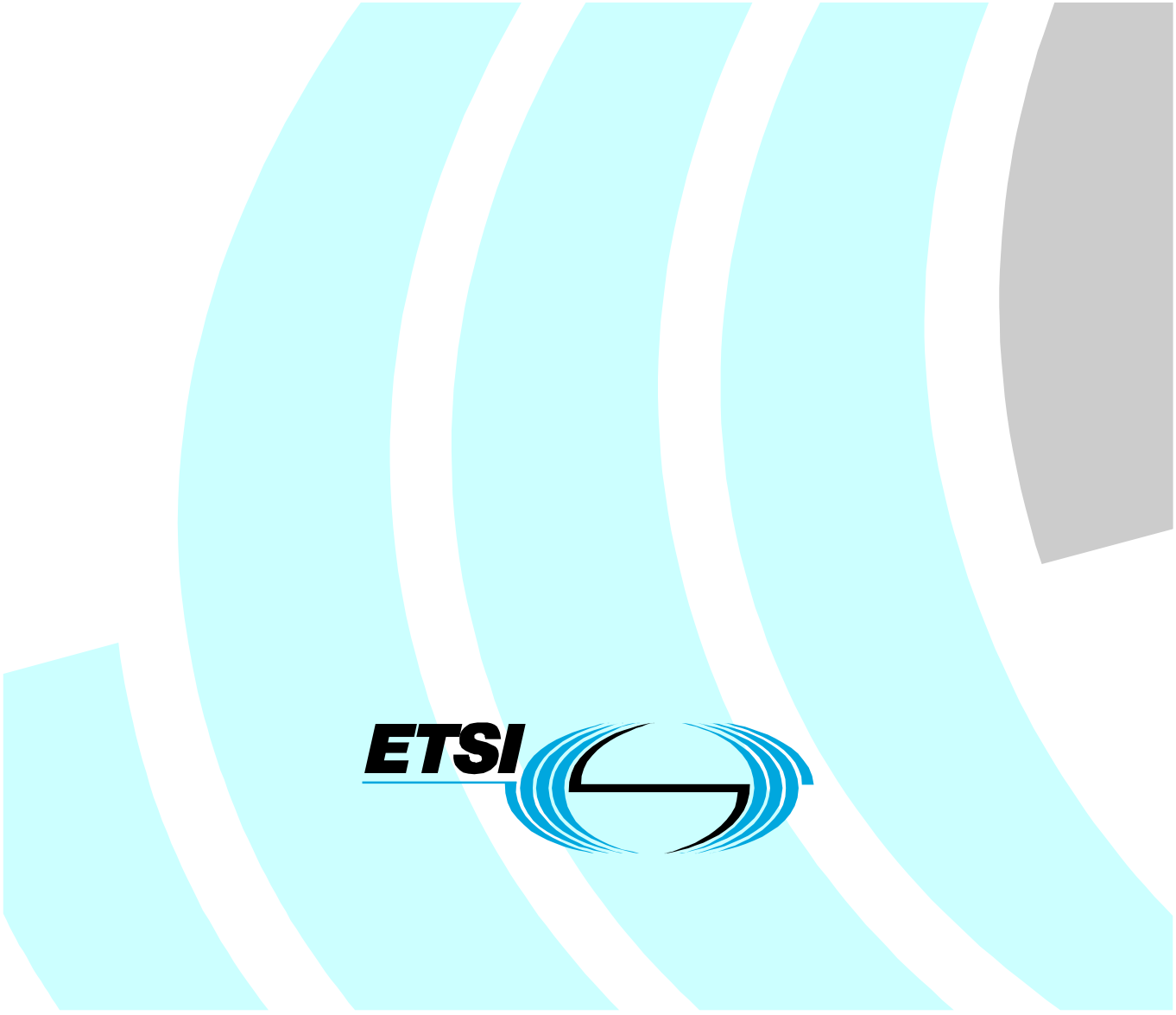
ETSI TS 101 952-1-5 V1.2.1 (2006-10)

Technical Specification

Access network xDSL transmission filters;
Part 1: ADSL splitters for European deployment;
Sub-part 5: Specification for ADSL over POTS distributed filters



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Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access and Terminals (AT).

The present document is part 1, sub-part 5 of a multi-part deliverable covering Access network xDSL transmission filters, as identified below:

Part 1: "ADSL splitters for European deployment":

Sub-part 1: "Generic specification of the low pass part of DSL over POTS splitters including dedicated annexes for specific xDSL variants";

Sub-part 2: "Specification of the high pass part of ADSL/POTS splitters";

Sub-part 3: "Specification of ADSL/ISDN splitters";

Sub-part 4: "Specification of ADSL over "ISDN or POTS" universal splitters";

Sub-part 5:"Specification for ADSL over POTS distributed splitters";

Part 2: "VDSL splitters for European deployment".

NOTE 1: The choice of a multi-part format for the present document is to facilitate maintenance and future enhancements.

NOTE 2: We recommend to use the present document together with the document on splitter tests TR 101 953-1-1 (see Bibliography).

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.

1 Scope

The present document specifies requirements and test methods for "ADSL over POTS" distributed filters. These filters are at the user side of the local loop in the customer premise.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- 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.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

[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 (all parts): "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".

[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 TS 101 270-1: "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional requirements".

[7] 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)".

[8] ETSI EN 300 659-1: "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; Part 1: On-hook data transmission".

[9] ETSI ES 200 778-1: "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; Part 1: On-hook data transmission".

[10] 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".

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

3 Definitions 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 filters: filters whose filtering function is implemented using some active components, not including exclusively passive filter implementations containing line state detection circuitry

central splitter: splitter that is used to isolate ADSL frequencies from POTS frequencies at a single point at the customer premises (master splitter)

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

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 filters: filters whose transfer function varies significantly depending on some external influence (e.g. the presence of line current)

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 TBR 021 [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 TBR 021 [3].

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

passive filters: filters 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

static filters: filters whose transfer function does not display significant dependence on external influences (e.g. the presence of line current). These filters are known as single state filters.

3.2 Abbreviations

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

AC	Alternating Current
ADSL	Asymmetric Digital Subscriber Line
CLI	Caller Line Identification
DC	Direct Current
DSL	Digital Subscriber Line
DTMF	Dual Tone Multi-Frequency
DUT	Device Under Test

HPF	High Pass Filter
ITU	International Telecommunication Union
NTP	Network Termination Point
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
TE	Terminal Equipment (e.g. Telephone, Fax, voice band modem etc.)
THD	Total Harmonic Distortion
VDSL	Very high speed Digital Subscriber Line

4 General functional description of ADSL over POTS distributed filters

The main purpose of the ADSL over POTS distributed filter is to protect voice band terminal equipment from interference due to egress (and ingress) from DSL signals. Equally it protects the DSL transmission from transients generated primarily during POTS signalling (dialling, ringing, ring trip, etc.), and it must also prevent interference to the ADSL service due to fluctuations in impedance and linearity that occur when telephones change operational state (e.g. from off-hook to on-hook). The differences between a distributed filter and a central splitter (the latter being specified in sub-part 1-1 of TS 101 952) are defined more by the location of the filter rather than the function. Central splitters are designed to be located at the demarcation point of the customer premise, and provide separation of POTS and ADSL signals at a single location. Distributed filters on the other hand are placed in series with each piece of voice grade terminal equipment. Thus distributed filters are two port devices, as seen in figure 1 (central splitters have three ports). Hence, when voice grade equipment is protected by distributed filters the ADSL signals are delivered over the entire customer premise wiring. Multiple filters will typically be used in a customer premises, as shown in figure 1.

NOTE: The quality of the POTS and the ADSL services may be negatively affected by the number of distributed filters installed. The extent of this effect is expected to be proportional to the number of distributed filters installed.

The distributed filters are intended to be a convenient solution that can be installed by the user. The performance of both the POTS and ADSL services is often reduced by using distributed filters instead of a central splitter. The central splitter almost always ensures a higher input impedance for the ADSL frequency band at the line port than the distributed filters in parallel. Moreover, in the ADSL band the central splitter isolates the in-house wiring from the external line and the ADSL system and will almost certainly reduce electromagnetic interference.

It is recognized that dynamic distributed filters can give improved performance over static filters, requirements for dynamic filters will be covered in the next revision of the present document.

4.1 Functional diagram

The functional diagram for distributed filters is given in figure 1. The filters specified by the present document are intended to be connected only in series with the POTS TE. Operation is not specified for serial stacking (i.e. connecting one distributed filter in series with another distributed filter). The stacking of distributed filters is not recommended.

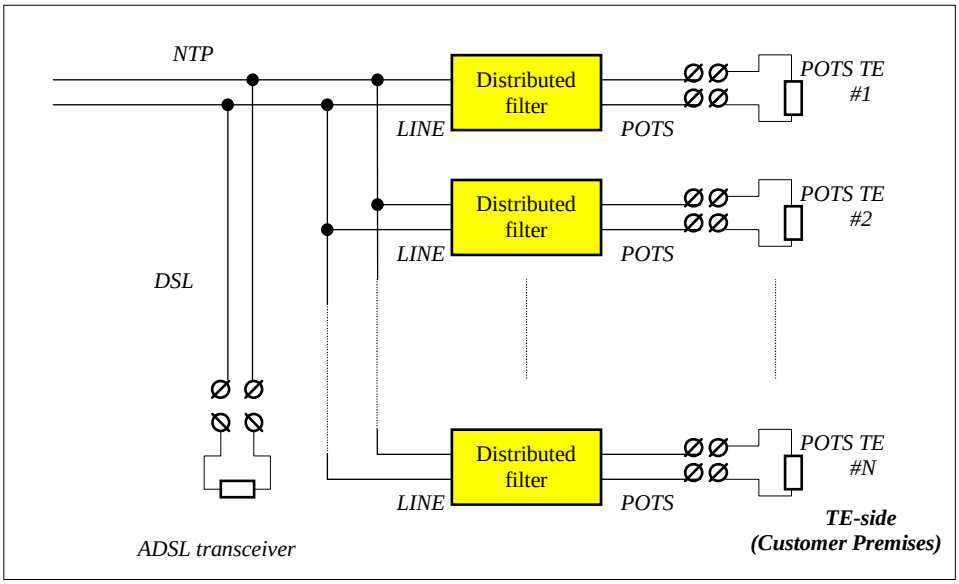


Figure 1: Functional diagram of the DSL splitter configuration

The transfer function between the POTS port and LINE port (and vice-versa) of each filter is that of a low pass filter.

5 Testing conditions

5.1 DC testing conditions

5.1.1 Polarity independence

The splitter shall conform to all the applicable requirements of the present document for both polarities of the DC line feeding voltage (and the DC line current) provided by the local exchange.

This may not apply in the case where a "signature network" is used as this may be polarity dependant.

5.1.2 DC feeding conditions (on/off hook)

The electrical requirements in the present document can be classified as follows:

- On-hook requirements, when the POTS terminal equipment is in the on-hook state.
- Off-hook requirements, when the POTS terminal equipment is in the off-hook state.
- Transitional requirements, when the POTS terminal equipment is in the transition between the on-hook and off-hook state (in either sense).

On-hook voiceband electrical requirements shall be met with a DC feeding voltage of 50 V.

Additionally in certain networks there may be on-hook signalling requiring a DC loop current in the range of 0,4 mA to 2,5 mA flowing through the distributed filter. In this case an impedance model of 600 Ω is used to terminate the LINE and POTS port of the distributed filter at voice frequencies.

Off-hook electrical requirements shall be met with a DC current of 13 mA to 80 mA.

Testing conditions for transitional requirements are specified in clause 6.13.

5.2 AC Terminating impedances

The impedances in this clause are intended for AC only. The DC feeding conditions of the line shall be controlled separately, e.g. by inserting the appropriate DC feeding and loading bridges.

5.2.1 Z_{DSL}

In many of the tests with voice frequencies, an impedance called Z_{DSL} is used. This impedance model represents the input impedance of the DSL transceiver (with the HPF), as seen from the low pass filter. This substitute circuit shown in figure 2 is a model which shall be applied to a distributed filter when verifying electrical requirements. The model is intended for filter specification in the context of the present document. This is not a requirement on the input impedance of the DSL transceiver.

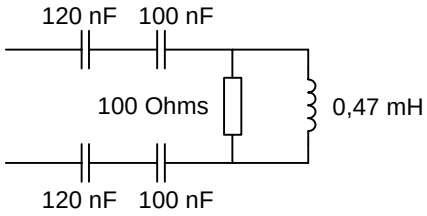


Figure 2: Schematic diagram of the impedance Z_{DSL}

5.2.2 Z_R and Z_{SL}

For most requirements relating to voice band frequencies described in the present document, either the terminating impedances Z_R or Z_{SL} is used to terminate the POTS port or the LINE port. Z_R is the European harmonized complex impedance as defined in ES 201 970 [7] and TBR 21 [3], Z_{SL} is an impedance used in TBR 038 [1] to simulate a short line terminated in 600 Ω.

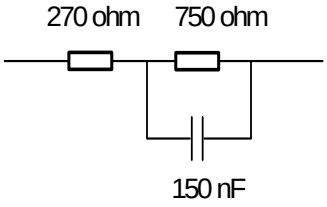


Figure 3: Impedance Z_R

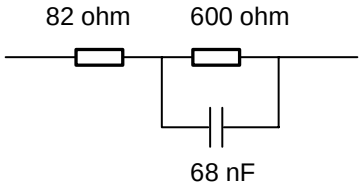


Figure 4: Impedance Z_{SL}

NOTE: In the case of filters to be deployed in some networks, alternative models of reference impedances instead of Z_R are currently used when matching the splitter requirements.

5.2.3 Z_{RHF}

For requirements relating to ADSL frequencies described in the present document, the terminating impedance Z_{RHF} is used to terminate POTS and LINE ports of the distributed filter. This is the European harmonized complex impedance Z_R with the modification proposed in TR 102 139 (see Bibliography). This network is shown in figure 5.

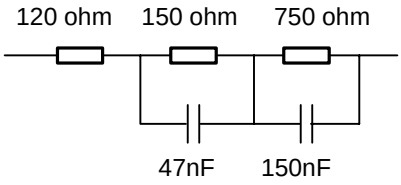


Figure 5: Impedance Z_{RHF}

5.2.4 Z_{ONHI}

For some on-hook requirements (as defined in clause 5.1.2) described in the present document, the terminating impedance Z_{ONHI} is used. This impedance is valid at AC frequencies only.

Actual impedances will vary greatly especially over the ADSL frequency range and thus the impedance model adapted here is just intended for the verification of splitters. It is not intended to be an equivalent circuit for a POTS TE.

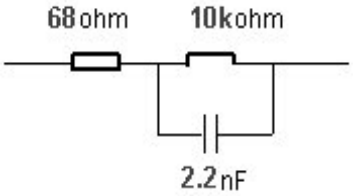


Figure 6: Impedance model to be used for some on-hook requirements

5.3 General transmission test setup

For many of the transmission related tests that are specified in the present document, a common general test setup is valid. This test setup is given in figures 7 and 8, for measurements at the LINE port and POTS port respectively.

The number of parallel filters to be used in the test setups is N-1. The maximum number of parallel filters that can be connected, for which the electrical requirements of the present document are fulfilled, shall be specified by the manufacturer.

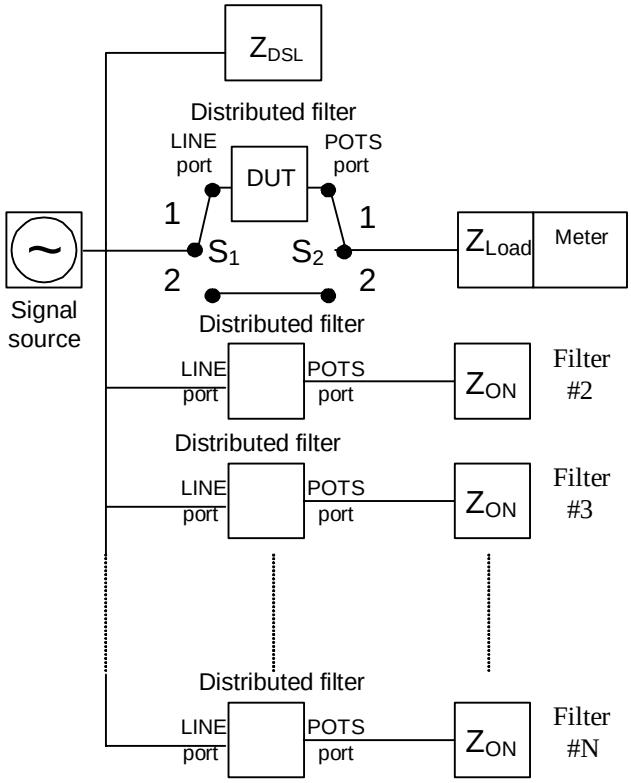


Figure 7: Test set up for transmission testing from LINE to POTS

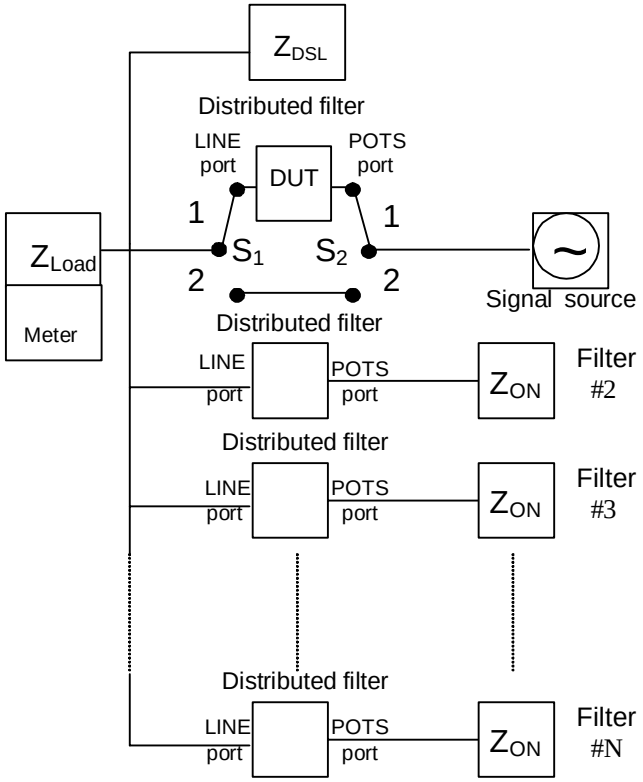


Figure 8: Test set up for transmission testing from POTS to LINE

6 Distributed filter requirements

6.1 Options for filter requirements

The electrical requirements in the present document are divided into two categories, Option A and Option B. In a practical sense, the requirements for Option A and Option B are identical with the exception of two clauses. The clauses in question are that specifying pass band return loss requirements in the off-hook state (see clause 6.6), and that concerning off-hook isolation (see clauses 6.9.2 and 6.10.2).

Although one of the purposes of the present document is to present a harmonized set of requirements for European networks, it has become apparent during the development of the present document that the relative importance of certain key requirements varies considerably between networks in Europe. For this reason it is felt necessary to define two options for the distributed filter. These can be broadly considered as in clauses 6.1.1 and 6.1.2.

6.1.1 Option A distributed filters

NOTE: Option A is appropriate for networks where the terminals and LE variants have several different reference impedance values (e.g. 600 Ω, harmonized European reference impedance Z_R and other complex impedances), and one single reference impedance is insufficient to accommodate the needs of all terminals and LE variants. Option A splitters have the potential for increased degradation of POTS service when compared to Option B splitters.

- Option A filters will meet return loss requirements for two reference impedances, which is appropriate for networks where the population of existing terminals or network presentations includes equipment designed against several different reference impedance values.
- Conversely, this option assumes that potential sidetone and far end echo effects can be adequately accounted for with relatively moderate return loss requirements.
- In addition Option A filters are considered to be appropriate to networks where concerns of potential interference between services (e.g. audible DSL interference to the POTS service) motivate a requirement of very high level of isolation.

6.1.2 Option B distributed filters

NOTE: Option B is appropriate for networks, which have one single reference impedance for all terminals and local exchanges.

- Option B filters are considered to be appropriate to networks where concerns of sidetone and far end echo effects motivate a very high return loss requirement.
- Additionally, this return loss requirement is only valid for one reference impedance, and thus Option B splitters are appropriate for networks for which it is felt that one single reference impedance is sufficient to accommodate the needs of all terminals and network presentations.
- Conversely, this option assumes that potential interference between services can be adequately accounted for with relatively moderate isolation requirements.

6.2 DC requirements

6.2.1 DC resistance to earth

The DC resistance between each terminal (i.e. A-wire and B-wire) of the filter and earth, when tested with 100 V DC, shall not be less than 100 MΩ.

This test should be performed while the filter is placed on an earthed metal plate of a sufficiently large size.

NOTE: No impedances should be connected to the filter for this test.

6.2.2 DC Insulation resistance between A-wire and B-wire

The DC resistance between the A-wire and B-wire at both the LINE and POTS port of the filter, when tested with 100 V DC, shall not be less than 25 MΩ.

NOTE: No impedances should be connected to the filter for this test.

6.2.3 DC series resistance

The DC resistance from the A-wire to the B-wire at the LINE port with the POTS port shorted, or at the POTS port with the LINE port shorted shall be less than or equal to 50 Ω.

6.2.4 DC signalling

The PSTN line typically may, according ES 201 970 [7], have 38 V to 78 V DC powering the analogue TE. When the POTS terminal is off hook, the voltage appearing across the splitter ports will normally be lower depending on the characteristics of the terminal and the line length.

The splitter shall not significantly affect any PSTN DC signalling in such a manner that would prevent it from performing its intended function.

The following DC signalling methods are commonly used:

- register recall signalling (specified in ES 201 729 [10]);
- reversals in polarity (commonly used in many networks to signal various events to the TE);
- loop disconnect dialling (specified in ES 201 187 [11]), although DTMF signalling is strongly preferred in combination with ADSL;
- K-break referred to in ES 201 970 [7], clause 14.6;
- CLI and other enhanced signalling, according EN 300 659 [8]; and
- ES 200 778-1 [9] may also be associated to some special DC signals.

NOTE 1: Clause 14 of ES 201 970 [7] refers to these signalling methods.

NOTE 2: Detailed specification in this area is for further study.

6.3 Ringing frequency requirements

The DC feeding conditions of clause 5.1.2 are not applicable to these requirements.

6.3.1 Voltage drop at 25 Hz and 50 Hz

Ringing signals with frequencies of 25 Hz and 50 Hz shall be used.

The maximum voltage drop at the load impedance due to the insertion of one filter, i.e. that marked "DUT" in the test setup of figure 7 with the switches S_1 and S_2 in position 1, shall be not more than 2 Vrms.

Table 1: Test conditions Voltage drop at 25 Hz and 50 Hz

Impedance of signal source	850 Ω (resistive)
Impedance of the load	2,7 kΩ + 2,2 µF at 25 Hz 2,7 kΩ + 1,0 µF at 50 Hz
Open voltage of the AC test signal source	35 Vrms
Level of the DC feeding voltage	60 V DC

6.3.2 Impedance at 25 Hz and 50 Hz

The LINE port of the filter shall have an impedance (when measured between the A-wire and the B-wire) at 25 Hz and 50 Hz of not less than 40 kΩ. When testing at the LINE port the POTS port is open circuit.

6.3.3 Total harmonic distortion at 25 Hz and 50 Hz

The filter shall be able to transfer the ringing signals to the AC-load without significant distortion. This is tested with two sets of source and feeding voltages, as given in table 2. The test shall be carried out at 25 Hz and 50 Hz. With those voltages applied, the total harmonic distortion of the AC signal shall be less then 10 %. The test setup is given in figure 7 with the switches S_1 and S_2 in position 1.

Table 2: Test conditions THD at 25 Hz and 50 Hz

Impedance of signal source	850 Ω (resistive)
Impedance of the load	2,7 kΩ + 2,2 µF at 25 Hz 2,7 kΩ + 1,0 µF at 50 Hz
Open voltage of the AC test signal source (test 1)	100 Vrms
Level of the DC feeding voltage (test 1)	50 V DC
Open voltage of the AC test signal source (test 2)	50 Vrms
Level of the DC feeding voltage (test 2)	78 V DC

6.4 POTS Pass band loss requirements (on-hook)

NOTE: A reference measurement according to figures 7 and 8 with the switches S_1 and S_2 in position 2 has to be performed first. The measurements with the DUT (switches S_1 and S_2 in position 1) are then recorded relative to the reference measurement.

6.4.1 On hook requirement for the case of high impedance load

The magnitude of the voltage gain of the filter in the range 200 Hz to 2 800 Hz shall be within the range -4 dB to +4 dB for the on-hook case with high impedance injection. The DC feeding shall be as specified in clause 5.1.2 for the on-hook case. The test set ups are given in figures 7 and 8. The test shall be executed with the combinations of source and load impedances in table 3.

Table 3: Impedances and test setup for the on hook voltage gain test

Test setup reference	Impedance of signal source	Impedance of the load
Figure 7	Z_R	Z_{ONHI}
NOTE: Level of the test signal = -4 dBV emf.		

6.4.2 On hook requirement for the case of low impedance load

The requirements of this clause are only applicable to certain networks. These networks use DTMF transmission as specified in annex A of ES 200 778-1 [9]. The equivalent AC impedance could be as low as 600 Ω. The DC feeding shall be as specified in clause 5.1.2 for the on-hook case.

6.4.2.1 On-hook POTS insertion loss

The insertion loss of one splitter shall be less then 1 dB at 1 kHz for the on-hook case with low impedance injection.

The on-hook pass band insertion loss shall be measured according to figures 7 and 8. Both the source and load shall be set at 600 Ω.

6.4.2.2 On-hook POTS insertion loss distortion

The absolute difference between the insertion loss at any frequency in the range 200 Hz to 2 800 Hz and the insertion loss at 1 kHz shall be less then 1 dB.

The on-hook pass band insertion loss distortion shall be measured according to figures 7 and 8. Both the source and load shall be set at 600 Ω.

6.5 POTS Pass band loss requirements (off-hook)

NOTE: A reference measurement according to figures 7 and 8 with the switches S_1 and S_2 in position 2 has to be performed first. The measurements with the DUT (switches S_1 and S_2 in position 1) are then recorded relative to the reference measurement.

6.5.1 Off-hook POTS pass band insertion loss

The insertion loss of one filter shall be less then 1 dB at 1 kHz.

The test set ups are given in figures 7 and 8. The off-hook passband insertion loss shall be measured according to both figures 7 and 8. Level of the test signal = -4 dBV emf.

The test shall be executed with both combinations of source and load impedances in table 4. The off-hook DC feeding current is specified in clause 5.1.2.

Table 4: Combinations of source and load impedances for the insertion loss test

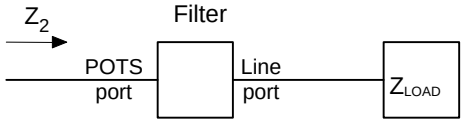
Source/Load combination	Impedance of signal source	Impedance of the load
Combination 1	Z_R	Z_R
Combination 2	600 Ω	600 Ω

6.5.2 Off-hook POTS passband insertion loss distortion

The absolute difference between the insertion loss at any frequency in the range 200 Hz to 4 000 Hz and the insertion loss at 1 kHz shall be less then 1 dB. The test shall be executed with both combinations of source and load impedances in table 4. The test setups are described in figures 7 and 8 and the off-hook DC feeding current is specified in clause 5.1.2.

6.6 POTS Passband return loss requirements (off-hook)

The return loss at both the POTS and LINE port of the filter shall be measured according to figures 7 and 8 with the switches S_1 and S_2 in position 1 and with only one distributed filter (DUT) connected (N = 1). The definition of return loss (for the case of a measurement at the POTS port) is given in figure 9.



$$RL = 20 \times \log \frac{|Z_{LOAD} + Z2|}{|Z_{LOAD} - Z2|}$$

Figure 9: Definition of return loss at the POTS port

There are two options for return loss testing. Return loss testing is to be carried out under the off-hook DC feeding current of clause 5.1.2.

6.6.1 Return loss requirements Options A and B

6.6.1.1 Return loss requirements, Option A

The device shall meet all the return loss requirements specified in table 5.

Table 5: Return loss requirements, Option A

Test #	Value of Z_{LOAD}	Frequency range	Minimum Return Loss
test 1	Z_{SL}	300 Hz to 3 400 Hz	12 dB
test 2	Z_{SL}	3 400 Hz to 4 000 Hz	8 dB
test 3	Z_R	300 Hz to 3 400 Hz	12 dB
test 4	Z_R	3 400 Hz to 4 000 Hz	8 dB
NOTE: A value of 14 dB for the minimum Return Loss instead of 12 dB is desirable.			

6.6.1.2 Return loss requirements, Option B

The device shall meet the return loss requirements specified in figure 10.

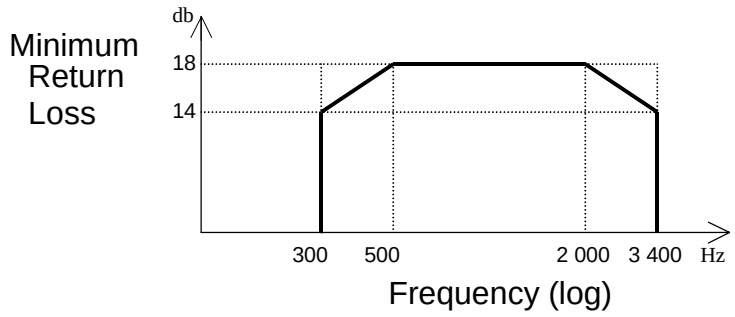


Figure 10: Minimum return loss template for Option B

For the case of Option B, Z_{LOAD} in figure 9 shall be Z_R.

6.7 Requirements relating to metering pulses at 12 kHz or 16 kHz

NOTE: A reference measurement according to figures 7 and 8 with the switches S_1 and S_2 in position 2 has to be performed first. The measurements with the DUT (switches S_1 and S_2 in position 1) are then recorded relative to the reference measurement.

In the case where pulse metering signals are deployed on the same lines as ADSL, the insertion loss due to the filter shall be measured at the frequency of the metering pulse. Due to the country specific nature of the rationale of this requirement, the required insertion loss shall be operator specific. A maximum insertion loss requirement in the range 3 dB to 5 dB per filter should be suitable for many European networks.

The test set up of figures 7 and 8 shall be used, using the condition of table 6. The level of the test signal is 3,5 Vrms. This requirement is valid only for the off-hook condition, with the DC feeding as specified in clause 5.1.2.

Table 6: Conditions for insertion loss test at 12 kHz or16 kHz

Level of source voltage	Impedance of signal source	Impedance of the load (Z in figures 9 and 10)	Impedance at the ADSL port
3,5 Vrms	200 Ω	200 Ω	Z_{DSL}
NOTE: This is an optional requirement, and can increase the complexity of the low pass filter implementation.			

6.8 Unbalance about Earth

The basic test setup for measuring unbalance at the POTS port is shown in figure 11. In the case of measuring at the LINE port, the test setup of figure 11 is used, however with the POTS and LINE terminations reversed. The test shall be carried out for the combinations described in table 7. Note that the source and measurement are always at the same port. This requirement is applicable for both the on hook and off hook case, with the DC feeding conditions as specified in clause 5.1.2. In the case of performing measurements at frequencies above the voiceband, for reasons of practical testing a 150 Ω impedance should be used in series with the longitudinal source (i.e. S1 in figure 11 should be open).

Table 7: Unbalance about earth, test setups

#Test setup	Source and Measurement	State of S2
1	POTS	open
2	POTS	closed
3	LINE	closed

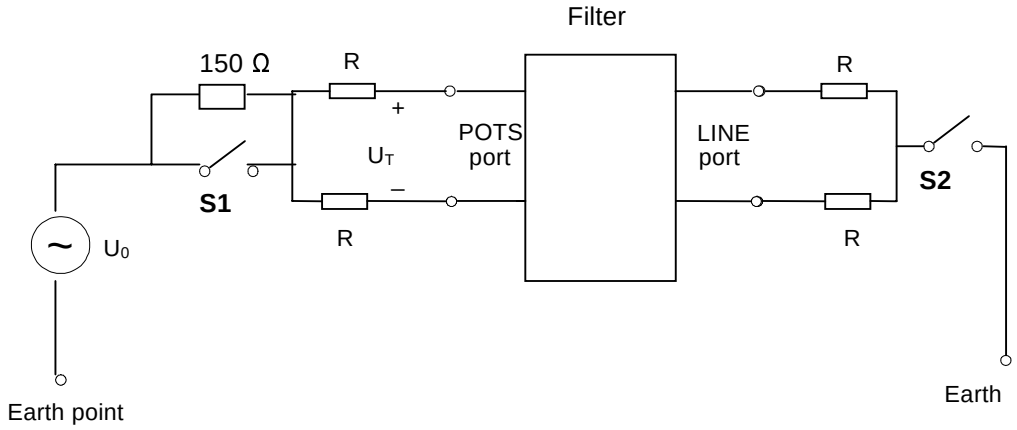
For each of the test setups described above, the splitter shall meet the unbalance about earth requirements as specified in table 8.

Table 8: Unbalance about earth, minimum values

Frequency range	State of S1	Value of R	Minimum Unbalance value
50 Hz to 600 Hz	Closed	300 Ω	40 dB
600 Hz to 3 400 Hz	Closed	300 Ω	46 dB
3 400 Hz to 4 000 Hz	Closed	300 Ω	40 dB
4 kHz to 30 kHz	Open	50 Ω	40 dB
30 kHz to 1 104 kHz	Open	50 Ω	45 dB
1 104 kHz to 5 MHz	Open	50 Ω	30 dB

The unbalance about earth is calculated by using the following equation:

$$\text{Unbalance} = 20\log_{10}\left|\frac{U_0}{U_T}\right| \qquad (\text{dB})$$



NOTE 1: The DC current feeding circuitry is not shown. Care should be taken that this circuitry is implemented in such a way as not to have significant influence on the accuracy of the measurement.
NOTE 2: For resistances R an equivalent circuit according to ITU-T Recommendation O.9 [5] can be used.

Figure 11: Unbalance about earth test setup

The test should be performed while the filter is placed on an earthed metal plate of a sufficiently large size.

6.9 ADSL band requirements

6.9.1 On-hook loss

The on-hook DC feeding conditions are specified in clause 5.1.2.

Table 9: On-hook loss, minimum values

Frequency range	Minimum value
32 kHz to 350 kHz	30 dB
350 kHz to 1 104 kHz	55 dB

The test setup for measuring isolation from Line Port to POTS Port is given in figure 12.

The test setup for measuring isolation from POTS Port to Line Port is given in figure 13.

NOTE: A distributed filter has only two ports: A Line port and a POTS port. The Line port is also the DSL port.

Table 10: Impedances applied for on-hook loss

	Distributed filter		
Test Direction	Impedance Z	POTS port Impedance	Line Port Impedance
Line (DSL) to POTS	Z_{RHF}	Z_{ONHI}	Z_{DSL}
POTS to Line (DSL)	Z_{RHF}	Z_{RHF}	Z_{DSL}

- Level of the test signal = -6,0 dBV emf.

In this case the isolation is defined as 20 log(V1/V2) where V1 is the source emf and V2 is the voltage appearing across the load at the POTS port.

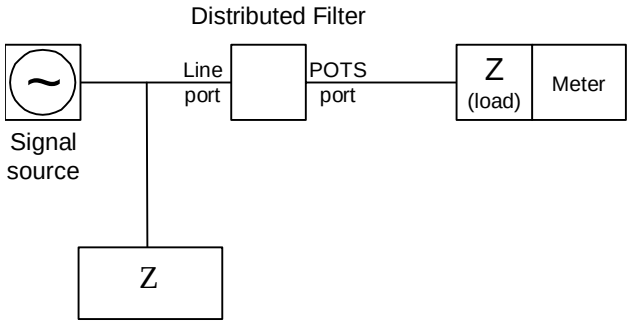


Figure 12: Isolation test setup (Line Port to POTS Port)

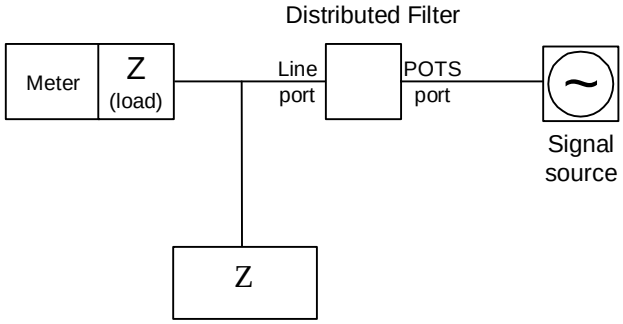


Figure 13: Isolation test setup (POTS Port to Line Port)

6.9.2 Off-hook isolation

The test setups to be used are given in figures 12 and 13, i.e. the isolation is to be measured at both the POTS and LINE ports. The off-hook DC feeding conditions are specified in clause 5.1.2. The impedances are given in table 11.

Table 10: Impedances applied for off-hook isolation

	Distributed filter		
Test Direction	Impedance Z	POTS port Impedance	Line Port Impedance
Line to POTS	Z_{DSL}	Z_{RHF}	Z_{RHF}
POTS to Line	Z_{DSL}	Z_{RHF}	Z_{RHF}

- level of the test signal = -6 dBV emf

The off-hook insertion loss requirement in table 11 and figure 14 shall be fulfilled.

Table 11: Isolation, minimum value in the case of return loss Option A and B (see figure 13a)

Frequency range	Minimum value
32 kHz to 200 kHz	30 dB to 55 dB
200 kHz to 1 104 kHz	55 dB

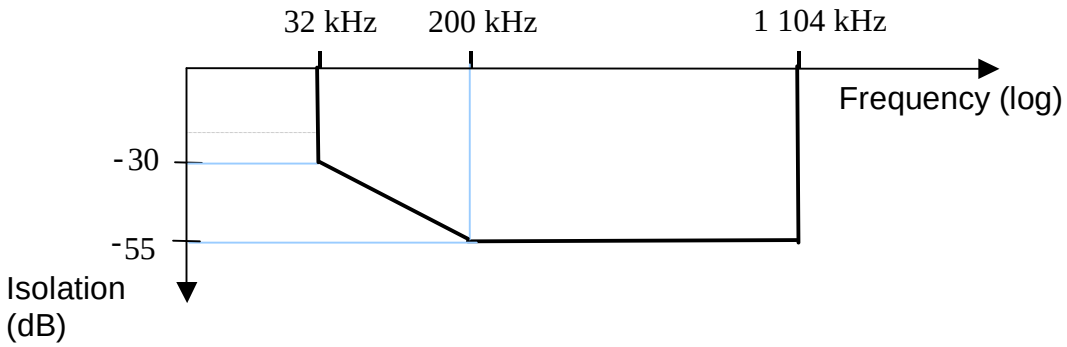


Figure 14: Isolation, minimum value in the case of return loss Option A and B

NOTE: Distributed filters have less stringent isolation requirements than central splitters below 200 kHz. Non-linearities of some telephone sets may then cause audible back-ground noise in the POTS band, disturbing the phone conversation and potentially even reducing the upstream capacity, as soon as the phone is picked-up.

6.9.3 Line side impedance in the ADSL band

The low pass filter should present an impedance to the line side of at least 1 000 Ω for the frequency range 32 kHz to 1 104 kHz. This requirement should apply with the POTS port terminated in $Z_{RHF.}$

NOTE: In the case where the filter is to be used with high frequency services such as home networking signals or VDSL, the line side impedance requirement is valid up to 12 MHz.

6.10 Noise

The noise requirements of clause 6.10.1 are valid for the off-hook condition. The noise requirements of clause 6.10.2 are valid for both the on-hook and off-hook condition. The DC feeding conditions are given in clause 5.1.2.

6.10.1 Audible noise level

The psophometric noise power, as defined in ITU-T Recommendation O.41 [4], measured at the LINE port and the POTS port of a filter, shall be less than -75 dBmp. The psophometer shall be referenced to Z_R. LINE port and POTS port should be terminated with Z_R.

6.10.2 ADSL band noise level

The noise in the frequency range 26 kHz to 1 104 kHz due to the filter, measured at the LINE port, should be less than -140 dBm/Hz measured in a bandwidth of 10 kHz.

NOTE: In the case where the filter is to be used with high frequency services such as home networking signals or VDSL, the noise requirement of clause 6.10.2 is valid up to 12 MHz.

The test setup of figure 15 shall be used.

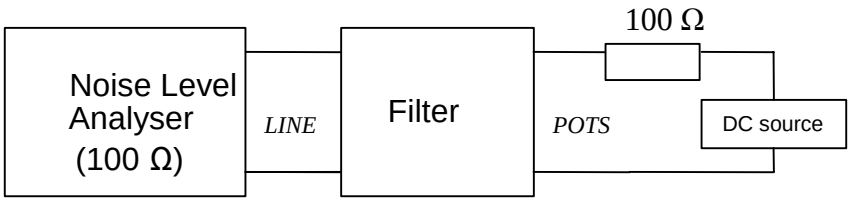


Figure 15: Test setup for measuring ADSL band noise at the LINE port

6.11 Distortion

6.11.1 POTS band intermodulation distortion

The test setup to be used is given in figure 7 with the switches S_1 and S_2 in position 1 and with only one distributed filter (DUT) connected (N = 1). Both the source and load impedance used shall be equivalent to Z_R. This requirement is valid for both the on-hook and off hook conditions. The DC feeding conditions are given in clause 5.1.2. The test signal to be used is as according to ITU-T Recommendation O.42 [2].

Using the 4-tone method at a level of -9 dBV, the second and third order harmonic distortion products shall be at least 57 dB and 60 dB, respectively below the received signal level.

The second and third order harmonics of the 4-tone signal are measured at POTS port.

NOTE: A methodology for performing this test in the presence of an ADSL signal is currently under study. This would represent a more realistic scenario for filter evaluation.

6.12 Group delay distortion

The increase of the group delay distortion by inserting one filter shall be less than the figures in table 12, relative to the lowest measured delay in the frequency range 300 Hz to 4 000 Hz.

Table 12: Group delay distortion, maximum values

Frequency range	Maximum value
200 Hz to 600 Hz	250 µs
600 Hz to 3 200 Hz	200 µs
3 200 Hz to 4 000 Hz	250 µs

- Impedance of signal source = 600 Ω (test 1)/Z_R (test 2);
- impedance of the load = 600 Ω (test 1)/Z_R (test 2);
- level of the test signal = -10 dBV.

The setup for measuring group delay distortion is given in figure 7 (N = 1). The DC feeding current is specified in clause 5.1.2. This requirement is valid for both the on hook and off hook conditions.

6.13 Requirements related to POTS transient effects

NOTE: To test how the transient signals caused by POTS affect the DSL system, a POTS transient test existed in previous versions of the present document. However, the need for this test and the test method are for further study. To keep a reference to the older version of this test, the complete text of this clause is put in annex A.

6.14 Line side impedance in the POTS band (on Hook)

This requirement is for further study.

The low pass filter should present an impedance to the line side that is greater than the impedance of a 27nF (currently suggested value) capacitor for the frequency range 0.2 kHz to 4 kHz (e.g. 29 kΩ at 0.2 kHz, 1.4 kΩ at 4 kHz). This requirement should apply with the POTS port open circuit. The DC feeding shall be as specified in clause 5.1.2 for the on-hook case.

NOTE: The return loss and the insertion loss of an arrangement of several distributed filters will be influenced by the distributed filters in the on hook state. A higher line side impedance of the distributed filters in the on hook state will have less influence on the return loss and the insertion loss of the installation.

Annex A (informative): Test related to POTS transient effects

NOTE 1: See clause 6.13.

NOTE 2: The need for this test and test method is for further study. The remaining text including figure A.1 in this clause reflects a former version of this test, which is included for information only.

The test setup is shown in figure A.1. It consists of a switch with an on/off transition time less than 2 µs on the POTS port. The resistors R_{SOURCE} are set at 1 kΩ. The DC source is set to 48 V.

The signal V_1 measured across the 1 000 Ω, due to each change of state of the switch S_1, should be less than 2 V p-p and the main lobe of the Fourier Transform of the transient has its peak at a frequency less than 15 kHz. This applies to both the on and off hook transitions of switch S_1.

NOTE 3: A possible implementation of switch S_1 is given in TR 101 728 (see Biblioraphy).

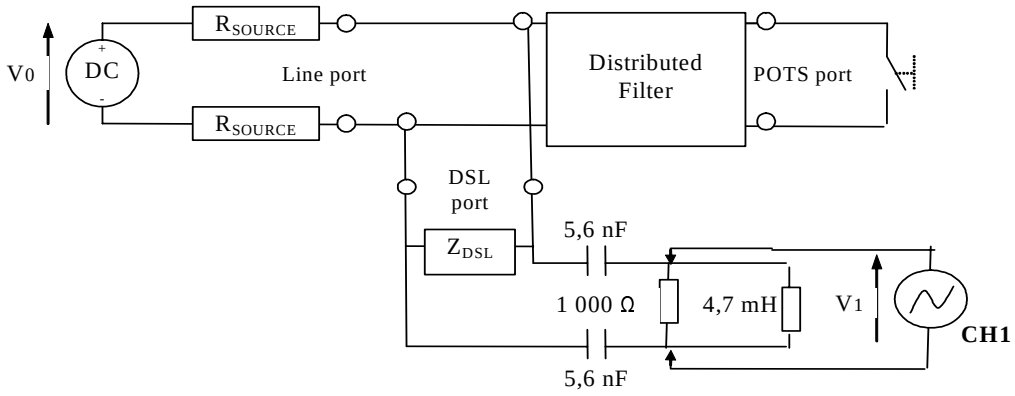


Figure A.1: Test circuit for large signal test

NOTE 4: In some cases there could be disturbances from POTS TE that could show a degree of asymmetry at higher frequencies, and therefore common mode suppression methods for filters are under study.

Annex B (informative): Bibliography

ITU-T Recommendation G.992.1: "Asymmetric Digital Subscriber Line (ADSL) transceivers".

ITU-T Recommendation G.117: "Transmission aspects of unbalance about earth".

ETSI EN 300 001: "Attachments to the Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN".

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

ETSI TS 102 080: "Transmission and Multiplexing (TM); Integrated Services Digital Network (ISDN) basic rate access; Digital transmission system on metallic local lines".

ETSI TS 101 952-1-2: "Access network xDSL transmission filters; Part 1: ADSL splitters for European deployment; Sub-part 2: Specification of the high pass part of ADSL/POTS splitters".

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

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".

ETSI TR 102 139: "Compatibility of POTS terminal equipment with xDSL systems".

History

Document history		
V1.1.1	May 2003	Publication
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