

**Access network xDSL transmission filters;  
Part 1: ADSL splitters for European deployment;  
Sub-part 1: Specification of the low pass part of  
ADSL/POTS splitters**

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Reference

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## Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access and Terminals (AT) and in co-operation with ETSI Technical Committee Transmission and Multiplexing (TM).

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

**Part 1: "ADSL splitters for European deployment";**

**Sub-part 1: "Specification of the low pass part of ADSL/POTS splitters";**

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 for ADSL/ISDN or POTS' universal splitters";

Sub-part 5: "Specification for ADSL/POTS distributed splitters".

Part 2: "VDSL splitters for European deployment".

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

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.

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# 1 Scope

The present document specifies requirements and test methods for DSL splitters. These splitters are intended to be installed at the Local Exchange side of the local loop and at the user side near the NTP. In the case of splitters at the user side, the present document specifies the master splitter that is intended for use at the demarcation point of the customer premises. Distributed splitters are not within the scope of the present document.

The present document specifies requirements and test methods for the low pass part of ADSL/POTS splitters.

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# 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.

- [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] ETSI TR 102 139: "Compatibility of POTS terminal equipment with xDSL systems".
- [3] ITU-T Recommendation O.42: "Equipment to measure non-linear distortion using the 4-tone intermodulation method".
- [4] ETSI TBR 021: "Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to the analogue Public Switched Telephone Networks (PSTNs) of TE (excluding TE supporting the voice telephony service) in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signalling".
- [5] ETSI TR 101 728: "Access and Terminals (AT); Study for the specification of low pass section of POTS/ADSL splitters".
- [6] ITU-T Recommendation O.41: "Psophometer for use on telephone-type circuits".
- [7] ITU-T Recommendation O.9: "Measuring arrangements to assess the degree of unbalance about earth".

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# 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

**distributed splitter:** splitter implementation that is valid only at the CP end of the loop

NOTE: For this implementation, a low pass filter is added in series with each of the parallel POTS TE. This configuration of parallel connected filters (by the in-house cabling) is known as a distributed splitter. These filters are also known as In-line filters, microfilters, and distributed filters.

**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 [4].

**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 [4].

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 shall the CPE be considered to be on hook from the perspective of testing the splitter.

**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

## 3.2 Abbreviations

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

AC	Alternating Current
ADSL	Asymmetric Digital Subscriber Line
CO	Central Office (Local Exchange)
CP	Customer Premise
CPE	Customer Premise Equipment
DC	Direct Current
HPF	High Pass Filter
ITU	International Telecommunication Union
LE	Local Exchange (Central Office)
NTP	Network Termination Point
POTS	Plain Old Telephone Service
TE	Terminal Equipment
NOTE:	(e.g. Telephone, Fax, voice band modem etc.)
THD	Total Harmonic Distortion

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## 4 General functional description of ADSL/POTS splitters

The main purpose of the ADSL/POTS splitter filter is to separate the transmission of POTS signals and ADSL signals, enabling the simultaneous transmission of both services on the same twisted pair. The splitter also serves to protect POTS from interference due to egress (and ingress) from ADSL signals. Equally it protects the ADSL 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).

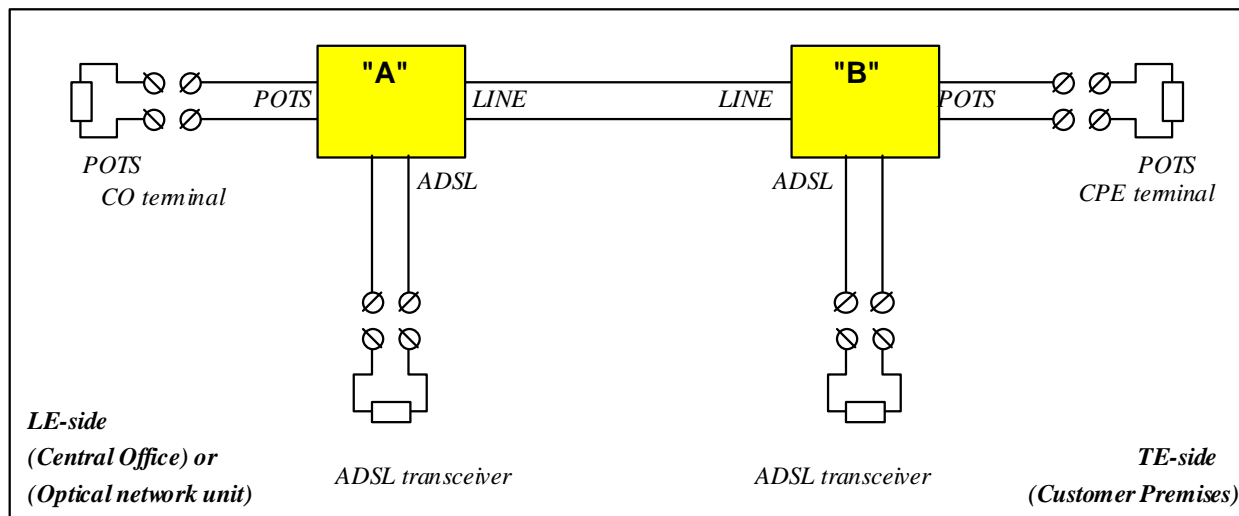
Information on various implementations of ADSL/POTS splitters is given in TR 101 728 [5].

Insertion of a splitter filter in existing POTS lines shall only have a low impact on the performance of these services.

The splitter filter may be implemented as an independent unit, separately from the ADSL transceiver, or may be integrated with the ADSL termination unit.

## 4.1 Functional diagram

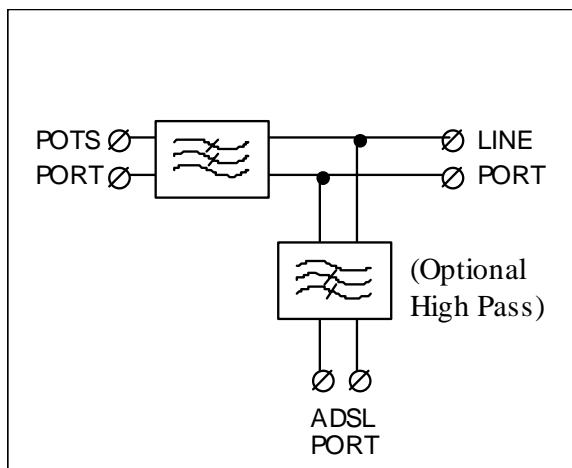
The functional diagram for the splitter combination is given in figure 1.



**Figure 1: Functional diagram of the DSL splitter configuration**

The transfer functions between the different ports of the splitter can be understood as follows:

- The transfer function from port "POTS" to "LINE" and vice-versa is that of a low-pass filter.
- A high level of isolation is required from port "ADSL" to "POTS" to prevent undesirable interaction between DSL and any existing narrowband services.
- The transfer function from port "ADSL" to "LINE" 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 ADSL transceiver (see part 1, sub-part 2 of TS 101 952).



**Figure 2: Structure of the ADSL splitter 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 current (on/off hook conditions)

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

- On-hook requirements, when the POTS CPE terminal equipment is in the on-hook state.
- Off-hook requirements, when the POTS CPE terminal equipment is in the off-hook state.
- Transitional requirements, when the POTS CPE 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 in two conditions:

- With a DC feeding voltage of 50 V, and using the impedance model  $Z_{ON}$ , as given in clause 5.2.4 of the present document.
- With a DC loop current in the range of 0,4 mA to 2,5 mA flowing through the splitter; and using an impedance model of 600  $\Omega$  to terminate the LINE and POTS port of the splitter at voice frequencies.

On-hook ADSL band electrical requirements shall be met in the following condition:

- With a DC feeding voltage of 50 V, and using the impedance model  $Z_{ON}$ , as given in clause 5.2.4 of the present document.

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 of the present document.

## 5.2 Terminating impedances

### 5.2.1 $Z_{ADSL-1}$ and $Z_{ADSL-2}$

In many of the tests with voice frequencies, the ADSL port of the low pass filter is terminated with an impedance called  $Z_{ADSL-1}$ . This impedance model represents the input impedance of the ADSL transceiver (with the HPF), as seen from the low pass filter. This substitute circuit shown in figure 3 is a model which shall be applied to a POTS splitter when verifying requirements of the low pass filter. The model is intended for splitter specification in the context of the present document. The purpose of this model impedance is for splitter specification, it is not a requirement on the input impedance of the ADSL transceiver.

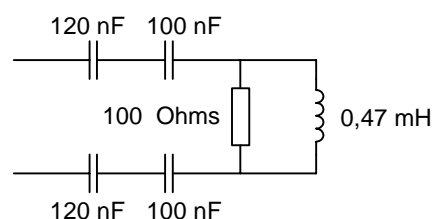
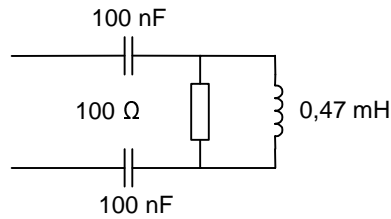


Figure 3: Schematic diagram of the impedance  $Z_{ADSL-1}$

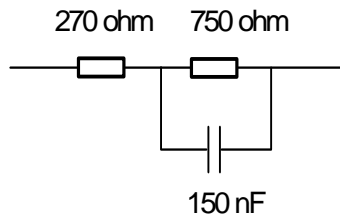
From the perspective of practical testing, the impedance model of figure 3 is valid for the case where the splitter does not contain blocking capacitors or a third order high pass filter. In the case where either of these are present, the impedance network of figure 4 shall be used to terminate the ADSL port of the splitter.



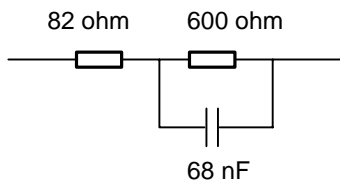
**Figure 4: Schematic diagram of  $Z_{\text{ADSL-2}}$  for the case where there is a high pass filter or blocking capacitors present in the splitter unit**

### 5.2.2 $Z_{\text{R}}$ and $Z_{\text{SL}}$

For most requirements relating to voice band frequencies described in the present document, either the terminating impedances  $Z_{\text{R}}$  or  $Z_{\text{SL}}$  is used to terminate the POTS port or the Line port.  $Z_{\text{R}}$  is the European harmonized complex impedance,  $Z_{\text{SL}}$  is an impedance used in TBR 038 [1] to simulate a short line terminated in 600  $\Omega$ .



**Figure 5: Impedance  $Z_{\text{R}}$**



**Figure 6: Impedance  $Z_{\text{SL}}$**

**NOTE:** In the case of splitters to be deployed by some network operators, alternative models of reference impedances instead of  $Z_{\text{R}}$  are currently used when matching the splitter requirements. These models are in annex A of the present document.

### 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 low pass filter. This is the European harmonized complex impedance  $Z_R$  with the modification proposed in TR 102 139 [2]. This network is shown in figure 7.

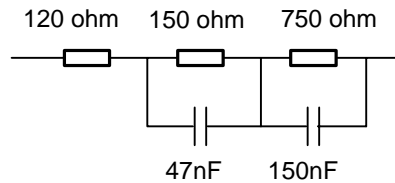


Figure 7: Impedance  $Z_{RHF}$

### 5.2.4 $Z_{ON}$

For some on-hook requirements (as defined in clause 5.1.2) described in the present document, the terminating impedance  $Z_{ON}$  is used.

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.

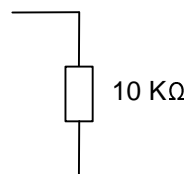


Figure 8: Impedance model to be used for some on-hook requirements

## 5.3 General transmission test set-up

For many of the transmission related tests that are specified in the present document, a common general test setup is valid. This test set-up is given in figures 9 and 10, for measurements at the LINE port and POTS port respectively.

It is required that a splitter also fulfils all requirements (with the exception of those specified in clauses 6.8, 6.10.2 and 6.13) if there is no ADSL load connected to the splitter.

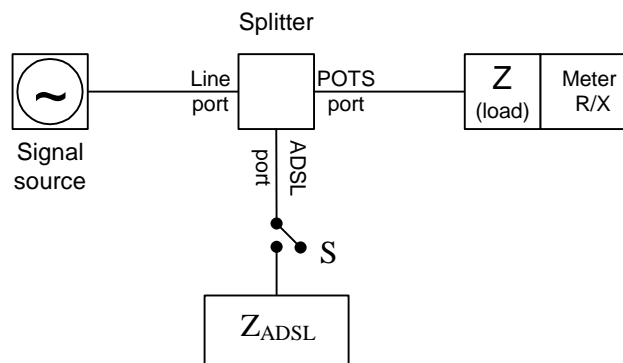


Figure 9: Test set up for transmission testing from LINE to POTS

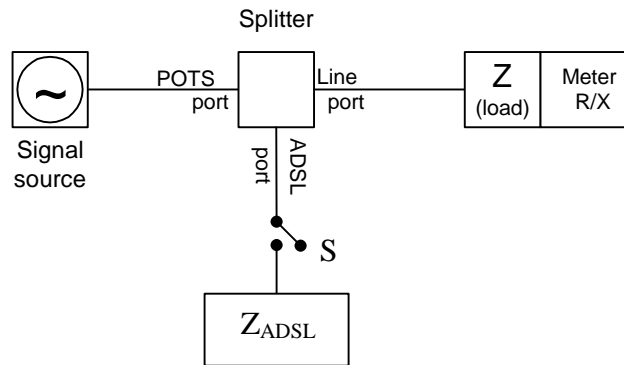


Figure 10: Test set up for transmission testing from POTS to LINE

## 6 Splitter requirements

### 6.1 Options for splitter 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 (clause 6.5), and that concerning off-hook isolation (clause 6.9.2).

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 splitter. These can be broadly considered as in clauses 6.1.1 and 6.1.2.

#### 6.1.1 Option A splitters

- Option A splitters 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 splitters 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 splitters

- Option B splitters 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 splitter and earth, when tested with 100 V DC, shall not be less than 20 M $\Omega$ .

This requirement only applies to splitters with a terminal directly connected to earth.

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

The DC resistance between the A-wire and B-wire terminal of the splitter, when tested with 100 V DC, shall not be less than 5 M $\Omega$ .

In the case where the splitter is fitted with a signature network, measurement of the DC isolation resistance becomes more difficult. Possible solutions include a switching system in order to open circuit the signature network for the measurement, or indeed performing the measurement before the signature network is added to the splitter card. It is left to the individual operator to determine how this measurement should be carried out. Depending on the particular test methodology used, the requirement shall be set accordingly.

### 6.2.3 DC series resistance

The DC resistance from the A-wire to the B-wire at the Line interface with the POTS terminal shorted, or at the POTS interface with the Line terminal shorted shall be less than or equal to 50  $\Omega$ .

This requirement shall be met for the feeding conditions described in clause 5.1.2 for both on and off hook conditions.

## 6.3 Ringing frequency 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 splitter, in the test set-up of figure 9, shall be not more than 2 V<sub>rms</sub>.

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

Impedance of signal source	850 $\Omega$ (resistive)
Impedance of the load	2,7 k $\Omega$ + 2,2 $\mu$ F at 25 Hz 2,7 k $\Omega$ + 1,0 $\mu$ F at 50 Hz
Open voltage of the AC test signal source	35 V <sub>rms</sub>
Level of the DC feeding voltage	60 V DC

### 6.3.2 Impedance at 25 Hz and 50 Hz

The POTS port and the Line port of the splitter 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 k $\Omega$ . When testing at either the POTS port or the LINE port all other ports are open circuit.

### 6.3.3 Total harmonic distortion at 25 Hz and 50 Hz

The splitter 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 than 10 %.

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

Impedance of signal source	850 $\Omega$ (resistive)
Impedance of the load	2,7 k $\Omega$ + 2,2 $\mu$ F at 25 Hz 2,7 k $\Omega$ + 1,0 $\mu$ F 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 Pass band loss requirements (on-hook)

### 6.4.1 On hook requirement for the case of high impedance injection

The magnitude of the voltage gain of the splitter 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. A DC voltage of 50 V shall be used. The test set ups are given in figures 9 and 10.

The test shall be executed with the combinations of source and load impedances in table 3.

NOTE: Different test set-ups are used in the case where the splitter is for the LE-side or TE-side (as defined in figure 1).

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

Splitter Type	Test setup reference	Impedance of signal source	Impedance of the load
LE	Figure 10	$Z_R$	$Z_{ON}$
TE	Figure 9	$Z_R$	$Z_{ON}$

Level of the test signal = -4 dBV emf.

### 6.4.2 On hook requirement for the case of low impedance injection

#### 6.4.2.1 On-hook insertion loss

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

The test set ups are given in figures 9 and 10. The off-hook pass band insertion loss shall be measured according to both figures 9 and 10 for either an LE or and TE splitter. In either case both the source and load shall be set at 600  $\Omega$ . This requirement is valid for DC current in the range from 0,4 mA to 2,5 mA.

#### 6.4.2.2 On-hook 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 than 1 dB.

The off-hook pass band insertion loss distortion shall be measured according to both figures 9 and 10 for either an LE or a TE splitter. In either case both the source and load shall be set at 600  $\Omega$ . This requirement is valid for DC current in the range 0,4 mA to 2,5 mA.

## 6.5 Pass band loss requirements (off-hook)

### 6.5.1 Off-hook pass band insertion loss

The insertion loss of one splitter shall be less than 1 dB at 1 kHz.

The test set ups are given in figures 9 and 10. The off-hook passband insertion loss shall be measured according to both figures 9 and 10 for either an LE or a TE splitter.

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**

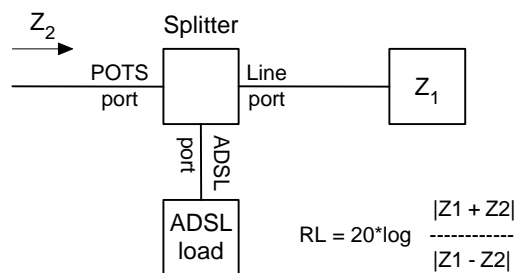
Source/Load combination	Impedance of signal source	Impedance of the load
Combination 1	$Z_R$	$Z_R$
Combination 2	600 $\Omega$	600 $\Omega$

### 6.5.2 Off-hook 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 than 1 dB. The test shall be executed with both combinations of source and load impedances in table 4. The test set-ups are described in figures 9 and 10, the off-hook DC feeding current is specified in clause 5.1.2.

## 6.6 Passband return loss requirements (off-hook)

The return loss at both the POTS and Line port of the splitter shall be measured according to figures 9 and 10. The definition of return loss (for the case of a measurement at the POTS port) is given in figure 11.



**Figure 11: Definition of return loss at the POTS port**

There are two options for return loss testing. The following test set-ups and requirements are equally applicable to the LE and TE splitters. 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.

NOTE: Option A is appropriate for networks where the population of existing terminals or network presentations includes equipment designed against several different reference impedance values (e.g. 600  $\Omega$ , harmonized European reference impedance  $Z_R$ , other complex impedances), such that it is felt that one single reference impedance is insufficient to accommodate the needs of all terminals and network presentations. Due to the wide range of impedances which are accommodated, the degree of potential degradation of the POTS service introduced by an option A ADSL splitter may not be as well controlled as in the case of option B.

**Table 5: Return loss requirements, option A**

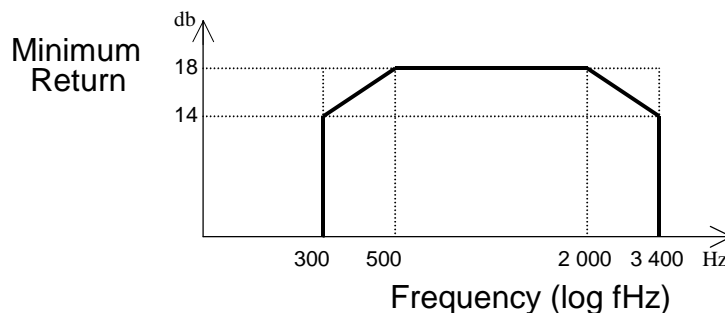
Test #	Value of $Z_1$	Frequency range	Minimum Return Loss
test 1	$Z_{SL}$	300 Hz to 3 400 Hz	12 dB
test 2	$Z_{SL}$	3 400 Hz to 4 000 Hz	8 dB
test 3	$Z_R$	300 Hz to 3 400 Hz	12 dB
test 4	$Z_R$	3 400 Hz to 4 000 Hz	8 dB

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 12.

NOTE: Option B is 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.



**Figure 12: Minimum return loss template for option B**

The reference impedance (i.e. the load impedance in figure 11) shall be  $Z_R$ .

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

In the case where pulse metering signals are deployed on the same lines as ADSL, the insertion loss due to the splitter 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 of in the range 3 dB to 5 dB per splitter should be suitable for many European networks.



The test set up of figures 9 and 10 shall be used, using the condition of table 6. The level of the test signal is 3,53 Vrms. This requirement is valid only for the off-hook condition, with DC current as specified in clause 5.1.2.

**Table 6: Conditions for insertion loss test at 12 kHz or 16 kHz**

Level of source voltage	Impedance of signal source	Impedance of the load (Z in figures 9 and 10)	Impedance at the ADSL port
3,53 Vrms	200 Ω	200 Ω	Z <sub>ADSL</sub>

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 set-up for measuring unbalance at the POTS port is shown in figure 13. In the case of measuring at the LINE port, the test set-up of figure 13 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 a DC current of 13 mA to 80 mA flowing through the splitter. 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 13 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

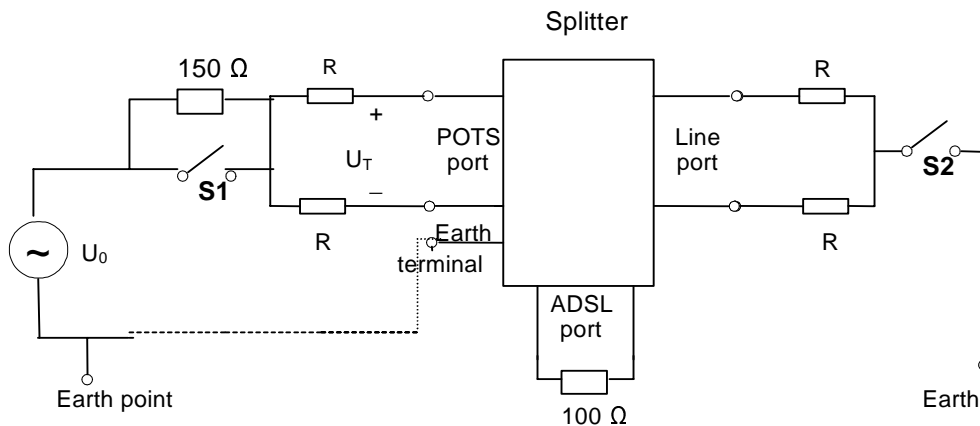
The ADSL port shall be terminated a 100 Ω resistor for all unbalance tests described in the present document. For each of the three test set-ups described above, the splitter shall meet the unbalance about earth requirements as specified in table 8.

**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:

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



- NOTE 1: The dotted circuit is only used if the splitter has an earth terminal.
- NOTE 2: 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 3: For resistances R an equivalent circuit according to ITU-T Recommendation O.9 [7] can be used.

**Figure 13: Unbalance about earth test set-up**

If the splitter has no earth terminal, the test should be performed while the splitter is placed on an earthed metal plate of a sufficiently large size.

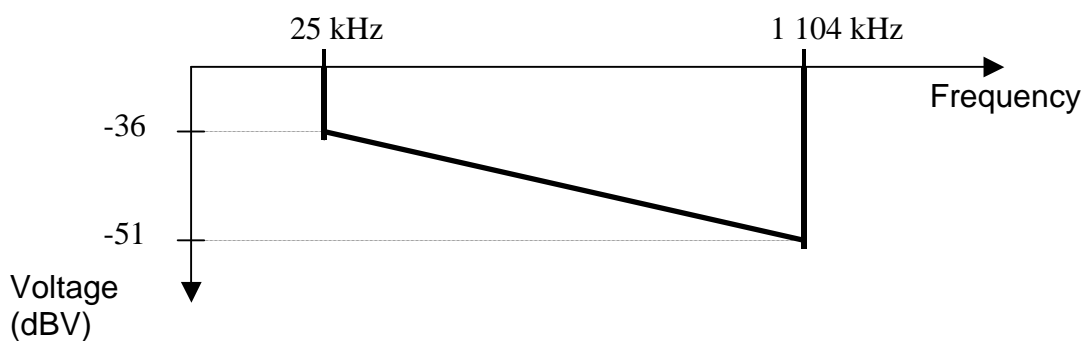
## 6.9 ADSL band loss requirements

### 6.9.1 On-hook loss requirements

Applying an input test signal of -6 dBV emf to either the POTS or LINE port of the splitter, the maximum output voltage level measured over the load impedance shall be below the template of figure 14. The DC feeding conditions for the on-hook condition are given in clause 5.1.2.

The test setups are given in figures 9 and 10.

The test shall be executed with the combinations of source and load impedances in table 9.



**Figure 14: On-hook voltage gain template (maximum allowed output voltage with input of -6dBV)**

**Table 9: Source and load impedances for the on hook isolation test**

Splitter Type	Test setup reference	Impedance of signal source	Impedance of the load
LE	Figure 9	$Z_{RHF}$	$Z_{ON}$
TE	Figure 10	$Z_{RHF}$	$Z_{ON}$

## 6.9.2 Off-hook isolation requirements

In the case where the return loss requirement of option A (see clause 6.6.1.1) is used in specifying the splitter, the off-hook isolation requirement of table 10 shall be fulfilled.

In the case where the return loss requirement of Option B (see clause 6.6.1.2) is used in specifying the splitter, the off-hook isolation requirement of table 11 shall be fulfilled.

The test setups to be used are given in figures 9 and 10, 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 splitter shall also fulfil the requirements if the signal source is connected to the ADSL port and the Line port is terminated with  $Z_{RHF}$ .

**Table 10: Isolation, minimum value in the case of return loss option A**

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

**Table 11: Isolation, minimum value in the case of return loss option B**

Frequency range	Minimum value
32 kHz to 138 kHz	45 dB
138 kHz to 1 104 kHz	55 dB

- Impedance of signal source =  $Z_{RHF}$ ;
- impedance of the load =  $Z_{RHF}$ ;
- level of the test signal = -6 dBV emf.

## 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 requirements

The psophometric noise power, as defined in ITU-T Recommendation O.41 [6], measured at the LINE port and the POTS port of a splitter, shall be less than -75 dBmp. The psophometer shall be referenced to  $Z_R$ . LINE port and POTS port should be terminated with  $Z_R$ . The ADSL port is terminated with the ADSL load as defined in clause 5.2.1.

### 6.10.2 ADSL band noise level requirements

In the case of a LE splitter, the noise in the frequency range 26 kHz to 1 104 kHz due to the splitter, measured at the both the ADSL port and at the LINE port, should be less than -125 dBm/Hz measured in a bandwidth of 10 kHz.

In the case of a TE splitter, the noise in the frequency range 26 kHz to 1 104 kHz due to the splitter, measured at the both the ADSL port and at the LINE port, should be less than -140 dBm/Hz measured in a bandwidth of 10 kHz.

The test set-ups of figures 15 and 16 shall be used.

- NOTE: It assumed that the splitter contains no blocking capacitors or high pass filter. In the case where either of these is present, the termination at the ADSL port shall be modified according to figure 4.

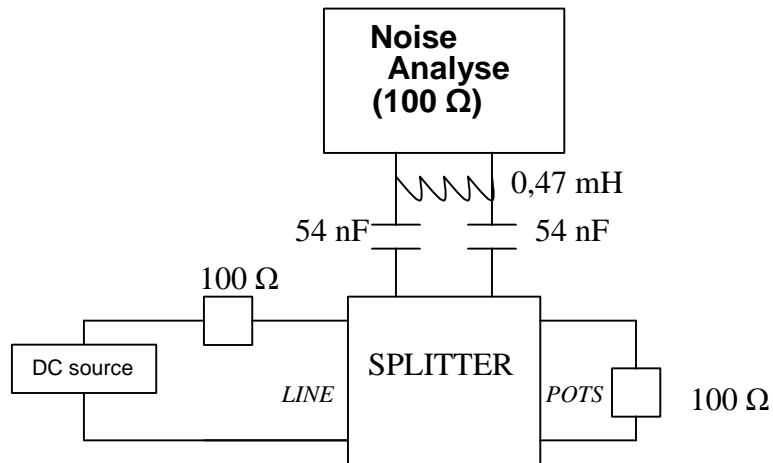


Figure 15: Test set-up for measuring ADSL band noise at the ADSL port

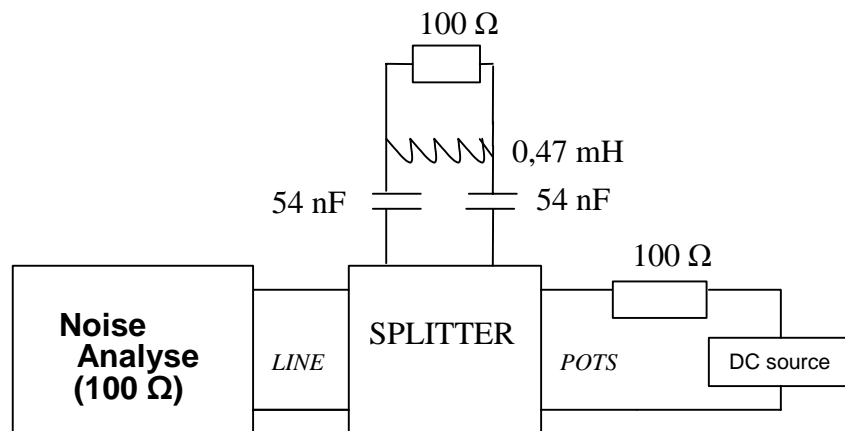


Figure 16: Test set-up for measuring ADSL band noise at the LINE port

## 6.11 Distortion and intermodulation distortion

### 6.11.1 POTS band intermodulation distortion requirements

The test setup to be used is given in figure 9. 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 [3].

Using the 4-tone method at a level of -9 dBm, 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 splitter evaluation.

## 6.12 Group delay distortion

The increase of the group delay distortion by inserting one splitter 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 $\mu$ s
600 Hz to 3 200 Hz	200 $\mu$ s
3 200 Hz to 4 000 Hz	250 $\mu$ s

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

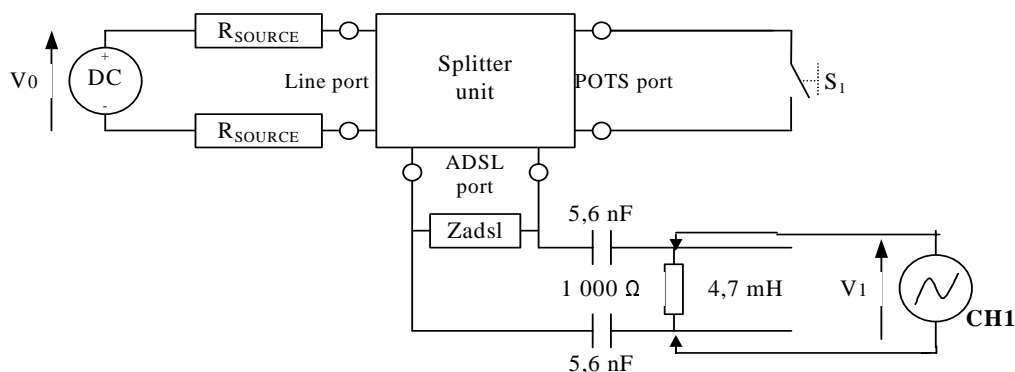
The set-up for measuring group delay distortion is given in figure 9. The DC feeding current is specified in clause 5.1.2. This requirement is valid for both the on hook and off hook conditions.

## 6.13 Requirements related to POTS transient effects

The test set-up is shown in figure 17. It consists of a switch with an on/off transition time less than 2  $\mu$ s on the POTS port. The resistors  $R_{SOURCE}$  are set at 1 k $\Omega$ . The DC source is set to 48 V.

The signal  $V_1$  measured across the 1 000  $\Omega$ , 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: A possible implementation of switch  $S_1$  is given in TR 101 728 [5].

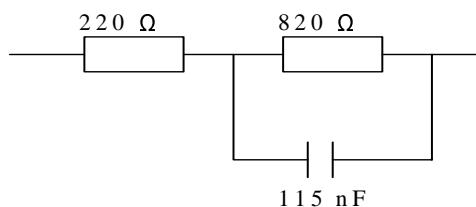


**Figure 17: Test circuit for large signal test**

NOTE: 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 splitters are under study.

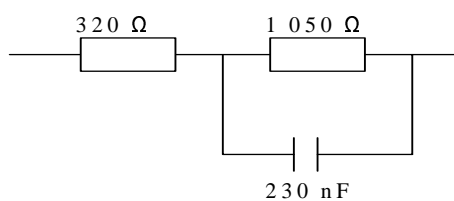
## Annex A (informative): Telephony matching impedances

Although it is preferable to have a single test impedance equal to that described in figure 5, it is recognized that some European operators are using alternative impedance models. For POTS operation in the Deutsche Telecom AG network, the following compromise matching impedance is currently used when meeting the splitter requirements.



**Figure A.1: Compromise reference impedance used by Deutsche Telecom AG (voice terminals)**

For POTS operation in the British Telecom plc network, the following compromise matching impedance is currently used when meeting the splitter requirements.



**Figure A.2: Compromise reference impedance used by British Telecom plc (voice terminals)**

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## 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".

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## History

<b>Document history</b>		
V1.1.1	May 2002	Publication