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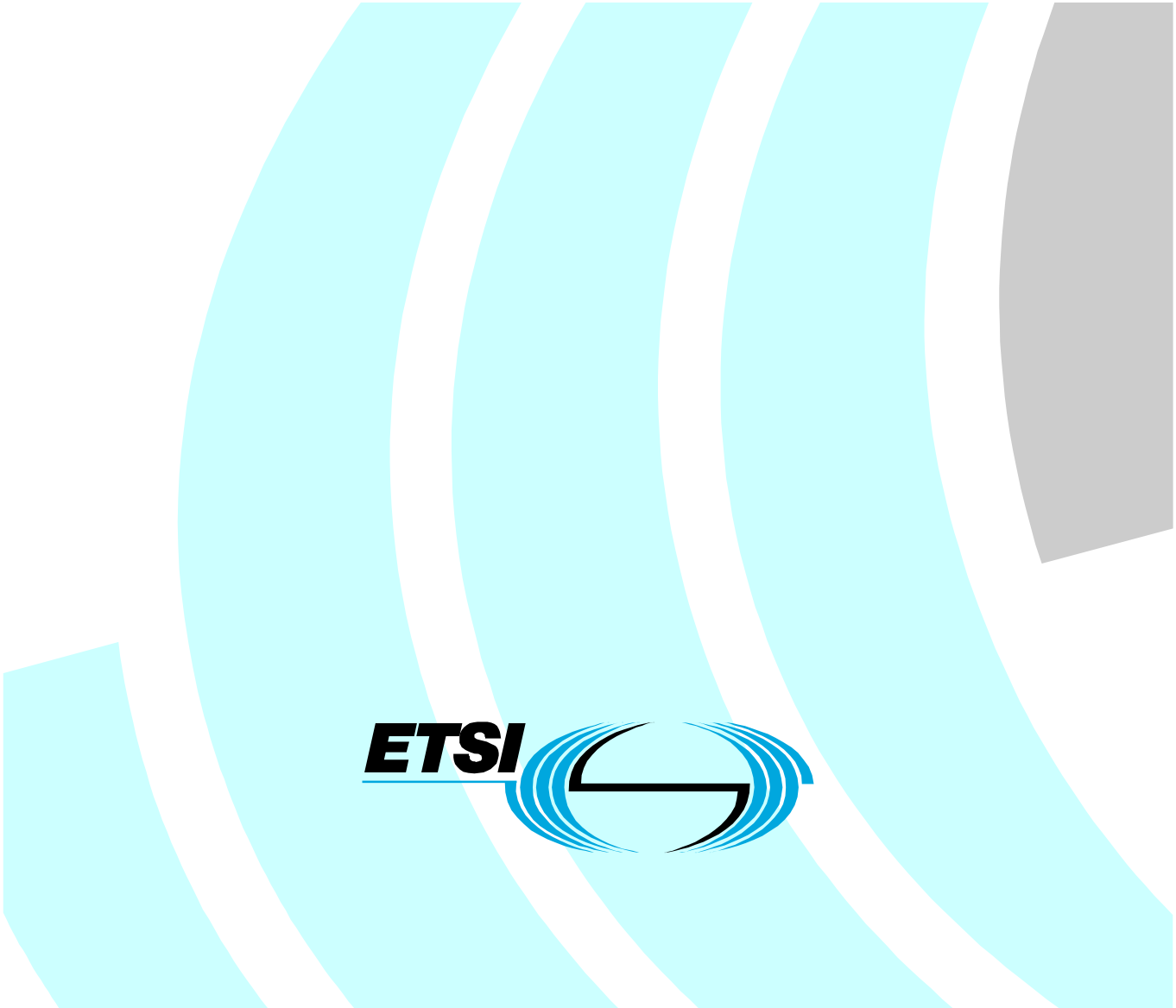
Technical Report

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



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ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

The present document is part 1, sub-part 2 of a multi-part deliverable supporting different aspects of European Specific DSL splitters, as identified below:

Part 1: "ADSL splitters for European Deployment";

Sub-part 1: "Specification of Testing methods for Low Pass part of ADSL/POTS splitters";

Sub-part 2: "Testing methods for High Pass part of ADSL/POTS splitters";

Sub-part 3: "Testing methods for ADSL/ISDN splitters";

Part 2: "VDSL splitters for European deployment".

NOTE: The choice of a multi-part format for this deliverable is to facilitate maintenance and future enhancements.

Introduction

The present document describes test methods for the high pass part of ADSL/POTS splitters.

The test methods of the present technical report are based on requirements of different documents describing ADSL/POTS splitters:

- TS 101 952-1-2 [10]: "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";
- TR 101 728 [8]: "Access and Terminals (AT); Study for the specification of low pass filter section of ADSL/POTS splitters";
- TS 101 388 [2]: "Transmission and multiplexing (TM); Access transmission systems on metallic access cables; Asymmetric Digital Subscriber Line (ADSL) - European specific requirements [ITU-T Recommendation G.992.1 modified]";
- ITU-T Recommendation G.992.1 [5]: "Asymmetric Digital Subscriber Line (ADSL) transceivers; Annex E (E1. Type 1 - European)".

The requirements from TR 101 728 [8], TS 101 952-1-2 [10] and the present document are assessed to be the "essential" or minimum tests. The additional tests that are required in ITU-T Recommendation G.992.1 [5] have been assessed as "optional" tests. There are two columns in each test matrix which inform about the "essential" and the "optional" tests.

For each test, the document describes:

- title of the test;
- purpose of the test;
- reference to the specifications;
- test configuration;
- test set-up;
- test parameters;
- test results matrix;
- measuring notes.

1 Scope

The present document describes test methods for the high pass section of ADSL/POTS 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 describes testing methods for the master splitter that is intended for use at the demarcation point of the customer premises. Distributed filters are not concerned by the present document.

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] Void.

[2] ETSI TS 101 388: "Transmission and multiplexing (TM); Access transmission systems on metallic access cables; Asymmetric Digital Subscriber Line (ADSL) - European specific requirements [ITU-T Recommendation G.992.1 modified]".

[3] Void.

[4] Void.

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

[6] 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".

[7] Void.

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

[9] Void.

[10] 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".

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

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: i.e. the state where the TE draws insufficient DC current to activate the POTS exchange. 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 should the CPE be considered to be on hook from the perspective of testing the splitter.

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: i.e. the state where the TE draws sufficient DC current to activate the POTS exchange (excluding the transitions from and to quiescent state).

3.2 Abbreviations

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

ADSL	Asymmetric Digital Subscriber Line
CPE	Customer Premises Equipment
dBm	Absolute power level expressed in decibels relative to 1 mW
DC	Direct Current
DUT	Device Under Test
I	Current
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
LE	Local Exchange (Central Office)
NF	Narrow-band Frequency
NTP	Network Termination Point
POTS	Plain Old Telephone Service
R	Resistance
TE	Terminal Equipment (e.g. Telephone, Fax, voice band modem etc.)
U	Voltage
Z	Impedance

4 Void

5 Test conditions and general notes

For each test, feeding bridge and holding circuit must comply to the requirements as specified in TBR 038 [6] with respect to the low frequency range. Similar performance is required for the high frequency range (up to 1 MHz). An equivalent accuracy may be obtained by calibrating the feeding bridge and holding circuit across the relevant frequency range.

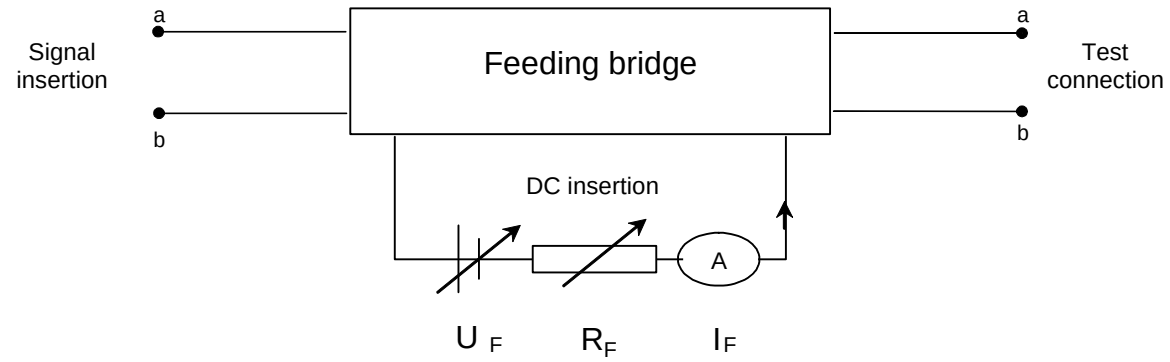


Figure 1: External circuitry for feeding bridge

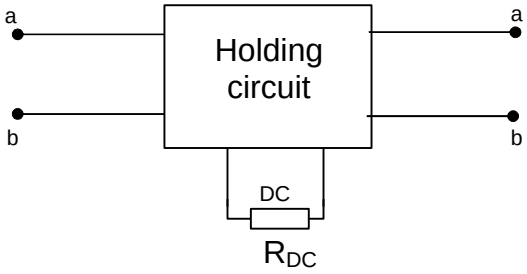


Figure 2: External circuitry for holding circuit

NOTE 1: Direction of the feeding current may impact the additional insertion loss caused by feeding bridge and holding circuit. A calibration/normalization measurement need to be taken before each single measurement step.

NOTE 2: When a test is proposing "alternating polarity" the test should be performed in a way that the direction of the feeding current is changed from test to test (e.g. when a test is to be performed with 0, 20, 60, 80 mA using alternating polarity the test should be performed with +0 mA, -20 mA, +60 mA, -80 mA).

NOTE 3: The connection of the DC feeding is essential, i.e. for LE splitters the feeding bridge should be connected to the POTS port and the holding circuit should be connected to the LINE port. For TE splitters the feeding bridge should be connected to the LINE port and the holding circuit should be connected to the POTS port. The feeding arrangements shown in the test set-ups in the present document are generally for testing TE splitters.

NOTE 4: The inaccuracy of the measurement which results from tolerances in the test set-up and its containing equipment should be carefully considered. When giving a verdict on the test results with respect to the requirement in the related standard this tolerance in the test results need to be taken into account.

Before splitters are tested the class of splitter should be categorized. Basis for this could be the schematic of the splitter or a statement of the manufacturer. The following classes have been identified so far in the course of this project:

- **passive**: splitters which do exclusively contain passive components;
- **passive with current/voltage detection**: splitters which perform NF filtering using passive components, which are enhanced by detection circuits based on the DC voltage and/or the DC current;
- **active**: splitters which contain active components (like OP amplifier) to perform the NF filtering.

NOTE 5: The splitters which have been evaluated during the validation of the test methods described herein are to be classified in clusters "passive" or "passive with current/voltage detection". No "active" splitters could be made available for evaluation. The results of ETSI STF 215 could be validated for the first two classes, for the third class (active splitters) theoretical test case validations have been discussed.

At some test cases in the present document, a difference is made between splitters which do not break the DC path and splitters which do break the DC path. The following drawings should give guidance for the separation of these two different types.

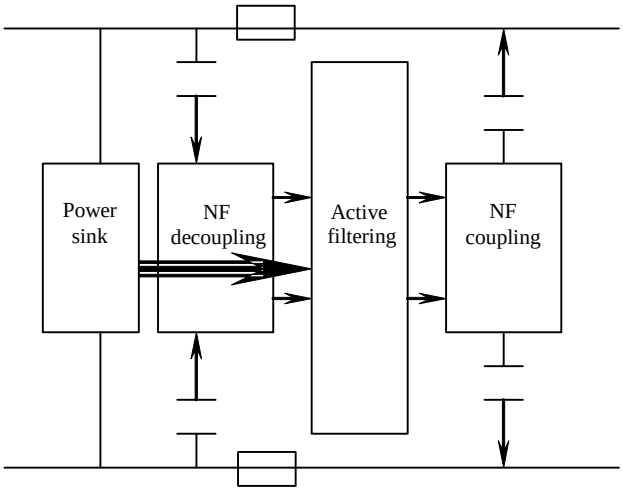


Figure 3: Example for a splitter not breaking the DC path

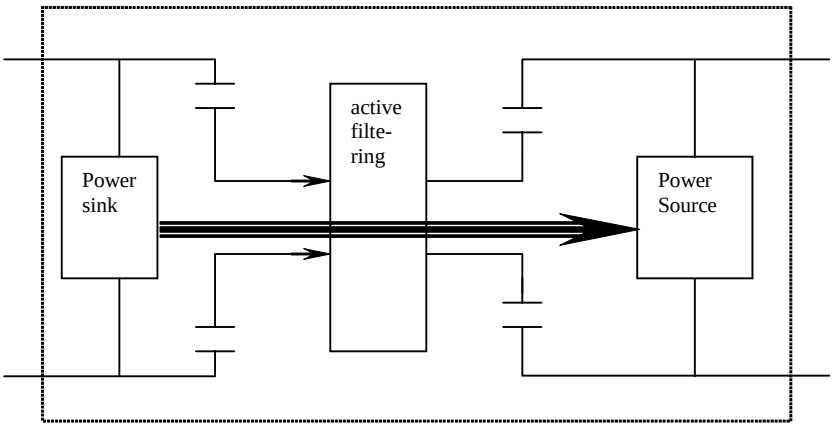


Figure 4: Example for a splitter breaking the DC path

Filters with current/voltage detection must be classified under the first type of splitter for their operating range (e.g. DC current above detection limit) and under the second type of splitter in the blocking range (e.g. DC current below detection limit).

6 Test cases for the high pass part of the ADSL over POTS splitter

The test cases described include:

- insertion loss in the pass band (ADSL) - ADSL to line;
- insertion loss in the pass band (ADSL) - Line to ADSL;
- unbalance about earth for the high pass filter.

6.1 Insertion loss in the pass band (ADSL) - ADSL to LINE

Table 1: Description of the insertion loss in the pass band (ADSL) - ADSL to LINE test case

Test case name:	insertion loss in the pass band (ADSL)
Reference:	TS 101 952-1-2 [10], clause 7.1
Test purpose:	to evaluate the insertion loss in the passband (ADSL) in when tested with the test parameters as given in the related standards
Test configuration:	see test set-up; DUT not configured

Test set up:

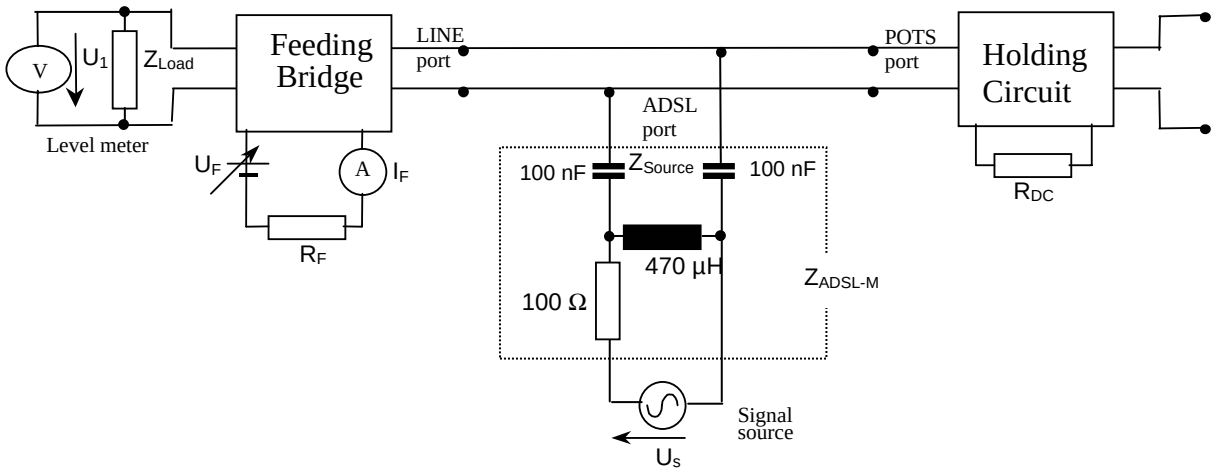


Figure 5: Verification of the test set-up for ADSL to LINE insertion loss testing

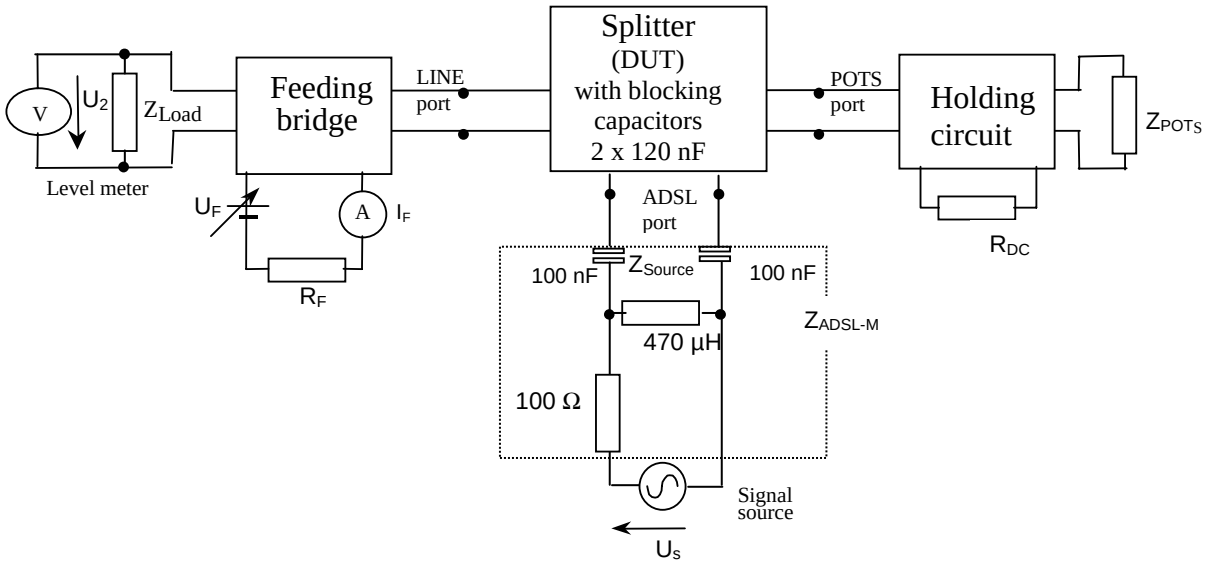


Figure 6: Test set-up for ADSL to LINE insertion loss testing

Test parameters:

Table 2: Test parameters for the insertion loss in the pass band (ADSL) - ADSL to LINE test case

Parameter	Value
Level of the test signal Us	-10 dBm
Frequency Range	30 kHz to 1104 kHz
Combination of source and load impedances	combination 1: Z_{source} = 100 Ω, Z_{load} = 100 Ω
Termination at POTS: Z_{POTS}	Z_{POTS} = short circuit (R < 0,01 Ω) Z_{POTS} = open circuit Z_{POTS} = Z_{RHF}
Level of Feeding voltage	50 V_{DC}
Level of Feeding current	0 mA 13 mA 80 mA
Polarity of feeding voltage/current	normal and reversed, alternating between the single measurements
Optional tests	none

Test matrix:

Table 3: Test matrix for the insertion loss in the pass band (ADSL) - ADSL to LINE test case

	TR 101 728 [8]	TS 101 952-1-2 [10]	ITU-T Recommendation G.992.1 [5]	Essential tests	Optional tests
Level of the test signal -10 dBm	X	X		X	
Frequency Range 30 kHz to 1 104 kHz	X	X		X	
Source/load combination 1	X	X		X	
DC feeding voltage/current					
+50 V_{DC}/0 mA	X	X		X	
-50 V_{DC}/13 mA	X	X		X	
+50 V_{DC}/80 mA	X	X		X	
Z_{POTS} = short circuit	X	X		X	
Z_{POTS} = open circuit	X	X		X	
Z_{POTS} = Z_{RHF}	X	X		X	
Number of tests	9 tests	9 tests	0 tests	9 tests	0 tests

Test procedure notes:

NOTE 1: The right hand side port of the holding circuit in figure 5 should be left open during verification.

NOTE 2: Normally the splitter consists of two parts: low pass filter and high pass filter realized with two blocking capacitors 120 nF each. If the splitter does not contain the blocking capacitors, the two capacitors 120 nF each have to be connected externally.

Test results:

Test result has to be recorded in dB, where: $I_L = -20 \log_{10} (U_2/U_1)$, where U_2 is the voltage observed when the splitter is connected as in test set-up and where U_1 is the voltage observed when the splitter is replaced by a direct wire connection of less than 0,01 Ω.

Measuring notes:

See general notes.

6.2 Insertion loss in the pass band (ADSL) - LINE to ADSL

Table 4: Description of the insertion loss in the pass band (ADSL) - LINE to ADSL test case

Test case name:	insertion loss in the pass band (ADSL)
Reference:	TS 101 952-1-2 [10], clause 7.1
Test purpose:	to evaluate the insertion loss in the pass band (ADSL) in when tested with the test parameters as given in the related standards
Test configuration:	see test set-up; DUT not configured

Test set-up:

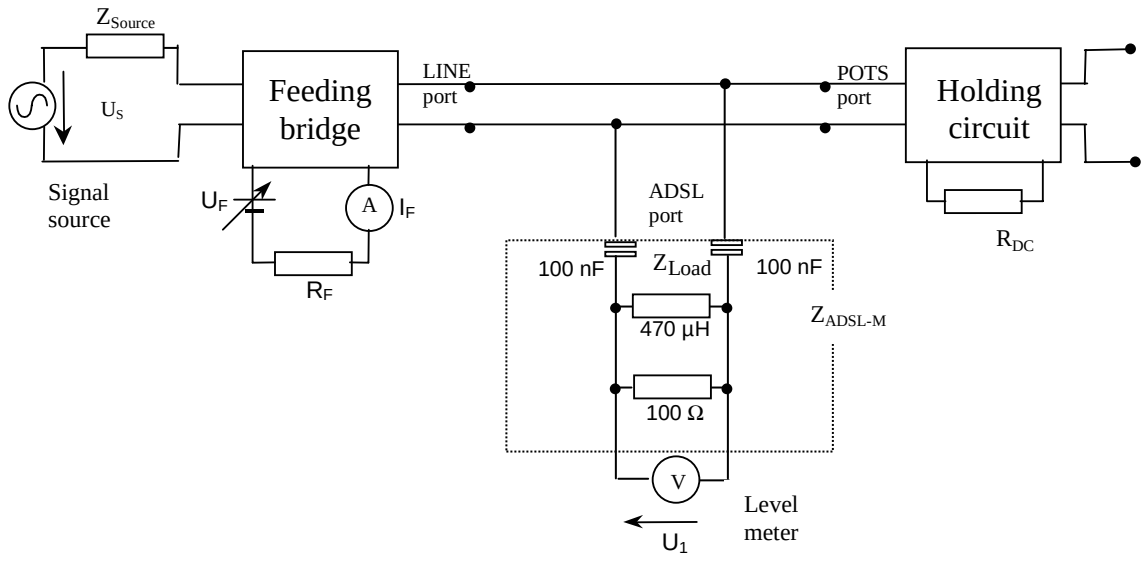


Figure 7: Verification of the test set-up for Line to ADSL insertion loss testing

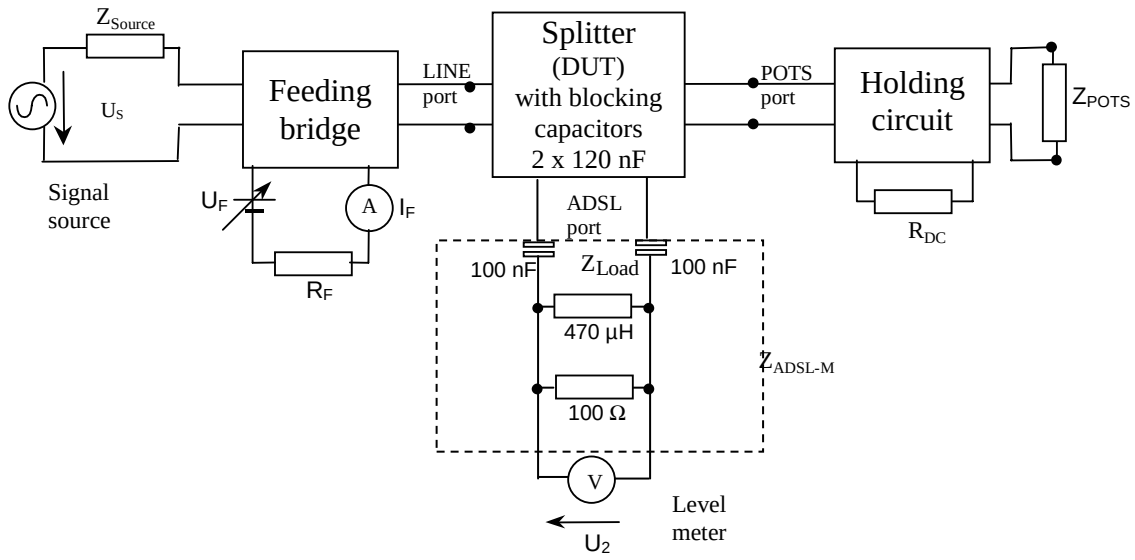


Figure 8: Test set-up for LINE to ADSL insertion loss testing

Test parameters:

Table 5: Test parameters for the insertion loss in the pass band (ADSL) - LINE to ADSL test case

Parameter	Value
Level of the test signal Us	-10 dBm
Frequency range	30 kHz to 1104 kHz
Combination of source and load impedances	combination 1: Z_{source} = 100 Ω, Z_{load} = 100 Ω
Termination at POTS: Z_{POTS}	Z_{POTS} = short circuit (R < 0,01 Ω) Z_{POTS} = open circuit Z_{POTS} = Z_{RHF}
Level of feeding voltage	50 V_{DC}
Level of feeding current	0 mA (not applied) 13 mA 80 mA
Polarity of feeding voltage/current	normal and reversed, alternating between the single measurements
Optional tests	none

Test matrix:

Table 6: Test matrix for the insertion loss in the pass band (ADSL) - LINE to ADSL test case

	TS 101 952-1-2 [10]	TR 101 728 [8]	ITU-T Recommendation G.992.1 [5]	Essential tests	Optional tests
Level of the test signal -10 dBm	X	X		X	
Freq. range 30 kHz to 1 104 kHz	X	X		X	
Source/load combination 1	X	X		X	
Z_{POTS} = short circuit	X	X		X	
Z_{POTS} = open circuit	X	X		X	
$Z_{POTS} = Z_{RHF}$	X	X		X	
DC feeding voltage / current					
+50 V_{DC}/0 mA (not applied)	X	X		X	
-50 V_{DC}/13 mA	X	X		X	
+50 V_{DC}/80 mA	X	X		X	
Number of tests (passive splitters)	9 tests	9 tests	0 tests	9 tests	0 tests

Test procedure notes:

NOTE 1: The insertion loss in the pass band (ADSL) of the tested passive splitters with current/voltage detection is depended on current, voltage and prehistory of the test (depending on if splitter has achieved "activation threshold"). For passive splitters there was no current dependence. But it could happen that some components in the splitter may change their characteristics at the highest current. This may influence the insertion loss in the pass band (ADSL). Special care has to be taken to this fact.

NOTE 2: So far this test was only performed without any DC-Feeding. Especially for active splitters it can be that the insertion loss in the pass band (ADSL) depends on the current. The measurement should also be performed with a DC-Feeding.

NOTE 3: The right hand side port of the holding circuit in figure 7 should be left open during verification.

NOTE 4: Normally the splitter consists of two parts: low pass filter and high pass filter realized with two blocking capacitors 120 nF each. If the splitter does not contain the blocking capacitors, the two capacitors 120 nF each have to be connected externally.

Test results:

Test result has to be recorded in dB, where: $I_L = -20 \log_{10} (U_2/U_1)$, where U_2 is the voltage observed when the splitter is connected as in test set-up and where U_1 is the voltage observed when the splitter is replaced by two direct wire connection of less than 0,01 Ω (one connection line Port to POTS port and one connection Line port to xDSL port).

Measuring notes:

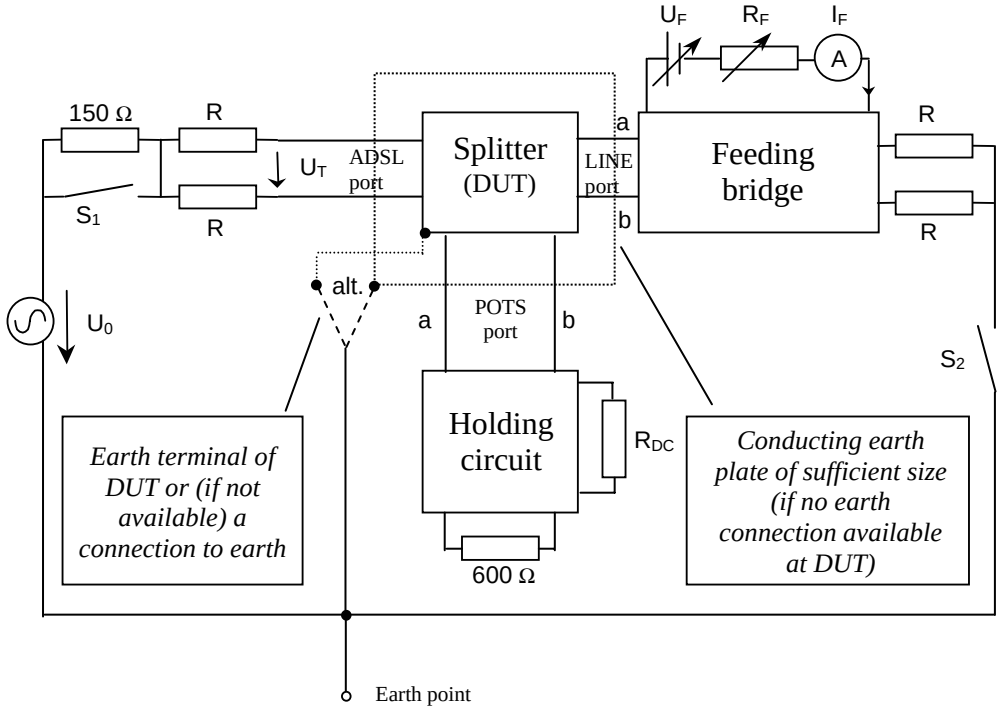
None.

6.3 Unbalance about earth for high pass filter

Table 7: Description of the unbalance about earth for high pass filter test case

Test case name:	unbalance about earth for the high pass filter
Reference:	TS 101 952-1-2 [10], clause 7.2
Test purpose:	to evaluate the Unbalance about earth of the high pass filter when tested with the test parameters as given in the related standards
Test configuration:	see test set-up; DUT not configured

Test set-up:



Note: The basic test set-up in figure 9 is for measuring unbalance at the ADSL port. In the case of measuring at the LINE port the ADSL and LINE terminations should be reversed.

Figure 9: Test set-up for unbalance about earth testing

Test parameters:

Table 8: Test parameters for the unbalance about earth for high pass filter test case

Parameter	Value
Level of test signal Uo	-10 dBm
Frequency ranges of test signal	50 Hz to 4 kHz 4 kHz to 5 MHz
Combination of test set-up	Combination 1: ADSL Port Measurement S1 Closed, S2 Closed, R = 300 Ω for 50 Hz < freq < 4 000 Hz Combination 2: ADSL Port Measurement S1 Open, S2 Closed, R = 50 Ω for 4kHz < freq < 5 MHz Combination 3: ADSL Port Measurement S1 Closed, S2 Open, R = 300 Ω for 50 Hz < freq < 4 000 Hz Combination 4: ADSL Port Measurement S1 Open, S2 Open, R = 50 Ω for 4kHz < freq < 5 MHz Combination 5: Line Port Measurement S1 Closed, S2 Closed, R = 300 Ω for 50 Hz < freq < 4 000 Hz Combination 6: Line Port Measurement S1 Open, S2 Closed, R = 50 Ω for 4kHz < freq < 5 MHz
Termination at POTS	600 Ω
Level of feeding voltage	50 V_{DC}
DC feeding current I_F in off-hook state	13 mA 80 mA
Polarity of feeding voltage/current	normal and reversed, alternating between the single measurements

Test matrix:

Table 9: Test matrix for the unbalance about earth for high pass filter test case

	TR 101 728 [8]	TS 101 952-1-2 [10]	ITU-T Recommendation G.992.1 [5]	Essential tests	Optional tests
Level of test signal -10 dBm	X	X	X	X	X
Test set-up Combination 1	X	X	X	X	X
Test set-up Combination 2	X	X	X	X	X
Test set-up Combination 3	X	X	X	X	X
Test set-up Combination 4	X	X	X	X	X
Test set-up Combination 5	X	X	X	X	X
Test set-up Combination 6	X	X	X	X	X
DC feeding voltage/current					
+50 V_{DC}/13 mA	X	X	X	X	
- 50 V_{DC}/80 mA	X	X	X	X	
+50 V_{DC}/100 mA			X		X
Number of tests	12 tests	12 tests	18 tests	12 tests	6 tests

Test procedure notes:

NOTE 1: It was noted that the required feeding bridge and holding circuit should comply with the requirements of TBR 038 [6]. However, it should be noted that the performance of the feeding bridge and holding circuit is only considered for voice-band operation. In test cases where measurements are required at much higher frequencies, the performance of the feeding bridge and holding circuit must be more critically specified.

It is felt to be reasonable to require the insertion loss of the feeding bridge and the holding circuit to be less than 1 dB in the addressed frequency range. The balance about earth of the test set-up should be at least 15 dB greater than the tested requirement.

NOTE 2: It was observed that changes in feeding current or polarity had no significant effect on the balance measurements. In view of this only minimum and maximum currents need to be employed on the device under test.

NOTE 3: If the splitter has no earth terminal, the test should be performed while the splitter is placed on an earthed metal plate with an area at least 50% larger than the foot-print of the splitter.

NOTE 4: This test is not applicable to two port splitter devices (meaning splitters only providing a low pass section).

Test results:

Test result should be recorded in dB, where: unbalance = $20 \log_{10} |U_0/U_T|$, where U_0 is the longitudinal voltage fed in by the generator and where U_T is the differential voltage observed at the input of the DUT.

Measuring notes:

On-hook DC feeding current requirements are not applicable.

Annex A: Bibliography

- ETSI ETR 328: "Transmission and Multiplexing (TM); Asymmetric Digital Subscriber Line (ADSL); Requirements and performance".
- ETSI TR 102 139: "Compatibility of POTS terminal equipment with xDSL systems".
- ITU-T Recommendation G.992.2: "Splitterless asymmetric digital subscriber line (ADSL) transceivers".
- 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".
- ETSI TS 101 952-1-1: "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".

History

Document history		
V1.1.1	May 2003	Publication