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Technical Specification

Access network xDSL splitters for European deployment; Part 1: Generic specification of xDSL over POTS splitters

Reference
RTS/ATTM-06021

Keywords
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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

The present document is part 1 of a multi-part deliverable covering Access network xDSL splitters for European deployment, as identified below:

Part 1: "Generic specification of xDSL over POTS splitters";

Part 2: "Generic specification of xDSL over ISDN splitters and xDSL universal splitters";

Part 3: "Generic specification of distributed filters for xDSL over POTS";

Part 4: "Additional specifications for dynamic distributed filters for xDSL over POTS".

NOTE 1: Before the publication of the 3 or 4 parts as described above, the TS 101 952 was composed of 2 parts, which discriminated between ADSL and VDSL, with several subparts. For reasons of simplicity the TS is now restructured as a set of only 3 (potentially 4) documents, intended for both ADSL and VDSL when applicable. The older structure of the documents is explained in the informative annex B.

NOTE 2: Useful information on splitter tests may be found in TR 101 953-1-1 [i.3], TR 101 953-1-2 [i.4], TR 101 953-2-1 [i.5] and TR 101 953-2-2 [i.6]. These documents are linked to the previous versions of the splitter specifications. [i.3], [i.4], [i.5] and [i.6] e.g. describe the combination of the AC testing conditions of the test set-ups with the DC conditions controlled via feeding and loading bridges. If there is a discrepancy between the present document and the older TR 101 953 series of documents, the present document prevails.

NOTE 3: The use of distributed filters is not recommended for VDSL but it is not excluded. For this reason parts 3 and 4 refer to distributed filters for xDSL and not just for ADSL.

The present document is fully in line with initiative "eEurope 2002 - An Information Society For All", under "The contribution of European standardization to the eEurope Initiative, A rolling Action Plan" especially under the key objective of a cheaper, faster and secure Internet.

Introduction

Remarks on and limitations of the present document

The present document covers all xDSL system variants, such as ADSL, ADSL2, ADSL2plus, VDSL1 and VDSL2. It is applicable at the Local Exchange (LE) (i.e. network) side of the line at the LE or at the cabinet and at the Terminal Equipment (TE) (i.e. user) side of the line. A number of limitations and remarks should be listed:

1) The use of the present documents is extended to splitters at the cabinet. Indeed, the previous versions of the present document clearly stated that they did not apply to splitters at the cabinet. However as explained in the informative annex C, this restriction was lifted.

2) The present document does not contain the requirements for splitters, which can handle both POTS and ISDN. These so-called xDSL over "ISDN or POTS" universal splitters are specified in part 2.

3) Splitters at the customer premises with a distributed topology, called distributed filters, are not within the scope of the present document. They are described in part 3 (and potentially part 4).

4) The present document covering xDSL over POTS splitters was gained from the experience with passive and static xDSL splitters, the original state of the art for this application. Furthermore, the experience was gained with identical requirements at either side of the line. Therefore, the requirements in the present document are primarily intended for passive and static filters, with identical requirements for the LE side and the TE side of the line. However, in the note under table A.3 an optional diversification between splitters requirements at the two sides of the line is described. For the TE side splitters an **optional** variant could be allowed with better downstream protection, with less IL in the upstream band and more IL in the downstream band. Similar differentiation between LE and TE is possible for the balance requirements, see the note under table A.10.

5) The present document covering xDSL over POTS splitters is limited to passive and static splitters. There are other classes of filters possible, besides passive and static splitters. Such active and/or dynamic filters are composed of other elements than passive components. Active/dynamic splitters require different and additional requirements and test methods to be specified. The full specification of requirements for active/dynamic splitter is F.F.S. An introduction to this is in the informative annex K.

6) For certain static properties in the present document it is possible to relax the requirements and prove in dynamic tests that the splitter performs sufficiently well. These dynamic tests are compiled in WT-127, by the Broadband Forum. The use of the WT-127 methodology for this purpose is outside the scope of this version of the document, but could prove useful to introduce splitters with reduced complexity, or active and/or dynamic splitters. The WT-127 methodology is not fully finalized. It is described in annex H. Finalizing splitter tests in the present document based on WT-127 is F.F.S.

7) To test distortion, noise and other requirements in the present document the WT-127 methodology is sometime a superior methodology, or even the only feasible method at an acceptable complexity. Indeed, WT-127 will prove that a splitter works correctly in a worst case xDSL test environment. With such tests, based on actual xDSL transceiver results, one can avoid requirements are either inadequate or potentially unnecessarily strong. Defining splitter tests based on WT-127 in the present document is F.F.S.

1 Scope

The present document specifies requirements and test methods for the low pass and high pass part of xDSL over POTS splitters. These splitters are intended to be installed at the LE (i.e. network) side of the local loop, either at the local exchange or at a remote cabinet, and at the TE (i.e. user) side near the NTP. When used at the remote cabinet, the POTS signals can be injected locally at the cabinet, or at the central office. In the case of splitters at the TE side, the present document specifies the central splitter that is intended for use at the demarcation point of the customer premises.

The majority of requirements in the present document are generic and applicable to all xDSL over POTS central splitters. In the case where any requirements are applicable to only one particular flavour of xDSL, this is clearly indicated in the clause describing the requirement. The relevant information about requirements for specific xDSL system variants is given in annex A.

The splitter filter, as specified by the present document, may be implemented as an independent unit, separately from the xDSL transceiver, or may be integrated with the xDSL termination unit. The splitter may also be integrated with the base band termination unit (e.g. POTS line card); however this is outside of the scope of the present document.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
- Non-specific reference may be made only to a complete document or a part thereof and only in the following cases:
  - if it is accepted that it will be possible to use all future changes of the referenced document for the purposes of the referring document;
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NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ETSI TBR 038: "Public Switched Telephone Network (PSTN); Attachment requirements for a terminal equipment incorporating an analogue handset function capable of supporting the justified case service when connected to the analogue interface of the PSTN in Europe".

[2] ITU-T Recommendation O.42: "Equipment to measure non-linear distortion using the 4-tone intermodulation method".

[3] ETSI ES 203 021-3: "Access and Terminals (AT); Harmonized basic attachment requirements for Terminals for connection to analogue interfaces of the Telephone Networks; Update of the technical contents of TBR 021, EN 301 437, TBR 015, TBR 017; Part 3: Basic Interworking with the Public Telephone Networks".

NOTE: ETSI TBR 021 has been made historical.

[4] ITU-T Recommendation O.41: "Psophometer for use on telephone-type circuits".

[5] ITU-T Recommendation O.9: "Measuring arrangements to assess the degree of unbalance about earth".

[6] ETSI ES 201 970: "Access and Terminals (AT); Public Switched Telephone Network (PSTN); Harmonized specification of physical and electrical characteristics at a 2-wire analogue presented Network Termination Point (NTP)".

[7] ETSI EN 300 659 (all parts): "Access and Terminals (AT); Analogue access to the Public Switched Telephone Network (PSTN); Subscriber line protocol over the local loop for display (and related) services".

[8] ETSI ES 200 778 (all parts): "Access and Terminals (AT); Analogue access to the Public Switched Telephone Network (PSTN); Protocol over the local loop for display and related services; Terminal equipment requirements".

[9] ETSI ES 201 729: "Public Switched Telephone Network (PSTN); 2-wire analogue voice band switched interfaces; Timed break recall (register recall); Specific requirements for terminals".

[10] ETSI ES 201 187: "2-wire analogue voice band interfaces; Loop Disconnect (LD) dialling specific requirements".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area**.** For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ETSI TR 102 139: "Compatibility of POTS terminal equipment with xDSL systems".

[i.2] ETSI TR 101 728: "Access and Terminals (AT); Study for the specification of low pass filter section of POTS/ADSL splitters".

[i.3] ETSI TR 101 953-1-1: "Access and Terminals (AT); Unified and Generic Testing Methods for European Specific DSL splitters; Part 1: ADSL splitters for European deployment; Sub-part 1: Specification of Testing methods for Low Pass part of ADSL/POTS splitters".

[i.4] ETSI TR 101 953-1-2: "Access network xDSL transmission filters; Part 1: ADSL splitters for European deployment; Sub-part 2: Testing methods for High Pass part of ADSL/POTS splitters".

[i.5] ETSI TR 101 953-2-1: "Access network xDSL transmission filters; Part 2: VDSL splitters for European deployment; Sub-part 1: Specification of Testing methods for low pass part of VDSL/POTS splitters".

[i.6] ETSI TR 101 953-2-2: "Access network xDSL transmission filters; Part 2: VDSL splitters for European deployment; Sub-part 2: Specification of Testing methods for high pass part of VDSL/POTS splitters".

[i.7] ITU-T Recommendation G.993.1: "Very high speed digital subscriber line transceivers".

[i.8] ITU-T Recommendation G.993.2: "Very high speed digital subscriber line transceivers 2 (VDSL2)".

[i.9] ITU-T Recommendation G.992.1: "Asymmetric digital subscriber line (ADSL) transceivers".

[i.10] ITU-T Recommendation G.992.3: "Asymmetric digital subscriber line transceivers 2 (ADSL2)".

[i.11] ITU-T Recommendation G.992.5: "Asymmetric Digital Subscriber Line (ADSL) transceivers - Extended bandwidth ADSL2 (ADSL2plus)".

[i.12] ETSI TS 101 952-2: "Access network xDSL splitters for European deployment; Part 2: Generic specification of xDSL over ISDN splitters and xDSL universal splitters".

NOTE: Part 2 of this multipart deliverable is under construction. Part 1 is the present document.

[i.13] ETSI TS 101 952-3: "Access network xDSL splitters for European deployment; Part 3: Generic specification of distributed filters for xDSL over POTS";

NOTE: Part 3 of this multipart deliverable is under construction. Part 1 is the present document.

[i.14] ETSI TS 101 952-4: "Access network xDSL splitters for European deployment; Part 4: Additional specifications for dynamic distributed filters for xDSL over POTS".

NOTE: Part 4 of this multipart deliverable is under study. Part 1 is the present document.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

A-wire and B-wire: wires in the 2-wire local loop connection provided from the exchange to the NTP

active splitters: splitters containing some active components, including splitters with "on/off-hook detection" circuitry

distributed filter: low pass filter that is added in series with each of the parallel connected POTS TEs

NOTE: Each of these parallel connected filters (in the in-house cabling) is known as a distributed filter. These filters are also known as In-line filters or microfilters.

dynamic splitter: splitter changing its transfer behaviour dynamically, e.g. based on the state of the POTS connection

far end echo: speech that is fed back to the talker in a telephony connection with a round trip delay (i.e. the delay between talking and hearing the feedback), of greater than 5 ms, resulting in a distinguishable echo

off-hook: state of the POTS equipment at either end of a loop connection when the NTP terminal equipment is in the steady loop state

NOTE: See ES 203 021-3 [3].

on-hook: state of the POTS equipment at either end of a POTS loop connection when the NTP terminal equipment is in the quiescent state

NOTE 1: See ES 203 021-3 [3].

NOTE 2: In the case where multiple TEs are present at the customer end of the loop, then the TE is considered to be on-hook from the perspective of testing the splitter only when all of terminals are on-hook.

passive splitters: splitters containing exclusively passive components

sidetone: speech that is fed back to the talker in a telephony connection with a round trip delay (i.e. the delay between talking and hearing the feedback), of less than approximately 5 ms, making it indistinguishable from the original utterance

signature network: circuitry included at the POTS port of the splitter, the values and configuration of which may be operator dependent, which has the purpose of enabling network operator's remote line testing equipment to determine the presence of a splitter on a line

xDSL: ADSL or VDSL

NOTE: This abbreviation stands for ADSL or VDSL and its use this way is strictly limited to the present document; e.g. HDSL, SDSL and SHDSL are not covered.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Att_{DB}	Attenuation in the xDSL Band (LINE port to xDSL port, or reversed)
C_{DCB}	DC Blocking capacitor as the optional high pass of first order
C_{DSL}	The capacitor C part of the Z_{DSL}
f_H	highest of the used frequencies in the xDSL Band
f_L	lowest of the used frequencies in the xDSL Band
f_{M1}	intermediate frequency, at the US(0) to DS edge for xDSL
f_{M2}	intermediate frequency, used for IL in on-hook
f_{Max}	maximum frequency above xDSL band for measurements
IL_{DBOffH}	Insertion Loss xDSL Band Off-Hook
IL_{DBOnH}	Insertion Loss (Isolation) xDSL Band On-Hook
IL_{Meter}	Insertion Loss for Metering (Off-Hook)
IL_{PBOffH}	Insertion Loss POTS Pass Band Off-Hook
IL_{PBOnH}	Insertion Loss POTS Pass Band On-Hook
IL_{TBOffH}	Insertion Loss Transition Band, only done in Off-Hook
LCL	Longitudinal Conversion Loss
LCTL	Longitudinal Conversion Transfer Loss
L_{DSL}	The inductance L part of the Z_{DSL}
N_{DB}	Noise in the xDSL band
N_{PB}	Noise in the POTS band (psophometric)
$R_{A\ to\ B\ wire}$	DC resistance between A and B wire
R_{DC}	DC Resistance of a splitter for POTS current
R_{DSL}	The resistive R part of the Z_{DSL} ($R_{DSL} \equiv Z_{RefDSL}$)
R_{FEED}	Variable DC feed resistor in figure 3
R_{LOAD}	Variable DC load resistor in figure 4
RL_{PBOffH}	Return Loss POTS Pass Band Off-Hook, option A or B
$R_{to\ Earth}$	Resistance to Earth
S_{DSL}	Switch to connect xDSL impedance Z_{DSL} to the test set-up
UaE	Unbalance about Earth
V_{RD}	V Ring-Drop
Z_{AC}	Generic name for the AC POTS impedance models
Z_{DSL}	Impedance model of the input filter of a particular xDSL
Z_{InRing}	The input impedance of the splitter at the ringing frequencies
Z_{ON}	Generic name of the POTS on-hook impedance
Z_{OnHI}	Impedance modelling POTS On-hook with High Impedance
Z_{OnHo}	Impedance modelling multiple parallel on-hook phones
Z_{OnLI}	Impedance modelling POTS On-hook with Low Impedance
Z_R	European harmonized complex reference POTS impedance
Z_{Ref}	Generic name of Reference POTS impedance in RL formula
Z_{RefDSL}	Nominal Reference Design Impedance of xDSL ($Z_{RefDSL} \equiv R_{DSL}$)
Z_{RHF}	Complex POTS impedance, extending Z_R to higher frequencies, [i.1]
Z_{Ring}	Impedance modelling the load represented by ringer circuits
Z_{SL}	Impedance Z Short Loop, modelling a short line terminated on 600 Ω

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
ADSL	Asymmetric Digital Subscriber Line
ADSL1	ADSL limited to 1,1 MHz, see ITU-T Recommendation G.992.1 [i.9]
ADSL2	ADSL revision 2, see ITU-T Recommendation G.992.3 [i.10]
ADSL2plus	ADSL revision "2plus", extended to 2,2 MHz; see ITU-T Recommendation G.992.5 [i.11]
AWGN	Additive White Gaussian Noise
CLIP	Calling Line Identification Presentation
CMRR	Common Mode Rejection Ratio
CO	Central Office (≡ Local Exchange ≡ LE)
CPE	Customer Premise Equipment (≡ Terminal Equipment ≡ TE)
DC	Direct Current
DS	Downstream, which is from LE side to TE side
DSL	Digital Subscriber Line
DSLAM	DSL Access Module, equipment at the LE side with multiple xDSL transceivers
DUT	Device Under Test
e.m.f.	Electro-Magnetic Force
F.F.S.	For Further Study
FDD	Frequency Division Duplexing
HPF	High Pass Filter
IL	Insertion Loss
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
LE	Local Exchange (≡ Central Office)
N.A.	Not Applicable
NTP	Network Termination Point
POTS	Plain Old Telephone Service

NOTE: The abbreviation POTS is used in the text of the present document instead of PSTN.

PSTN	Public Switched Telephone Network

NOTE: The abbreviation PSTN is replaced by POTS in the text of the present document.

RL	Return Loss
RMS	Root Mean Square
SLIC	Subscriber Line Interface Circuit
SDSL	Symmetric DSL
TBD	To Be Determined
TE	Terminal Equipment (e.g. Telephone, Fax, voice band modem, etc.)
THD	Total Harmonic Distortion
UaE	Unbalance about Earth
US	Upstream, which is from TE side to LE side
US0	US (Upstream) "0" band, the lowest VDSL upstream band
VDSL	Very high speed Digital Subscriber Line
VDSL1	VDSL variant defined in ITU-T Recommendation G.993.1 [i.7]
VDSL2	VDSL variant defined in ITU-T Recommendation G.993.2 [i.8]

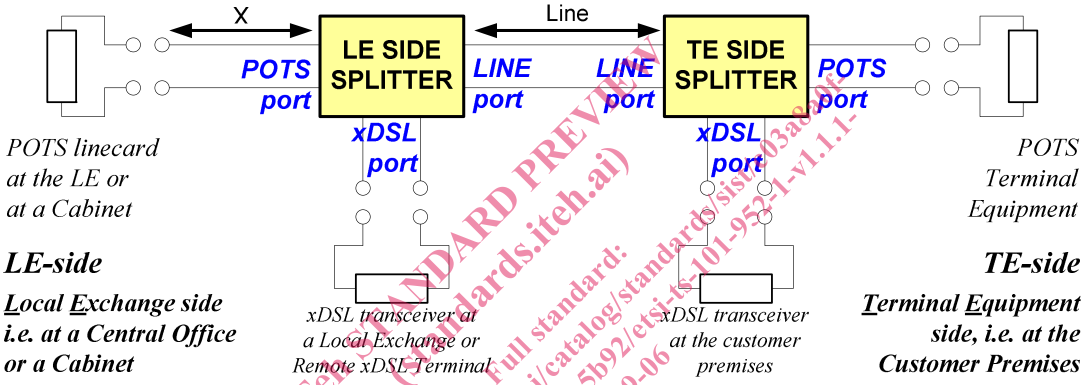
NOTE: xDSL is defined under clause 3.1 with definitions.

4 General functional description of xDSL over POTS splitters

The main purpose of the xDSL over POTS splitter is to separate the transmission of POTS signals and xDSL signals, enabling the simultaneous transmission of both services on the same twisted pair. The splitter also serves to protect POTS from interference due to ingress from xDSL signals. Equally it protects the xDSL transmission from transients generated primarily during POTS signalling (dialling, ringing, ring trip, etc.), and it must also prevent interference to the xDSL service due to fluctuations in impedance and linearity that occur when telephones change operational state (e.g. from off-hook to on-hook). Information on various implementations of ADSL over POTS splitters is given in TR 101 728 [i.2]. Insertion of a splitter filter in existing POTS lines shall only have a low impact on the performance of the POTS service. A tutorial on the transmission and separation of POTS and xDSL signals is contained in annex I.

4.1 Functional diagram

The functional diagram for the splitter combination is given in figure 1.



NOTE: For a Local Exchange xDSL deployment, the length "X" in this figure will typically be far less than 1 km. For a remote xDSL terminal deployment, the length "X" can be up to several kilometres.

Figure 1: Functional diagram of the xDSL splitter configuration

The types of transfer functions between the different ports of the splitter are shown in figure 2 and can be understood as follows:

- The transfer function from the POTS port to the LINE port and vice-versa is that of a low pass filter.
- A high level of isolation is required from the xDSL port to the POTS port to prevent undesirable interaction between the xDSL transmission and any existing narrowband services, i.e. in both directions.
- The transfer function from the xDSL port to the LINE port and vice-versa is either that of a high pass filter, or it may be all pass in nature, in the case where the full high pass filter function is implemented in the xDSL transceiver.

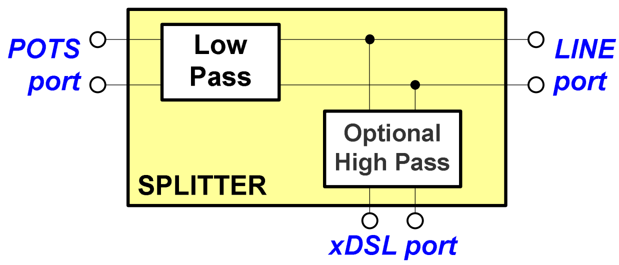


Figure 2: Structure of the xDSL splitter filter