It is strictly forbidden to reverse the transmission direction.

- In this case, the following naming convention is used:
 - Downstream signal limits are mandatory for signals that are injected into an LT-port of the local loop wiring. LT-ports are located at the central office side of the local loop wiring.
 - Upstream signal limits are mandatory for signals that are injected into an NT-port of the local loop wiring. NT-ports are located at the customer side.
- These ADSL2plus signals may share, accordingly, the same wire pair with POTS or ISDN BA signals.
- ADSL2plus over POTS Downstream passband PSD shall respect PSD mask defined by ITU-T G.992.5 §A.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements 8.10).
- ADSL2plus over POTS Upstream PSD shall respect PSD mask defined by ITU-T G.992.5 §A.2.2 ATU-R upstream transmit spectral mask (supplements 8.10).
- ADSL2plus over ISDN Upstream PSD shall respect PSD mask defined by ITU-T G.992.5 §B.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements 8.10). In accordance with ITU-T G.992.5 §B.1.3, tones above 254kHz are used for downstream transmission, and thus shall not be used for upstream transmission.
- ADSL2+ annex M Downstream pass band PSD shall respect PSD mask defined by ITU-T G.992.5 §M.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements 8.10).
- ADSL2+ annex M Upstream PSD shall respect PSD mask defined by ITU-T G.992.5 §M.2.2 ATU-R upstream transmit special mask (supplements 8.10).
- The spectral mask EU-64 defined by ITU-T G.992.5 table M.3 is not allowed.
- ADSL2+ annex M is not allowed for local loops with attenuation at 800Hz exceeding 3,5dB.
- ADSL2+ from LEX/LDC is not allowed on local loops which pass via a street cabinet where “ADSL from ROP” is activated.

83. Further, ADSL2plus systems shall also comply with the same restrictions as outlined for ADSL in section 6.7.

6.11 Specific requirements for extended SDSL

84. Extended SDSL (ETSI TS 101 524 annex E and ITU-T G991.2 Annex G) is allowed for deployment in the loop on type 2 and type 3 raw copper loops.

85. Only TC-PAM32 is allowed above 2312 kbps.

86. The following table defines the extended SDSL deployment rules. In order to protect other xDSL systems performances, the rules define the maximum allowed line rate as function of the loop attenuation at 800Hz; linear interpolation is to be used for line rates that are not listed in the table:

Att @ 800Hz	Line Rate (kbps)

1,7	5696
2,2	4640
2,6	4000
3,2	2312
3,4	2056
3,7	1800
3,8	1672
3,9	1552
4	1480
4,4	1300
4,8	1224
5,1	1160
5,9	1033
No Limit	<1033

6.12 Specific requirements for VDSL2

87. VDSL2 systems complying with recommendation ITU-T G.993.2 main body and annex B shall be allowed for use on local loop from LEX in any of the following situations:
88. Loops are directly connected to the LEX without any KVD.
89. Loops are connected to a specific KVD, wherefore it has been estimated that over 90% of the End-Users behind it are located at less than one 1 km from LEX, where no ROP is installed and Proximus confirmed there are no plans to install a ROP.
90. When allowed, VDSL2 systems for use on local loop from LEX shall respect the deployment rules as defined in section 5.1.

7. Technical specifications for the equipment to be connected to the Shared Pair Loop

7.1 General requirements

91. For all applications the following general requirements are made for user equipment:

- The systems must be insensitive to the crossing of the wires in a pair.

7.2 Requirements for ADSL over POTS equipment to be connected to the Shared Pair Loop

92. The requirements are identical to the requirements given in 6.5.

93. Note that the only equipment that can be connected is ADSL equipment; no PSTN equipment can be connected to the Shared Pair Loop.

7.3 Requirements for ADSL over ISDN equipment to be connected to the Shared Pair Loop

94. The requirements are identical to the requirements given in 6.6.

95. Note that the only equipment that can be connected is ADSL equipment, no ISDN equipment can be connected to the Shared Pair Loop.

7.4 Specific requirements for spectral compatibility between ADSL over POTS and ADSL over ISDN

96. The requirements are identical to the requirements given in 6.7.

7.5 Requirements for ADSL2 over POTS equipment to be connected to the Shared Pair Loop

97. The requirements are identical to the requirements given in 6.9.

98. Note that the only equipment that can be connected is ADSL2 equipment; no PSTN equipment can be connected to the Shared Pair Loop.

7.6 Requirements for ADSL2 over ISDN equipment to be connected to the Shared Pair Loop

99. The requirements are identical to the requirements given in 6.9.

100. Note that the only equipment that can be connected is ADSL2 equipment, no ISDN equipment can be connected to the Shared Pair Loop.

7.7 Specific requirements for spectral compatibility between ADSL2 over POTS and ADSL2 over ISDN

101. The requirements are identical to the requirements given in 6.9.

7.8 Requirements for ADSL2plus over POTS equipment to be connected to the Shared Pair Loop

102. The requirements are identical to the requirements given in 6.10.

103. Note that the only equipment that can be connected is ADSL2plus equipment; no PSTN equipment can be connected to the Shared Pair Loop.

7.9 Requirements for ADSL2plus over ISDN equipment to be connected to the Shared Pair Loop

104. The requirements are identical to the requirements given in 6.10.

105. Note that the only equipment that can be connected is ADSL2plus equipment, no ISDN equipment can be connected to the Shared Pair Loop.

7.10 **Specific requirements for spectral compatibility between ADSL2plus over POTS and ADSL over ISDN**

106. The requirements are identical to the requirements given in 6.10.

8. Technical specifications of the splitter interface used by Proximus in order to provide the Shared Pair

8.1 General

107. The interface that will be described is the interface between the splitter and the ADSL equipment from the Beneficiary as depicted in the figure below:

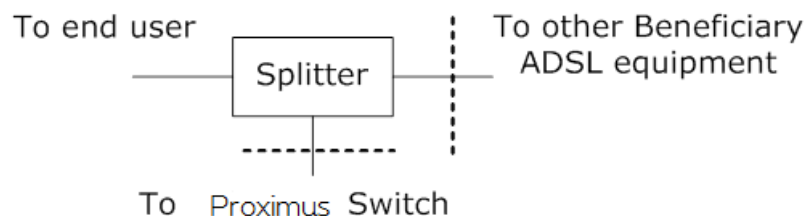


Fig. 5

108. Two types of splitters will be used: the splitters to be used for ADSL over POTS and the splitters to be used for ADSL over ISDN.

8.2 Splitter specifications

109. The POTS splitter is fully compliant with the Recommendation found in ITU-T 992.1 Annex E Type 1 European.

110. The ISDN (4B3T) splitter is fully compliant with the Recommendation found in ETSI TS 101 952-1 sub-part 3.

111. Both splitters (POTS and ISDN) include a DC-blocking functionality.

112. The splitter does not include any High Pass Filter (HPF) functionality.

9. g.ShDSL deployment rules

113. The following table defines the g.ShDSL deployment rules. In order to protect other xDSL systems performances, the rules define the maximum allowed line rate as function of the loop attenuation at 800Hz; linear interpolation is to be used for line rates that are not listed in the table:

Att @ 800Hz	Line Rate (kbps)
3,2	2312
3,4	2056
3,7	1800
3,8	1672
3,9	1552
4	1480
4,4	1300
4,8	1224
5,1	1160
5,9	1033
No Limit	<1033

Note: this table is subject to evolution and has to be considered as starting point for the deployment of the first g.ShDSL systems.

10. Loop unbundling in the LDC

10.1 General

114. A Local Distribution Center (LDC) is a concentration point, created essentially in order to de-saturate feeding cables and to avoid expensive works of laying new cables.

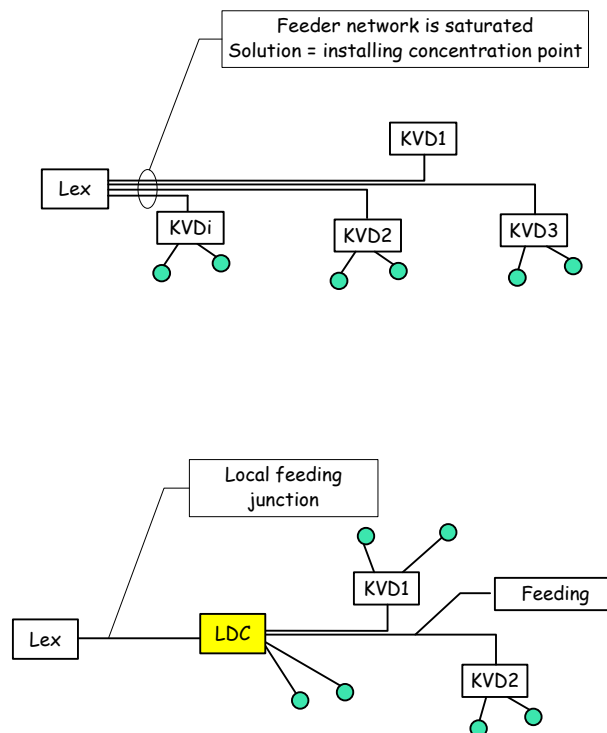


Fig. 6

115. The customers located behind the LDC are normally connected to this LDC; nevertheless, the optimization of the switching resources in the LEX and in the LDC may lead to still connect a certain percentage of these customers to the LEX. It is however impossible to connect all the customers located behind the LDC to the LEX, due to the fact that the local junction - cables between the LEX and the LDC - does not have a sufficient capacity.

116. Loop at the LDC offers the possibility to install DSLAM equipment in the LDC or close to it.

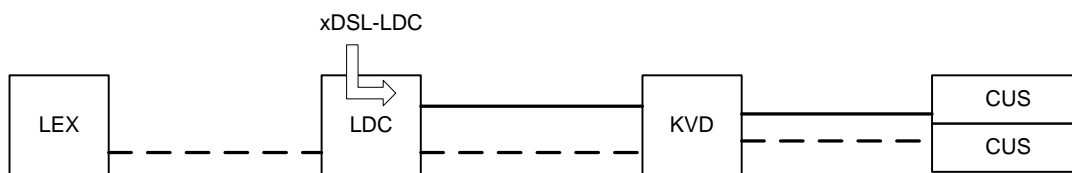


Fig. 7

117. The distance between the LEX and the LDC varies between about 800 meters and several kilometers; the majority of the LDCs are located at less than 5 km from the LEX. A complete list of LDCs with the real distance (measured in effective cable length) between the LEX and the LDC is published on the secured part of the Proximus wholesale web site.

118. The distance between the LDC and the customers may also be of several kilometers.

10.2 Spectrum management issues

10.2.1 Introduction

119. A remote signal may have a negative impact on a signal generated in the LEX. The impact depends on different factors, i.e.:

- the technologies present,
- the bitrate (in case of SDSL),
- the distance between the LEX and the remote injection point,
- the distance to the End-User,
- the number of systems deployed from the remote point,
- the spectral proximity of the systems (disturbers – victims).

120. The following table summarizes the effect between ADSL and SDSL. The relevant combinations are treated more in detail further on.

“Disturber”	“Victim”		
	ADSL-LEX downstream	ADSL-LEX upstream	SHDSL-LEX
Remote ADSL	Interference	No problem	No problem
Remote SHDSL 2 Mbps	Interference	No problem	No problem
Remote SHDSL 1 Mbps	No problem	No problem	No problem

121. The intensity of the “interference” can be different according to the fact that the remote injection is at LDC or at KVD level.

10.2.2 Impact of remote ADSL on ADSL-LEX

10.2.2.1 Generalities

122. Remote ADSL does not interfere with ADSL-LEX upstream.
123. ADSL-LDC may have an impact on ADSL-LEX downstream due to FEXT coupling. This impact mainly depends on the following parameters:
- the spectral proximity of the disturber and the victim in the cable: spectral pollution generally occurs between pairs located in the same cable binder;
 - distance between the LEX and the LDC:
 - ADSL-LEX will maintain acceptable performance (> 1 Mbps) when the distance between the LEX and the LDC is short (about 1 to 1,5 km);
 - ADSL injected in the LDC located at large distance (about 4,5 km) from the LEX do not cross ADSL-LEX, because the distance to the customer (from the LEX) is too high to offer ADSL service from the LEX;
 - the number of disturbers.
124. ADSL-KVD ("ADSL from ROP") may have an important impact on ADSL-LEX downstream due to FEXT coupling. This impact mainly depends on the following parameters:
- the spectral proximity of the disturber and the victim in the cable: this proximity can be rather important, because of the cables with small capacity used in the distribution network;
 - distance between the LEX and the KVD:
 - ADSL-LEX will maintain acceptable performance (> 1 Mbps) when the distance between the LEX and the KVD is short (about 1 to 1,5 km);
 - the majority of the KVDs are located at less than 5 km from the LEX; important spectral problems may be expected for most of them;
 - the number of disturbers.
125. (Re)ADSL(2+)-LEX is not allowed on Type 3 Loops (i.e. local loops which pass via a street cabinet where "ADSL from ROP" is activated).

10.2.2.2 Probability of disturbance

126. Loop at the LDC: due to the fact that the cables between the LDC and the KVDs are composed with layers or with binders; that the percentage of pairs in service between the LDC and the KVD is relatively low; and that the splicing in this part of the network is not homogeneous, a random separation occurs between the circuits coming from the LEX and the circuits coming from the LDC; and therefore the probability of experiencing disturbance is expected to be low.

10.2.3 Impact of remote ADSL on SDSL-LEX

127. Remote ADSL has no impact on the performance of SDSL-LEX, therefore SDSL-LEX is allowed on Type 3 Loops (i.e. local loops which pass via a street cabinet where "ADSL from ROP" is activated).

10.2.4 Impact of remote SDSL on ADSL-LEX

128. The impact of remote SDSL essentially depends on the bitrate of the SDSL:

- a. SDSL at bitrate higher than 1 Mbps has an important impact on the performance of the ADSL-LEX;
- b. SDSL at max 1 Mbps has a low impact on ADSL-LEX.

10.2.5 Impact of remote SDSL on SDSL-LEX

129. Remote SDSL has no impact on the performance of SDSL-LEX.

10.3 How to reduce the effect of remote ADSL ?

130. Because of the differences between the LDC and the KVD in terms of distances to the customer and disturbance probability, different solutions have to be considered.

10.3.1 Loop at the LDC

131. LDCs have been created due to the saturation of the cables feeding some directions in a local network. Offering ADSL to the customers located behind the LDC is mainly possible by installing DSLAMs in the LDC.

10.3.2 Migration to the LDC

132. Descending to the LDC to generate ADSL is a logical and efficient way to connect the customers located behind the LDC and to avoid spectral problems. It is moreover the only way to address and connect the entirety or nearly entirety of customers behind the LDC.

133. Therefore, when one Beneficiary begins to deploy from a LDC, Proximus advises that it is preferable – but not mandatory – that all other operators also offer their ADSL services from this LDC.

10.3.3 Power Back Off

134. Power back off consists in reducing up to 12 dB the power level of the remote ADSL.

135. Thanks to PBO, the distance between the LEX and the LDC for which the impact on ADSL-LEX remains acceptable is about 2,5 km. It is therefore mandatory that any DSLAM installed in an LDC is able to deliver at least PBO up to 12 dB.

136. PBO may not be considered as an universal solution. Moreover, applying PBO to the ADSL-LDC will reduce the performance of this circuit (reducing the reach or bitrate).

10.3.4 Application of the solution

137. The LDC has to be considered a good injection point for ADSL and the migration of the DSLAM to the LDC is a possible solution in the long term perspective with the present available technology.

138. Because of the low risk of disturbance (see before), another solution like PBO will only be applied in case of ADSL-LEX problem due to the presence of DSLAMs in the LDC and after examination of the benefits and impacts of the chosen solution.

10.4 How to reduce the effect of remote injected SDSL at LDC?

139. As explained before, SDSL injected at a remote point leads to ADSL-LEX important degradation when the bitrate exceeds 1 Mbps.
140. A solution is to limit the bitrate of remote injected SDSL at 1 Mbps on one pair (services at 2 Mbps are possible by using 2 pairs). Remote injection is also permitted at another bitrate on condition that the remote injection respects the deployment rules for SDSL from LEX as depicted in chapter 9. Therefore the distance on the X-axis has to be considered as the sum of the distance LEX-LDC and the loop length.

10.5 Summary

141. Although the migration of all the ADSL to the LDC seems to be a solution (with the present available technology) to avoid any spectral pollution between ADSL-LEX and ADSL-LDC when the distance LEX-LDC is comprised between 1,5 and 4,5 km, other solutions like PBO and pair changes will be used in the short term when a problem occurs. If HDSL or HDB3 equipment are used by Proximus and are the source of the problem or the source of the impossibility to find a solution, Proximus has the obligation to replace this equipment by equipment using an allowed technology. ADSL from the KVD (also known as “ADSL from ROP”) is not compatible with ADSL from the LEX/LDC.

10.6 Remote VDSL2 from LDC

142. VDSL2 systems complying with recommendation ITU-T G.993.2 main body and annex B shall be allowed for use on local loop from LDC in any of the following situations:
- a. Loops are directly connected to the LDC without any KVD.
 - b. Loops are connected to a specific KVD, wherefore it has been estimated that over 90% of the End-Users behind it, where no ROP is installed and Proximus confirmed there are no plans to install a ROP.
143. When allowed, VDSL2 systems for use on local loop from LDC shall respect the deployment rules as defined in section 5.1.