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TITLE **Definition of required splitter parameters for VDSL and ADSL**

PROJECT VDSL part 1, and ADSL

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STATUS Proposal, for action

ABSTRACT The progress on adequate splitter requirements for VDSL was impeded by the lack of common view on functional requirements, design targets and definition of relevant parameters. This contribution proposes literal text for the most relevant splitter parameters, to settle this issue first.

1. Problem description

In the recent past, several splitter requirements have been proposed. The progress on adequate splitter requirements for VDSL was impeded by the lack of common view on functional requirements, design targets and definition of relevant parameters. We have to settle this first, separated from discussions on actual numbers.

The goal is to get requirements who will guaranty sufficient quality for the services involved (POTS or ISDN and xDSL) and minimum complexity (= costs) for the splitter. So far, contributions for requirements were focussed on (high performing?) filters that are terminated with well-defined impedances. The problem is that ***this does not match with an operational environment***. The splitter filters are terminated in practice with ***a wide range of impedances***, such as 600 Ω of a telephone, or a complex impedance originated from a long cable, or modern equipment that match the new European requirements on complex terminal impedance, etc.
The splitter filter should handle all these impedances, for 100 Ω cables as well as 150 Ω cables, and this consideration may have a strong impect on how tight we can specify requirements.

This proposal is focussed on how to describe the requirements for splitter filters under a wide range of terminating impedances. By separating the discussion on the most relevant parameters from their actual requirements, we think that ETSI-TM6 can make a major step forward in solving this issue.

2. Proposal

The proposed text below, can be copied literally into the VDSL or ADSL draft. Unless explicitly specified, the word xDSL is used as place holder for VDSL or ADSL. The reference [*] is a place holder for a numbered reference to tables that will be added in future at the end of this literal text proposal

X. Splitter filter requirements

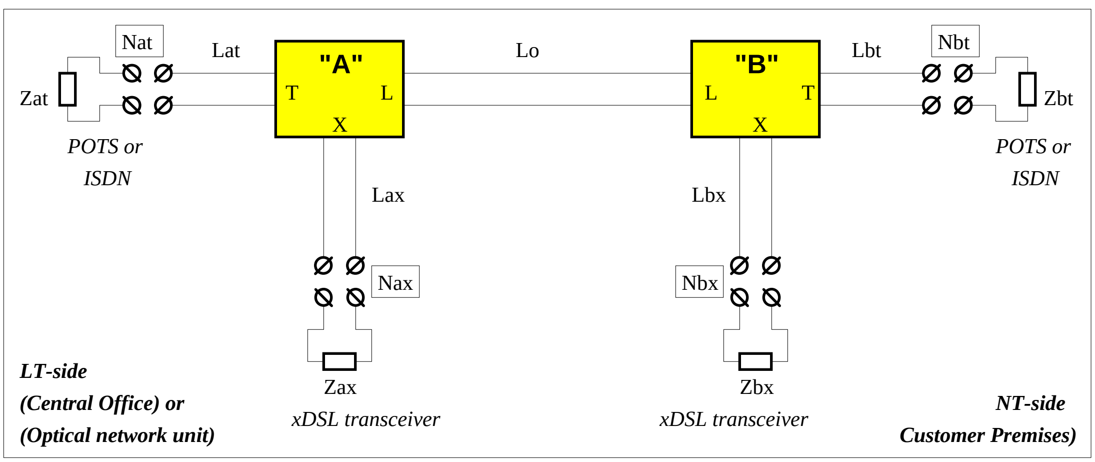
The main purpose of the splitter filter is to separate the transmission of “tele band” signals (originated from POTS or ISDN-BRA), and “xDSL band” signals (originated from VDSL or ADSL). A second purpose is to isolate poorly balanced “tele band” equipment from the line at “xDSL band” frequencies, in order to prevent unneccesairy egress (and ingress) from xDSL signals.
Insertion of a splitter filter in existing POTS or ISDN-BRA lines shall have only a low impact on the performance of this service. An excellent splitter filter is therefore *near transparant* for frequencies in a specified pass band. Near transparancy between two ports means that (1) the transfer function in the pass band is close to 0 dB and that (2) the input impedance at one port is close to the load impedance at the other port over a specified *range* of load impedances.
The splitter filter may be implemented as an independent unit, separately from the xDSL transceiver, or may be integrated with the xDSL transceiver.

The splitter shall meet the requirements of this clause [*] with all VDSL transceiver impedances that are tolerated by the return loss specification in 8.3.2.
Designs shall take into careful account the relevant national specifications. In the absence of national specifications the narrowband requirements of ETS 300 001 [*] and TBR 021 [*] shall be met for POTS and ETR 080 [*] for ISDN-BA.

X.1 Functional diagram

A splitter filter is required at both ends of the line which carries xDSL signals if existing baseband services are to remain unaffected by the presence of higher frequency xDSL signals on the same wire-pair. The functional diagram of this combination is given in figure 1.
The position of the two splitter filters shall be irrelevant for the minimum guaranteed performance, provided that:

- the end-to-end insertion loss from port “N_{ax}“ to “N_{bx}“ do not exceed the maximum values as specified for the testloops in clause [*]; and
- the length of cable section L_{ax}, L_{bx}, L_{at}, and L_{bt} do not exceed the values specified in table [*].



plaatje 1

Figure 1 Functional diagram of the xDSL splitter filter configuration

Port “X” of the splitter-filter connects to the xDSL transceiver. Port “T” connects to the existing POTS or ISDN-BA equipment. Port “L” connects to the line. Two different splitter-filter types are identified by the nature of the transfer between port “X” and “L”. This is shown in figure 2 by a functional diagram, and summarized below:

- The transfer from port “T” to “L” and reverse is that of a low-pass filter.

- Exceptional isolation is required from port “X” to “T” to prevent undesirable interaction between xDSL and any existing narrowband services.
- The transfer from port “T” to “L” and reverse is high-pass in nature for a “type High-pass” splitter.
- The transfer from port “T” to “L” and reverse is all-pass in nature for a “type All-pass” splitter. This reduced requirement is applicable only for xDSL transceivers with sufficiently high-pass filtering build-in.

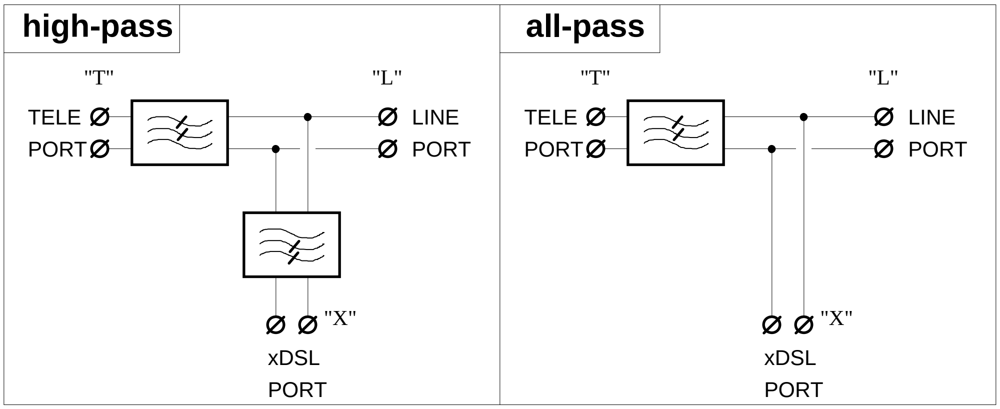


Figure 2 Structure of the xDSL splitter filter

X.2 Insertion loss or isolation definition

The splitter filter shall be near transparant from port “T” to “L” (and reverse) within the relevant frequency band. This means that the injected voltage U_T observed at port “T” is close to the transfered voltage U_L observed at port “L”. This must hold for a wide range of tolerated impedances around a nominal value. In this example, where signals are injected in port “T” , these impedances are:

- a range of line impedances Z_L around a nominal value Z_{L0}, that are terminating port “L”.
- a range of of xDSL impedances Z_X, around a nominal value Z_{X0}, that are terminating port “X”.

Similar properties apply for signals injected in port “X” or port “L”.

The various insertion loss parameters, as defined in figure 3 shall meet the requirements specified in table [*] for all load impedances tolerated by table [*] and xDSL transceiver impedances that are tolerated by the return loss specification in sub clause [8.3.2].

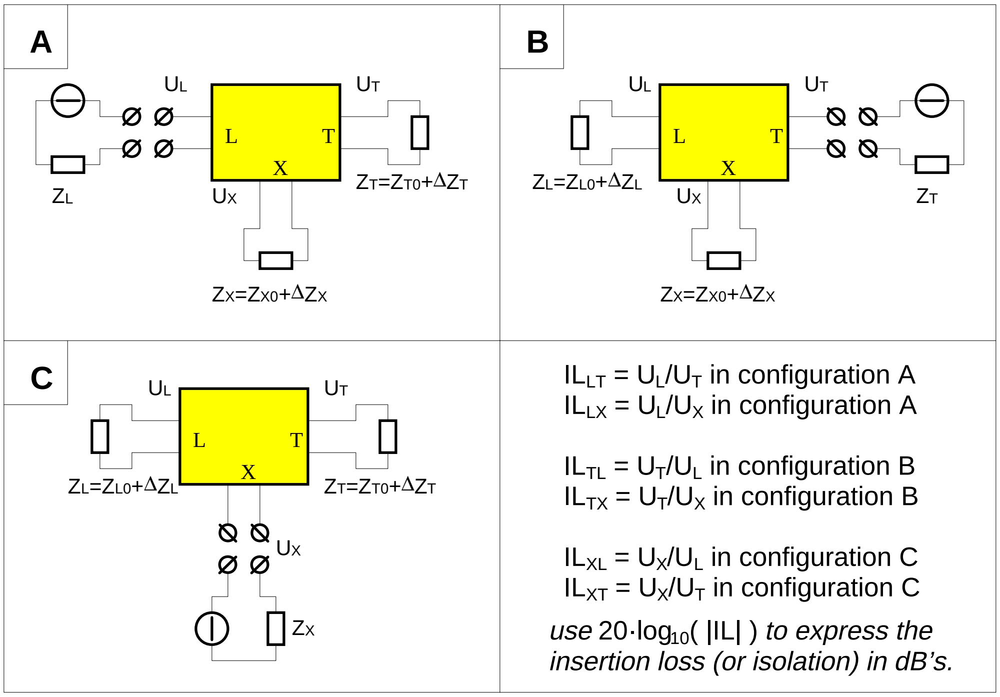


Figure 3 Configuration that defines the insertion loss of a single splitter filter

X.3 Return loss definition

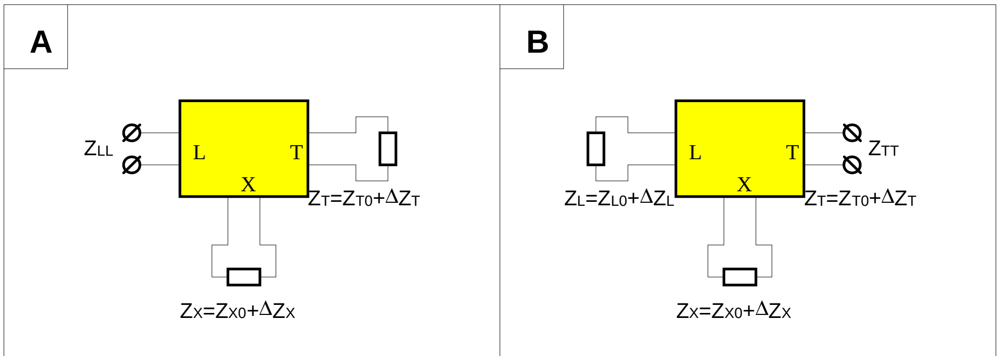
The splitter filter shall be near transparant from port "T" to "L" (and reverse) within the relevant frequency band. This means that the impedance Z_{TT} observed at port "T" equals the line impedance Z_L connected to port "L" . This must hold for a wide range of tolerated impedances around a nominal value. In this example, where signals are injected in port "T" , these impedances are:

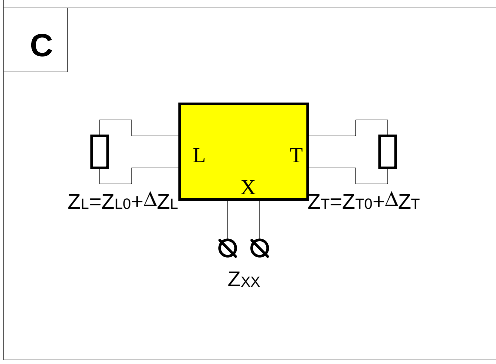
- a range of line impedances Z_L around a nominal value Z_{L0}, that are terminating port "L".
- a range of of xDSL impedances Z_X, around a nominal value Z_{X0}, that are terminating port "X".

Similar properties apply for signals injected in port "X" or port "L".

The requirements can be defined in terms of an impedance ratio (in this example Z_{TT}/Z_L) or in terms of a return loss (in this example $(Z_{LL}+Z_T) / (Z_{LL}–Z_T)$). These two quantities are interrelated. In this requirement, the return loss definitions are dedicated to the basic design goal of "near transparancy".

The various return loss parameters, as defined in figure 4 shall meet the requirements specified in table [*] for all load impedances tolerated by table [*] and xDSL transceiver impedances that are tolerated by the return loss specification in sub clause [8.3.2].





$RL_{LT} = (Z_{LL}+Z_T) / (Z_{LL}–Z_T)$ in config A
$RL_{LX} = (Z_{LL}+Z_X) / (Z_{LL}–Z_X)$ in config A

$RL_{TL} = (Z_{TT}+Z_L) / (Z_{TT}–Z_L)$ in config B
$RL_{TX} = (Z_{TT}+Z_X) / (Z_{TT}–Z_X)$ in config B

$RL_{XL} = (Z_{XX}+Z_L) / (Z_{XX}–Z_L)$ in config C
$RL_{XT} = (Z_{XX}+Z_T) / (Z_{XX}–Z_T)$ in config C

use $20\cdot\log_{10}(\,|RL|\,)$ *to express the return loss in dB's.*

Figure 4 Configuration that defines the return loss of a single splitter filter

X.4 Longitudinal Conversion Loss definition (LCL)

As described in ITU-T Recommendation G.117 sub-clause 4.1.3.

X.5 Requirements

X.5.1 Insertion loss or isolation requirements for POTS or ISDN

frequency band	**insertion loss IL_{TL}**	**impedance Z_L**	**range $\lvert\Delta Z_L / Z_{L0}\rvert$**	**impedance Z_X**	**range $\lvert\Delta Z_X / Z_{X0}\rvert$**
f1 .. f2	< x dB < x dB < x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_X = 135Ω	0 .. x %
f2 .. f3	< x dB < x dB < x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_X = 135Ω	0 .. x %
f3 .. f4	< x dB < x dB < x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_X = 135Ω	0 .. x %

details for further study, contributions invited,
"Z=complex" means the frequency dependent european impedance for new equipment,
"Z=cable" means the frequency dependent impadance of a cable with a long length

X.5.3 Return loss or isolation requirements for POTS or ISDN

frequency band	**insertion loss RL_{TL}**	**impedance Z_L**	**range $\lvert \Delta Z_L / Z_{L0} \rvert$**	**impedance Z_X**	**range $\lvert \Delta Z_X / Z_{X0} \rvert$**
f1 .. f2	> x dB > x dB > x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_X = 135Ω	0 .. x %
f2 .. f3	> x dB > x dB > x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_X = 135Ω	0 .. x %
f3 .. f4	> x dB > x dB > x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_X = 135Ω	0 .. x %

contributions invited

X.5.4 Insertion loss or isolation requirements for xDSL

frequency band	**insertion loss IL_{TL}**	**impedance Z_L**	**range $\lvert \Delta Z_L / Z_{L0} \rvert$**	**impedance Z_T**	**range $\lvert \Delta Z_T / Z_{T0} \rvert$**
f1 .. f2	< x dB < x dB < x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_{T0} = 600Ω Z_{T0} = complex Z_{T0} = cable	0 .. x %
f2 .. f3	< x dB < x dB < x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_{T0} = 600Ω Z_{T0} = complex Z_{T0} = cable	0 .. x %
f3 .. f4	< x dB < x dB < x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_{T0} = 600Ω Z_{T0} = complex Z_{T0} = cable	0 .. x %

contributions invited

X.5.2 Return loss or isolation requirements for xDSL

frequency band	**return loss RL_{TL}**	**impedance Z_L**	**range $\lvert \Delta Z_L / Z_{L0} \rvert$**	**impedance Z_T**	**range $\lvert \Delta Z_T / Z_{T0} \rvert$**
f1 .. f2	> x dB > x dB > x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_{T0} = 600Ω Z_{T0} = complex Z_{T0} = cable	0 .. x %
f2 .. f3	> x dB > x dB > x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_{T0} = 600Ω Z_{T0} = complex Z_{T0} = cable	0 .. x %
f3 .. f4	> x dB > x dB > x dB	Z_{L0} = 600Ω Z_{L0} = complex Z_{L0} = cable	0 .. x %	Z_{T0} = 600Ω Z_{T0} = complex Z_{T0} = cable	0 .. x %

contributions invited