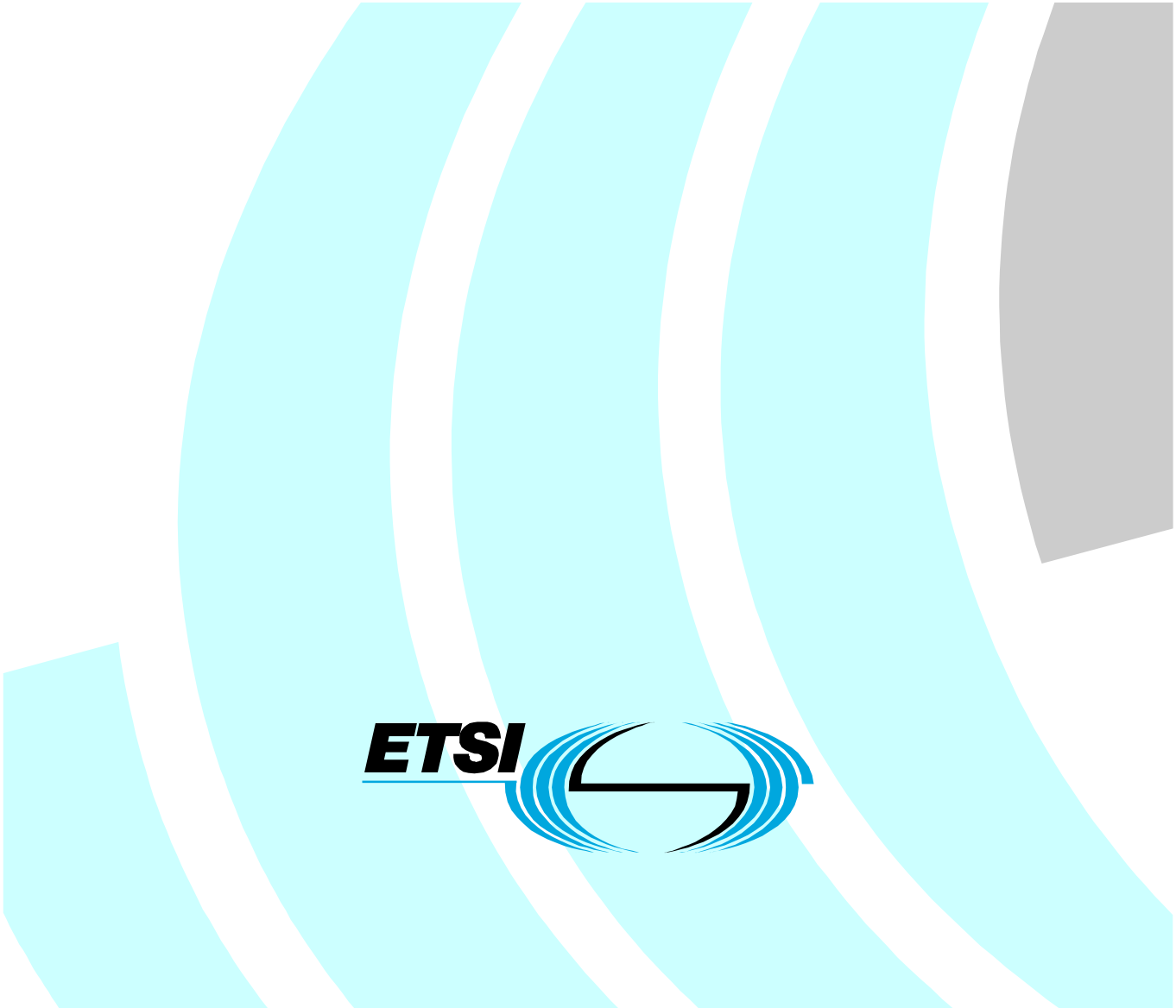
ETSI TR 101 953-2-2 V1.1.1 (2004-07)

Technical Report

Access network xDSL transmission filters;
Part 2: VDSL splitters for European deployment;
Sub-part 2: Specification of Testing methods
for high pass part of VDSL/POTS splitters



Reference
DTR/TM-06027-2-2

Keywords
ADSL, ISDN, splitter, testing, POTS, VDSL, xDSL

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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) as collaboration between:

- AT Analogue of Technical Committee Access and Terminals (AT); and
- TM6 of Technical Committee Transmission and Multiplexing (TM).

The present document is part 2, 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";

Part 2: "VDSL splitters for European deployment":

Sub-part 1: "Specification of Testing methods for the low pass part of VDSL/POTS splitters";

Sub-part 2: "Specification of Testing methods for high pass part of VDSL/POTS splitter";

Sub-part 3: "Specification of Testing methods for VDSL/ISDN splitters".

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

1 Scope

The present document describes test methods for the high pass section of VDSL/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 test methods for the master splitter that is intended for use at the demarcation point of the customer premises. Distributed filters are outside the scope of the present document.

NOTE 1: At some locations in the present document impedances values are listed. These values might differ from the values listed in the requirement specifications TS 101 952-2-2 [2]. If the values differ the values of TS 101 952-2-2 [2] have to be used.

NOTE 2: At some locations in the present document measurements are only shown for splitters at the user side. E.g. this is the case in figure 3. When measuring a splitter at the Local Exchange side the position of the Feeding bridge and the Holding Circuit have to be exchanged.

NOTE 3: Remark, that in the present state of TS 101 270 [1] the use of distributed filters is not applicable for VDSL-over-POTS.

2 References

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

[1] ETSI TS 101 270 (all parts): "Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL)".

[2] ETSI TS 101 952-2-2: "Access network xDSL transmission filters; Part 2: VDSL splitters for European deployment; Sub-part 2: Specification of the high pass part of VDSL/POTS splitters for use at the Local Exchange (LE) and the user side near the Network Termination Point (NTP)".

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

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

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

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

[7] 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".

[8] 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".

[9] ETSI EG 201 120: "Public Switched Telephone Network (PSTN); Method of rating terminal equipment so that it can be connected in series and/or in parallel to a Network Termination Point (NTP)".

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: 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

3.2 Abbreviations

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

ADSL	Asymmetric Digital Subscriber Line
CPE	Customer Premises Equipment
DC	Direct Current
DSL	Digital Subscriber Line
dBm	Absolute power level expressed in decibels relative to 1 mW
DUT	Device Under Test
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
LE	Local Exchange (Central Office)
NF	Narrow-band Frequency
NTP	Network Termination Point
OP	Operational Amplifier
POTS	Plain Old Telephone Service
STF	Specialist Task Force
TE	Terminal Equipment (e.g. Telephone, Fax, voice band modem etc.)
VDSL	Very high speed Digital Subscriber Line
Z_{RHF}	Reference Termination Impedance for high frequencies (refer to TS 101 952-2-2 [2])

4 Introduction

The present document is part 2, sub-part 2 of a multi-part deliverable supporting different aspects of European Specific DSL splitters.

It has been produced based on the activities of ETSI STF 248.

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

The test methods of the present document are based on requirements of the following document:

- TS 101 952-2-2 [2]: "Specification of the high pass part of VDSL/POTS splitters for use at the Local Exchange (LE) and the user side near the Network Termination Point (NTP)".

Furthermore certain aspects of the following documents have been considered as to provide a document which is consistent with the specifications of the other sub-parts of TR 101 953:

- TS 101 952-2-1 [3]: "Specification of the low pass part of VDSL/POTS Splitters";
- TR 101 953-2-1 [4]: "Specification of Testing methods for the low pass part of VDSL/POTS splitters".

For each test, the document describes:

- Title of the test.
- Purpose of the test.
- Requirement in reference to the specifications.
- Test configuration.
- Test set up.
- Test parameters.
- Test results matrix.
- Measuring notes.

5 Test conditions and general notes

For some tests feeding bridges and holding circuits are foreseen. For all of these tests, feeding bridge and holding circuit must comply with the requirements as specified in TBR 038 [7] with respect to the low frequency range. Similar performance is required for the high frequency range (up to 12 MHz). An equivalent accuracy may be obtained by calibrating the feeding bridge and holding circuit across the relevant frequency range.

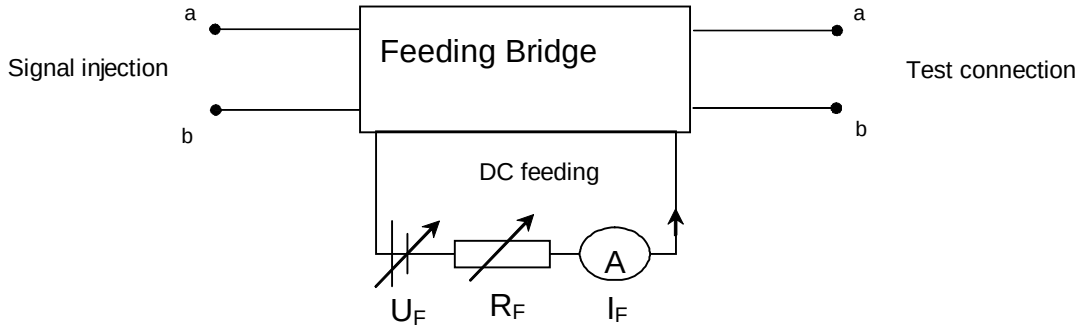


Figure 1: External circuitry for feeding bridge

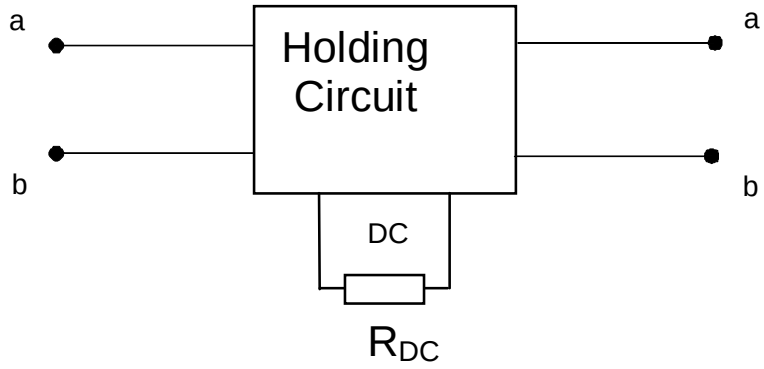


Figure 2: External circuitry for holding circuit

General notes:

Polarity of the feeding voltage and with this the direction of the feeding current may impact the additional insertion loss caused by the feeding bridge and holding circuit. A calibration/normalization measurement need to be taken before each single measurement step.

For active splitters 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.

Test set-ups as given in the present document show TE test set-ups unless stated otherwise. Tests for LE splitter evaluation should be set up considering the aforementioned.

The inaccuracy of the measurement resulting 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. A 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) to perform the NF filtering.

NOTE: The splitters that have been evaluated during the validation of the test methods described herein are to be classified in cluster "passive". Although the STF 248 has not had a splitter classified in cluster "passive with current/voltage detection" at hand for the validation, the experience from STF 215 allowed to assess the test methods for that type, too. No "active" splitters could be made available for evaluation. The results of the STF 248 work could be validated for the first two classes, for the third class (active splitters) theoretical test case validations have been discussed.

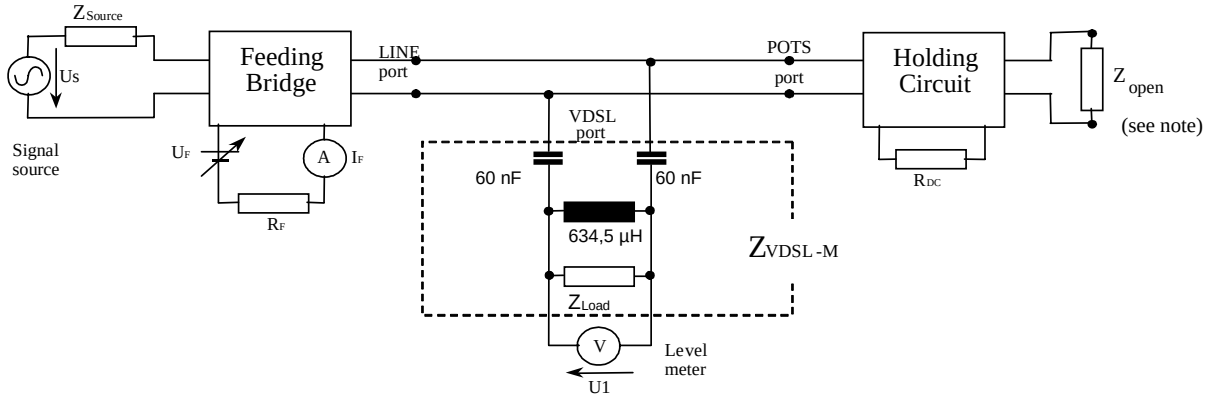
6 List of test cases for the low pass part of the VDSL over POTS splitter

6.1 Insertion Loss Requirements for Options A, B and C

Table 1

Test case name:	Insertion Loss in the Pass Band (VDSL)
Reference:	TS 101 952-2-2 [2], clause 7.1
Test purpose:	To evaluate the Insertion Loss in the Pass Band (VDSL) 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 for Measuring Direction LINE to VDSL:



NOTE: When the calibration measurement is done according to the figure above the influence of the Holding Circuit is not entirely taken into account as Z_{POTS} is left open. The Holding Circuit should be checked separately on the influence to Z_{RHF} by measuring Z_{RHF} over the entire frequency band both with and without the Holding Circuit inserted in the measurement. The influence of the Holding Circuit should not lead to a deviation of > 0,2 dB which means the Holding Circuit shall have a return loss better than 16 dB in the entire frequency band.

Figure 3: Test set up for calibration LINE to VDSL Insertion Loss testing on a splitter

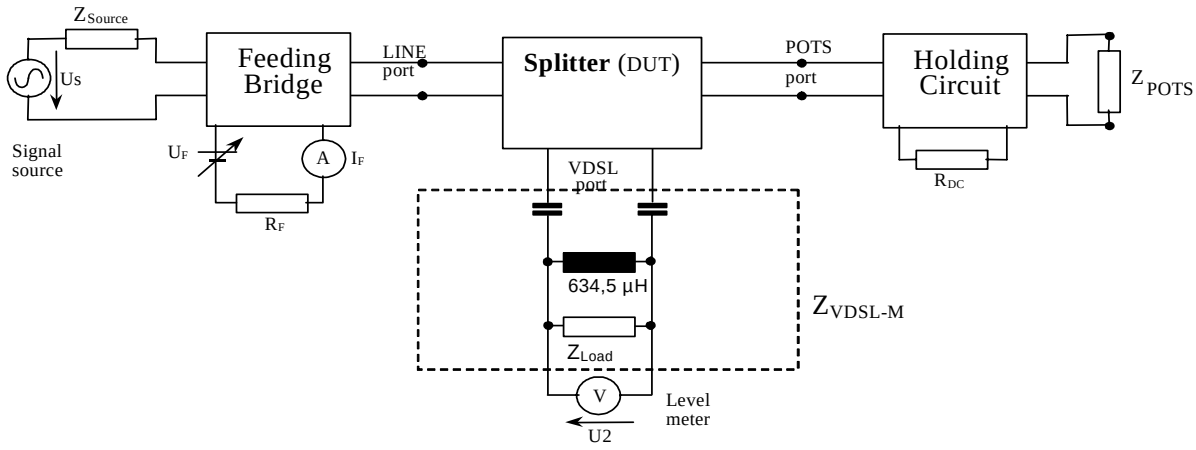


Figure 4: Test set up for LINE to VDSL Insertion Loss testing on a splitter

Test Set-Up for Measuring Direction VDSL to LINE:

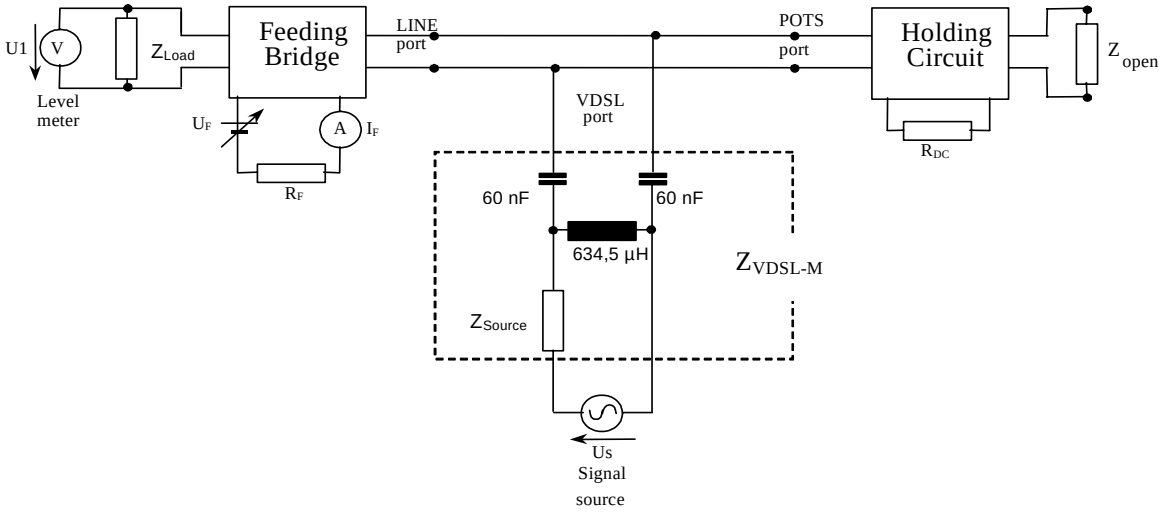


Figure 5: Test set up for calibration VDSL to LINE Insertion Loss testing on a splitter

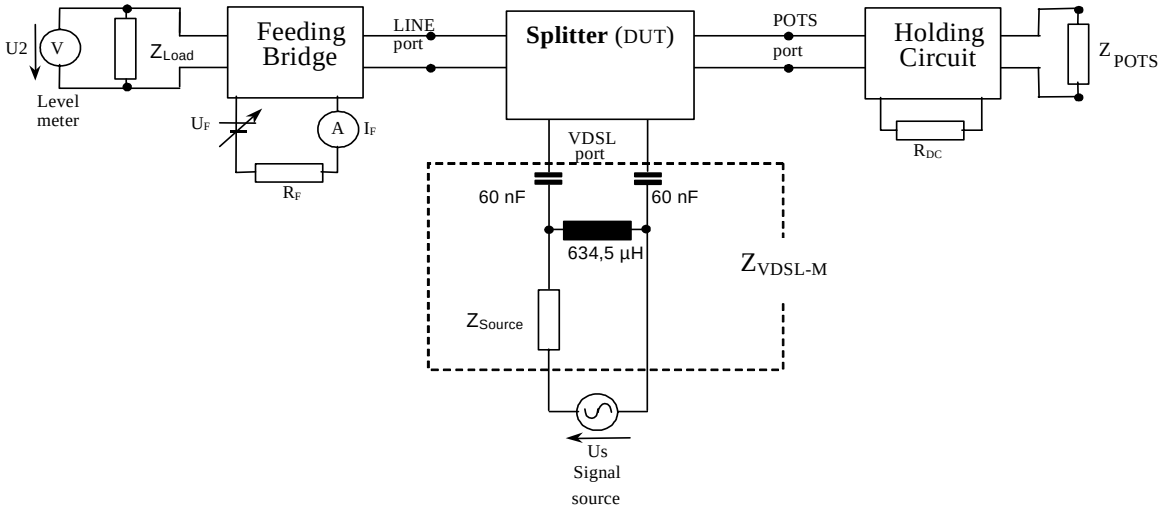


Figure 6: Test set up for VDSL to LINE Insertion Loss testing on a splitter

NOTE: Even though there would not be any component in the high pass part, when there is no 120 nF blocking capacitor included (Option A Splitter), the measurement must be performed. This is required, as the low pass part of the splitter acts as a parallel load to the VDSL link which might harm the VDSL performance.
Alternative splitter requirements (such as specifying a minimal input impedance of the low pass) and the related test methods are for further study.

Test Parameters:

Table 2

Parameter	Value
Measurement Direction	VDSL → LINE LINE → VDSL
Level of the test signal Us	-10 dBm
Frequency Range	32 kHz to 12 MHz
Combination of Source and Load Impedances	combination 1: Z_{source} = 135 Ω, Z_{load} = 135 Ω
Termination at POTS for calibration only, Z_{open}	Z_{open} = open circuit
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} -50 V_{DC}
Load resistance R_{DC}	470 Ω
DC feeding current I_F	0 mA to 80 mA

Test Matrix:

Table 3

	TS 101 952-2-2 [2]	Essential Tests	Optional Tests
Direction: VDSL - LINE	X	X	
Direction: LINE - VDSL	X	X	
Level of the test signal - 10 dBm	X	X	
Frequency Range 32 kHz to 12 MHz	X	X	
Source/load combination 1	X	X	
Z_{POTS} = short circuit	X	X	
Z_{POTS} = open circuit	X	X	
Z_{POTS} = Z_{RHF}	X	X	
Level of feeding voltage +50 V_{DC}	X	X	
Level of feeding voltage -50 V_{DC}	X	X	
Value of feeding current 0 mA	X	X	
Value of feeding current 13 mA	X	X	
Value of feeding current 80 mA	X	X	
Number of tests	18 tests	18 tests	0 tests

Test procedure notes:

NOTE 1: The source impedance Z_{SOURCE} shall be implemented in a symmetrical way.

NOTE 2: During the STF 248 validation work the following spurious effects were observed: When capacitors were connected externally for the testing (in this case in form of the capacitors contained in Z_{VDSL-M}) this lead to resonance effects with components of the low pass branch. As a result dips occurred at single frequencies above 1 MHz exceeding the specified insertion loss limits. If such behaviour is seen, a re-test with slightly changed external capacitors is recommended. It was observed that a variation in the range of +10 % was sufficient.

Test results:

Test Result shall be recorded in dB, where: I_L = 20 lg (U2/U1), where U2 is the voltage observed when the splitter is connected as in Test Set-Up (see figures 4 and 6) and where U1 is the voltage observed when the splitter is replaced by a direct wire connection of less than 0,01 Ω (see figures 3 and 5).

Measuring notes:

Please refer to the general notes given in clause 5.

6.2 Unbalance about earth requirements for options B and C

6.2.1 Unbalance about earth requirements for options B and C without DC feeding

Table 4

Test case name:	Unbalance about Earth
Reference:	TS 101 952-2-2 [2], clause 7.2
Test purpose:	To evaluate the symmetry (unbalance) of the splitter about earth when tested with the test parameters as given in the related standards
Test configuration:	See Test Set-up; DUT not configured

Test set-up:

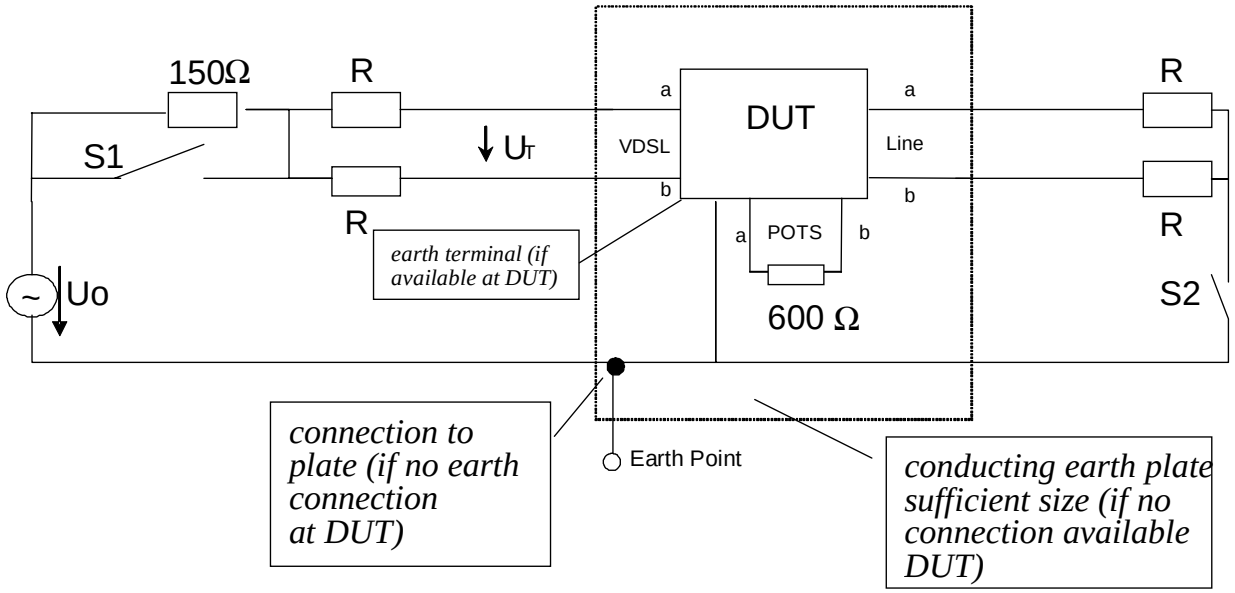


Figure 7: Test set up for Unbalance about Earth Measurements at the VDSL port

NOTE: When measuring at the Line port, source and load of the test set-up have to be reversed accordingly.

Test Parameters:

Table 5

Parameter	Value
Level of the test signal Uo	-10 dBm
Frequency of the test signal Uo	frequency range 1: 50 Hz to 4 kHz frequency range 2: 4 kHz to 12 MHz
Combination of Source and Load Impedances	combination 1: R = 600 Ω/2 = 300 Ω combination 2: R = 68 Ω
Splitter Option	Option B Option C
Status of S1	open closed
Status of S2	open closed

Test Matrix:

Table 6

	TS 101 952-2-2 [2]	Essential Tests	Optional Tests
Level of the test signal -10 dBm	X	X	
Splitter Option B **Splitter Option C**	X X	X X	
Frequency Range 1 (50 Hz to 4 kHz) **Frequency Range 2 (4 kHz to 12 MHz)**	X X	X X	
Impedance combination 1 **Impedance combination 2**	X X	X X	
Status of S1 = closed **Status of S1 = open**	X X	X X	
Measured at VDSL port; S2 = open **Measured at VDSL port; S2 = closed** **Measured at LINE port; S2 = open** **Measured at LINE port; S2 = closed**	X X X X	X X X X	
Z_{POTS} = 600 Ω	X	X	
number of tests	8 tests	8 tests	0 tests

Test procedure notes:

NOTE: At the frequencies as used in this specific test wiring gets important. Special care shall be taken with respect to a wiring that does not unnecessarily impact the test result. Furthermore, the selection of termination components need to be performed carefully taking into account the test frequencies. Before performing the measurements as described in this clause a reference measurement should be done, testing the test set-up without the splitter (splitter replaced by a short).

Test results:

Test Result shall be recorded in dB, where: unbalance = 20 log10 (Uo/U_T), where Uo is the longitudinal voltage fed in by the generator and where U_T is the differential voltage observed at the input of the SUT.

Measuring notes:

Please refer to the general notes given in clause 5.

6.2.2 Unbalance about earth requirements for options B and C with DC feeding

This is for further study.

History

Document history		
V1.1.1	July 2004	Publication