

**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**



Reference

DTR/AT-010091-01-01

Keywords

ADSL, POTS, splitter, testing

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Access and Terminals (AT).

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

The present document is part 1, sub-part 1 of a multi-part deliverable covering Unified and Generic Testing Methods for 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: "Specification of Testing methods for High Pass part of ADSL/POTS splitters";

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

1 Scope

The present document describes test methods for the low pass section of POTS/ADSL 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 not concerned by the present document.

2 References

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

- [1] ETSI ETR 328: "Transmission and Multiplexing (TM); Asymmetric Digital Subscriber Line (ADSL); Requirements and performance".
- [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] 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)".
- [4] ETSI TR 102 139: "Compatibility of POTS terminal equipment with xDSL systems".
- [5] ITU-T Recommendation G.992.2: "Splitterless asymmetric digital subscriber line (ADSL) transceivers".
- [6] ITU-T Recommendation G.992.1: "Asymmetric Digital Subscriber Line (ADSL) transceivers".
- [7] ETSI TBR 38: "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 21: "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 TR 101 728: "Access and Terminals (AT); Study for the specification of low pass filter section of POTS/ADSL splitters".
- [10] 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".
- [11] ITU-T Recommendation O.42: "Equipment to measure non-linear distortion using the 4-tone intermodulation method".

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: ostate 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 Premise Equipment
dBm	Absolute power level expressed in decibels relative to 1 mW
dBV	Absolute voltage level expressed in decibels relative to 1 Volt
DC	Direct Current
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
TE	Terminal Equipment (e.g. Telephone, Fax, voice band modem etc.)

4 Introduction

The present document is part 1 of a multi-part deliverable supporting different aspects of European Specific DSL splitters.

It has been produced based on the activities of ETSI STF 215.

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

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

- TS 101 952-1-1 [10] (ES 201 952-1-1);
- TR 101 728 [9];
- TS 101 388;
- ITU-T Recommendation G.992.1 [6], annex E (E1. Type 1 - European).

The requirements from TR 101 728 [9] and TS 101 952-1-1 [10] are assessed to be the "essential" or minimum tests. The additional tests that are required in ITU-T Recommendation G.992.1 [6] 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 present document describes:

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

5 Test conditions and general notes

For each test, feeding bridge and holding circuit must comply to the requirements as specified in TBR 38 [7] 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.

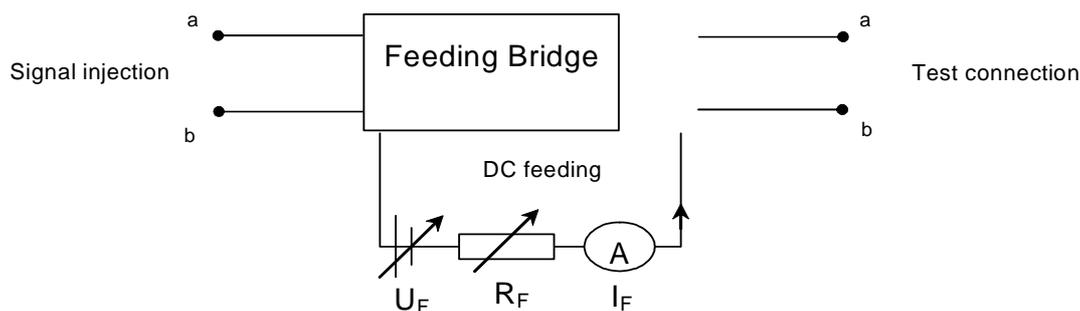


Figure 1: External circuitry for feeding bridge

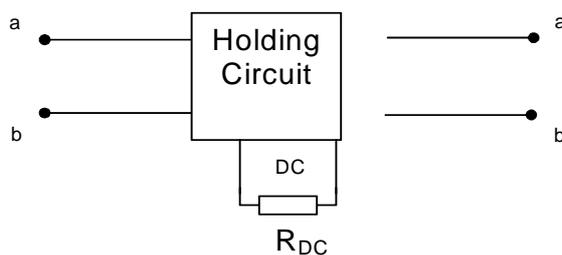


Figure 2: External circuitry for holding circuit

General notes:

Polarity 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.

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.

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: 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 the STF 215 work 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 a guidance for the separation of this two different types:

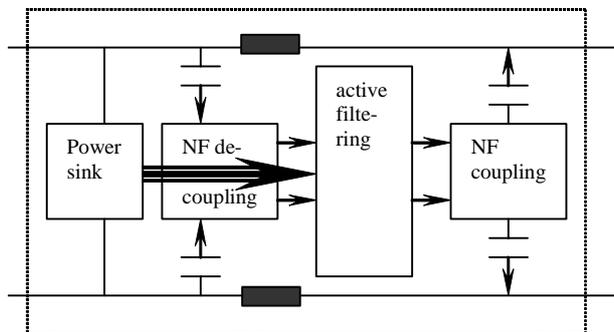


Figure 3: Example for a splitter not breaking the DC path

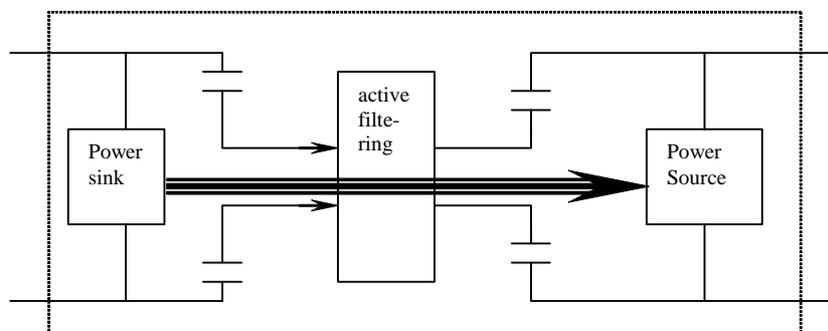


Figure 4: Example for a splitter breaking the DC path

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

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

- 6.1) Insertion loss in the pass band (POTS)
- 6.2) Insertion loss distortion in the pass band (POTS)
- 6.3) Return loss in the pass band (POTS)
- 6.4) Group delay distortion in the pass band (POTS)
- 6.5) Isolation (insertion loss) at 32 kHz to 1 100 kHz
- 6.6) Distortion and Intermodulation
 - 6.6.1) Distortion (distortion and intermodulation)
 - 6.6.2) Intermodulation (distortion and intermodulation)
- 6.7) DC Requirements
 - 6.7.1) DC resistance to earth
 - 6.7.2) DC resistance between a-wire and b-wire (open ports)
 - 6.7.3) DC series resistance
- 6.8) Ringing Voltage Requirements
 - 6.8.1) Voltage drop at 25 Hz and 50 Hz (ringing frequency requirements)
 - 6.8.2) Total harmonic distortion at 25 Hz and 50 Hz (ringing frequency requirements)
- 6.9) Impedance at 25 Hz and 50 Hz (ringing frequency requirements)
- 6.10) Unbalance about earth for the low pass filter
- 6.11) Noise Requirements
 - 6.11.1) Noise in the band from 300 Hz to 4 000 Hz (POTS band)
 - 6.11.2) Noise in the band from 26 kHz to 1 100 kHz (ADSL band)
- 6.12) Metering at 12 kHz or 16 kHz

6.1 Insertion Loss in the Pass Band (POTS)

Void.

6.2 Insertion Loss Distortion in the Pass Band (POTS)

Table 1

Test case name:	Insertion Loss in the Pass Band (POTS) and Insertion Loss Distortion in the Pass Band (POTS)
Reference:	TS 101 952-1-1 [10], clauses 6.4.1, 6.4.2 and 6.5
Test purpose:	To evaluate the Insertion Loss in the Pass Band (POTS) as well as the Insertion Loss Distortion in the Pass Band (POTS) in Off-Hook and in On-Hook state when tested with the test parameters as given in the related standards
Test configuration:	See Test Set-up; DUT not configured

Test set-up:

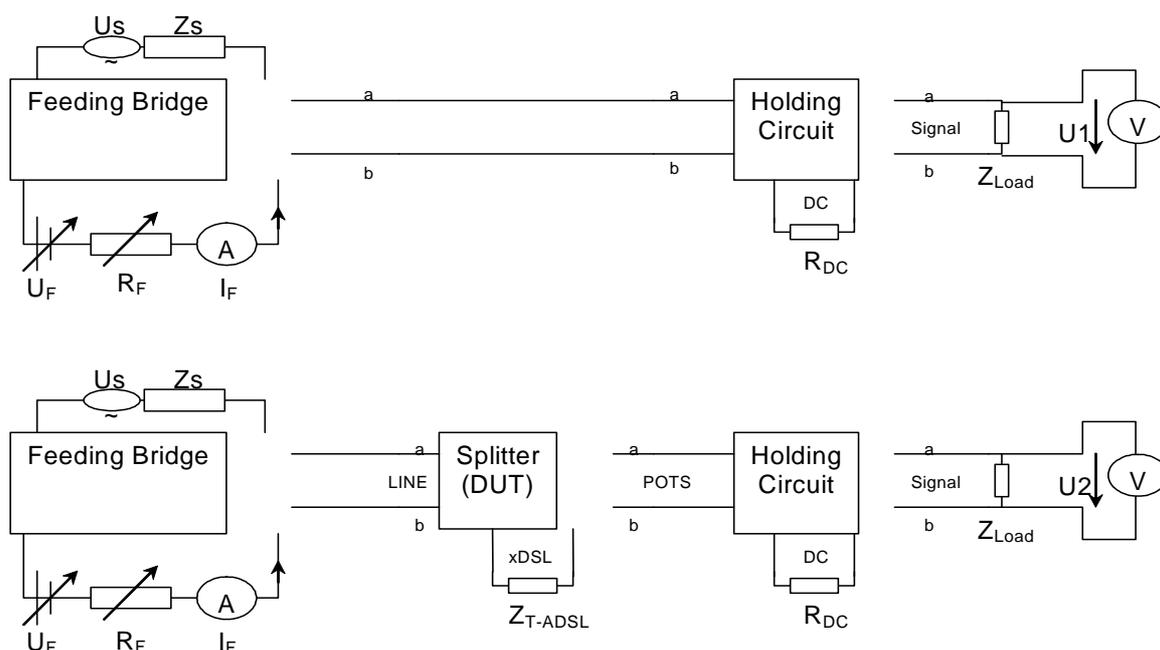


Figure 5: Test set-up for insertion loss testing on a splitter

Test parameters:

Table 2

Parameter	Value
Level of the test signal U_s	-4 dBV emf
Frequency of the test signal U_s	-1 000 Hz for clause 2.1.1 - Insertion Loss in the Pass Band (POTS) -200 Hz to 4 000 Hz for clause 2.1.2 - Insertion Loss Distortion in the Pass Band (POTS)
Combination of Source and Load Impedances	combination 1: source: Z_R , load: Z_R , $R_{DC} = 470 \Omega$ combination 2: source: 600Ω , load: 600Ω , $R_{DC} = 470 \Omega$ (for combinations 1 and 2 R_F should be adjusted to feeding current values) combination 3: source: Z_R , load: Z_{ON} , $R_F = 0$, $R_{DC} = \text{variable}$ (to be adjusted to feeding current values)
Termination at xDSL: Z_{T-ADSL}	$Z_{T-ADSL} = Z_{ADSL}$ $Z_{T-ADSL} = \text{open circuit}$
Level of feeding voltage	+50 V _{DC} -50 V _{DC}
Level of feeding current in on-hook state	0,4 mA 2,5 mA
Level of feeding current in off-hook state	80 mA 13 mA
Direction of Transmission	passive: LINE - POTS passive with current/voltage detection: LINE - POTS active: LINE - POTS and POTS - LINE
Optional tests	$I_{DC} = 100 \text{ mA}$; positive polarity $U_F = 60 \text{ V}$, $R_F = 0 \Omega$ $I_{DC} = 100 \text{ mA}$; negative polarity $U_F = -60 \text{ V}$, $R_F = 0 \Omega$ combination 4: source: $Z_{\text{complex}(2)}$; load: $Z_{\text{complex}(2)}$; $R_{DC} = 470 \Omega$ combination 5: source: $Z_{\text{complex}(3)}$; load: $Z_{\text{complex}(3)}$; $R_{DC} = 470 \Omega$ combination 6: source: 800Ω ; load: 800Ω ; $R_{DC} = 470 \Omega$

Test Matrix:

Table 3

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	essential Tests	optional Tests
level of the test signal -4 dBV emf	X	X	X	X	X
Frequency of the test signal 1 000 Hz or 200 Hz to 4 000 Hz for distortion	X	X	X	X	X
source/load combination 1	X	X	X	X	
source/load combination 2	X	X	X	X	
source/load combination 3		X		X	
source/load combination 4			X		X
source/load combination 5			X		X
source/load combination 6			X		X
Level of feeding voltage 50 V _{DC}	X	X		X	
Level of feeding voltage 60 V _{DC}			X		X
Level of feeding current 0,4 mA	X	X	X	X	X
Level of feeding current 2,5 mA	X	X		X	
Level of feeding current 13 mA	X	X		X	
Level of feeding current 80 mA	X	X		X	
Level of feeding current 100 mA			X		X
polarity of the feeding current	alternating	alternating	alternating	alternating	alternating
Z _{T-ADSL} = Z _{ADSL}	X	X		X	
Z _{T-ADSL} = open circuit	X	X		X	
Direction LINE - POTS	active and passive	active and passive	active and passive	active and passive	active and passive
Direction POTS - LINE	active only	active only	active only	active only	active only
Number of tests	passive: 16 active: 32	passive: 12 active: 24	passive: 10 active: 20	passive: 12 active: 24	passive: 6 active: 12

Test procedure notes:

NOTE 1: Polarity of the feeding current should not impact the insertion loss of splitters.

NOTE 2: For passive splitters and for passive splitters with current/voltage detection it is sufficient to measure insertion loss in one direction (LINE to POTS or POTS to LINE). Differences in the insertion loss in the two directions might be visible due to differences in the impedance matching, however, this will anyhow be seen in the return loss measurement.
For active splitters it is necessary to measure both directions.

NOTE 3: When verifying the test set-up, a verification measurement should not just be taken with 0 Ω, but also with a resistor which leads to an insertion loss of about 1 dB for 600 Ω source/load impedance. A simple way to set-up such an attenuation is by inserting 2 x 75 Ω resistors instead of the SUT.

NOTE 4: If necessary, the feeding voltage can be increased to achieve the specified feeding current.

NOTE 5: The feeding conditions for active splitters and for passive splitters with current/voltage detection need to be determined and are for further study.

NOTE 6: It need to be clarified, if a specific signal (e.g. ringing signal) must be sent to the device under test before performing off-hook tests on active splitters or passive splitters with current/voltage detection.

NOTE 7: For active and for passive splitters it is sufficient to measure at the lowest and the highest specified current for both off-hook condition and on-hook condition.

Test results:

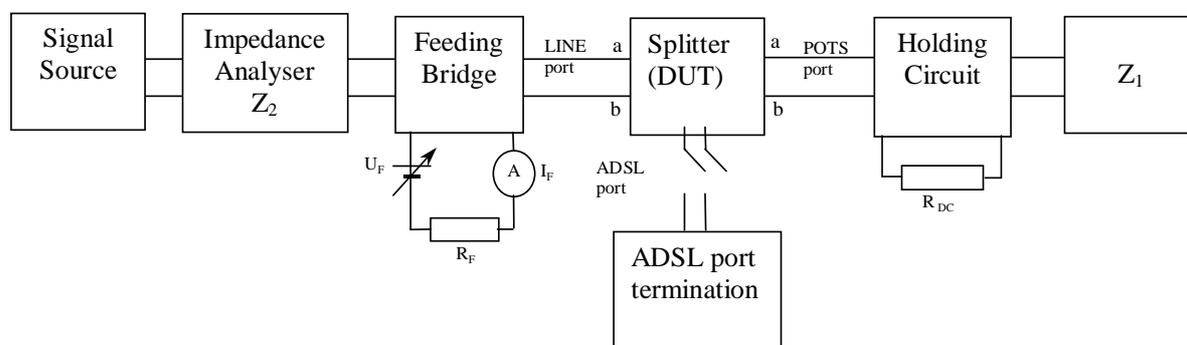
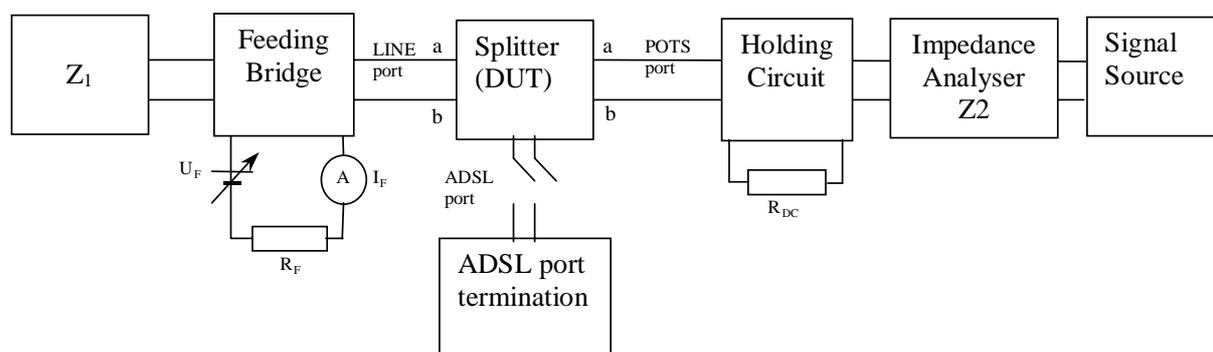
Test Result should be recorded in dB, where: $I_L = 20 \lg (U_2/U_1)$, where U₂ is the voltage observed when the splitter is connected as in Test Set-Up and where U₁ is the voltage observed when the splitter is replaced by a direct wire connection of less than 0,01 Ω.

Measuring notes:

See general notes.

6.3 Return loss in the pass band (POTS)**Table 4**

Test case name:	Return Loss
Reference:	TS 101 952-1-1 [10], clause 6.6
Test purpose:	To evaluate the splitter return loss 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 6: Test set-up for return loss testing on a splitter (at the Line Port)****Figure 7: Test set-up for insertion loss testing on a splitter (at the POTS Port)**

Test parameters:

Table 5

Parameter	Value
Level of test signal	-10 dBV
Frequency range of test signal	300 Hz to 4 000 Hz
Combination of Port and load Impedances	Option A combination 1: Z_R /LINE Port test combination 2: Z_R /POTS Port test combination 3: Z_{SL} /LINE Port test combination 4: Z_{SL} /POTS Port test Option B combination 1: Z_R /LINE Port test combination 2: Z_R /POTS Port test
Termination at xDSL	ADSL load = Z_{ADSL} ADSL load = open circuit
Level of feeding voltage	+50 V _{DC} -50 V _{DC}
Load resistance R _{DC}	470 Ω in off-hook state
DC feeding current I _F in off-hook state	13 mA 80 mA
Optional tests	I _{DC} = 100 mA; positive polarity U _F = 50 V _{DC} I _{DC} = 100 mA; negative polarity U _F = -50 V _{DC}

Test matrix:

Table 6

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
Level of test signal -10 dBV	X	X	X	X	X
Impedance of a splitter (Option A) combination 1: Z_R /Line Port test combination 2: Z_R /Pots Port test combination 3: Z_{SL} /Line Port test combination 4: Z_{SL} /Pots Port test	X X X X	X X X X	X X	X X X X	X X
Impedance of a splitter (Option B) combination 1: Z_R /Line Port test combination 2: Z_R /Pots Port	X X	X X	X X	X X	X X
Level of feeding voltage +50 V _{DC} Level of feeding voltage -50 V _{DC}	X X	X X	X X	X X	X X
Value of feeding current 13 mA Value of feeding current 80 mA Value of feeding current 100 mA	X X	X X	X X X	X X	X
ADSL load = Z_{ADSL} ADSL load = open circuit	X X	X X	X X	X X	
Number of Tests (Option A) (Option B)	32 Tests 16 Tests	16 Tests 8 Tests	24 Tests 24 Tests	16 Tests 8 Tests	4 Tests 4 Tests
2 port splitter (no ADSL load) (Option A) (Option B)	16 Tests 8 Tests	8 Tests 4 Tests	12 Tests 12 Tests	8 Tests 4 Tests	2 Tests 2 Tests

Test procedure notes:

None.

Test result:

Test Result should be the return following the definition:

$$R_L = 20 \lg \frac{|Z_1 + Z_2|}{|Z_1 - Z_2|}$$

Measuring notes:

NOTE 1: The reduction of line feeding currents to just 13 mA and 80 mA has shown to be appropriate as no significant differences were evident between the various current results.

NOTE 2: Positive and negative feed voltages produced no significant differences in the return loss results. However, it is suggested that the positive/negative aspect of the test should still be present. Consequently, it is recommended that the results are measured with half of the tests performed with +50 V and the remaining half performed with -50 V (alternating polarity).

6.4 Group delay distortion in the pass band (POTS)

Table 7

Test case name:	Group delay distortion in the pass band (POTS)
Reference:	TR 101 728 [9], clause 5.11 TS 101 952-1-1 [10], clause 6.12
Test purpose:	To measure the increase in group delay distortion in the POTS band caused by the splitter with ADSL load, relative to the lowest measured delay without the splitter, when tested with the test parameters as given in the related standards
Test configuration:	See Test Set-up; DUT not configured

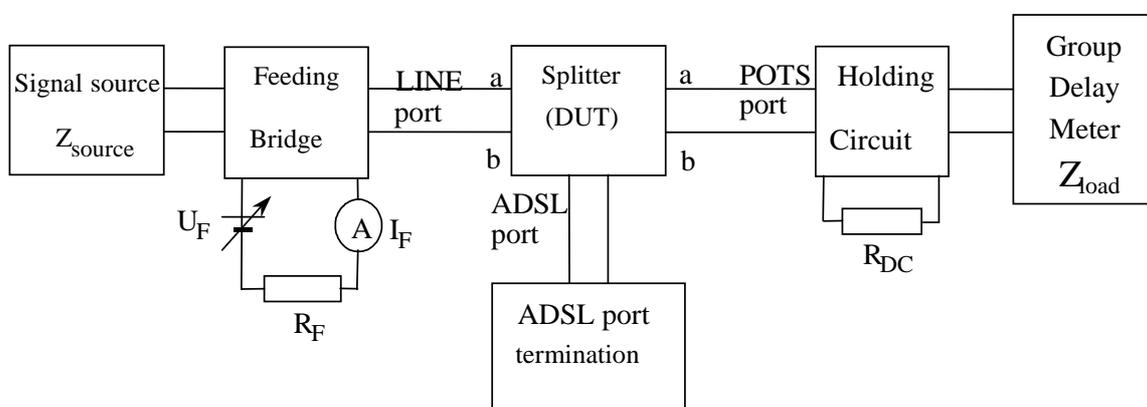
Test set-up:

Figure 8: Test set-up for group delay distortion testing on a splitter

Test parameters:

Table 8

Parameter	Value
Level of the test signal	-10 dBV
Source impedance	Balanced 600 Ω resistive (test 1); Z_R (test 2)
Load impedance	Balanced 600 Ω resistive (test 1); Z_R (test 2)
ADSL termination	Z_{ADSL}
DC feeding current I_F in off-hook state	13 mA 80 mA
Optional tests	None

Test matrix:

Table 9

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
Source: 600 Ω resistive (test 1) Source: Z _R (test 2)	X X	X X		X X	
Load: 600 Ω resistive (test 1) Load: Z _R (test 2)	X X	X X		X X	
Value of feeding current 13 mA	X	X		X	
Value of feeding current 80 mA	X	X		X	
Number of tests	4 Tests	4 Tests	0 Tests	4 Tests	0 Tests

Test procedure notes:

GDD_f formula is as follows:

$$GDD_f = GD_{nf} - GD_{\min}$$

where:

- GDD_f is the Group Delay Distortion at frequency f
- GD_{nf} is the normalized Group Delay at frequency f
- GD_{min} is the minimum normalized Group Delay for all frequencies for that load

Measuring notes:

For each test case, the normalized group delay is to be obtained by subtracting the group delay values without the splitter from the group delay values with the splitter at each measured frequency point:

$$GD_{nf} = GD_{sf} - GD_{of}$$

where:

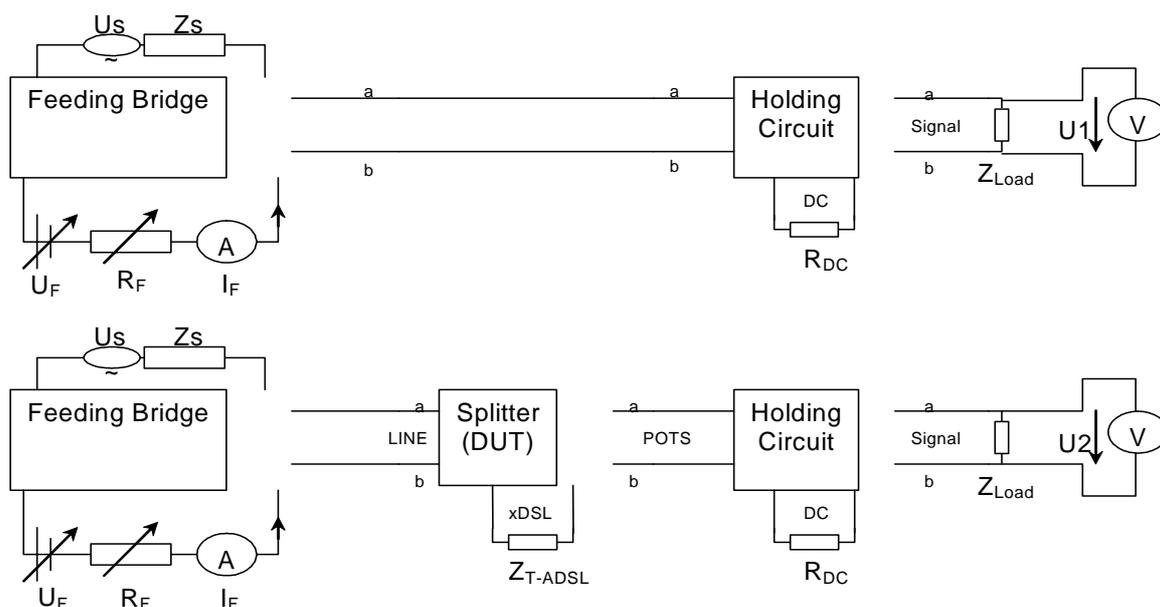
- GD_{nf} is the normalized Group Delay at frequency f
- GD_{sf} is measured Group Delay at frequency f with splitter in circuit
- GD_{of} is measured Group Delay at frequency f without splitter in circuit

NOTE: It was noted that the requirement states that the increase in group delay distortion caused by the splitter must be less than 20 μs. This seems excessively large. In practice the increase in GDD indicated results in the order of 40 μs worst case (lower frequency range).

6.5 Isolation (Insertion Loss) at 32 kHz to 1 100 kHz

Table 10

Test case name:	Isolation (Insertion loss) at 32 kHz to 1 100 kHz
Reference:	TR 101 728 [9], clause 5.8 TS 101 952-1-1 [10], clause 6.9
Test purpose:	To measure the isolation of the POTS port from the ADSL signals in the frequency range from 32 kHz to 1 100 kHz which may impact voice-band services through non-linear or other effects
Test configuration:	See Test Set-up; DUT not configured

Test set-up:**Figure 9: Test set-up for isolation testing on a splitter**

NOTE: Feeding Bridge and Holding Circuit have to be evaluated with respect to their influence on the measurement accuracy, especially at frequencies above 4 kHz (not considered in TBR 38 [7]). It is expected that the insertion loss of Feeding Bridge and Holding Circuit is lower than 1 dB.

Test Parameters:**Table 11**

Parameter	Value
Level of test signal U_S	-6 dBV emf (corresponds to -3,78 dBm into 600 Ω)
Frequency range of U_S	32 kHz to 1 104 kHz off-hook; 25 kHz to 1 104 kHz on-hook
Combinations of directions	On-hook state: combination 1: LINE to POTS combination 2: POTS to LINE Off-hook state: combination 1: LINE to POTS combination 2: ADSL to POTS combination 3: POTS to ADSL
Source impedance Z_{Source}	Z_{RHF}
Load impedance Z_{Load}	Z_{RHF} in off-hook state; Z_{ON} in on-hook state
LINE termination Z_{T-Line}	Z_{RHF}
ADSL termination Z_{T-ADSL}	Z_{ADSL}
Level of feeding voltage	+50 V _{DC} -50 V _{DC}
Load resistance R_{DC}	470 Ω in off-hook state; variable in on-hook state (to be adjusted to meet the current requirement)
DC feeding current I_F in on-hook state	0,4 mA 2,5 mA
DC feeding current I_F in off-hook state	13 mA 80 mA
Optional tests	None

Test matrix:

Table 12

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
Level of test signal -6 dBV	X	X		X	
Frequency range in on-hook state		X		X	
Frequency range in off-hook state	X	X		X	
On-hook state: combination 1: LINE to POTS combination 2: POTS to LINE		X X		X X	
Off-hook state: combination 1: LINE to POTS combination 2: ADSL to POTS combination 3: POTS to ADSL	X X X	X X X		X X X	
Level of feeding voltage +50 V _{DC}	X	X		X	
Level of feeding voltage -50 V _{DC}	X	X		X	
Value of feeding current 0,4 mA		X		X	
Value of feeding current 2,5 mA		X		X	
Value of feeding current 13 mA	X	X		X	
Value of feeding current 80 mA	X	X		X	
Number of tests	6 Test	10 Test	0 Tests	10 Test	0 Tests

Test procedure notes:

None.

Measuring notes:

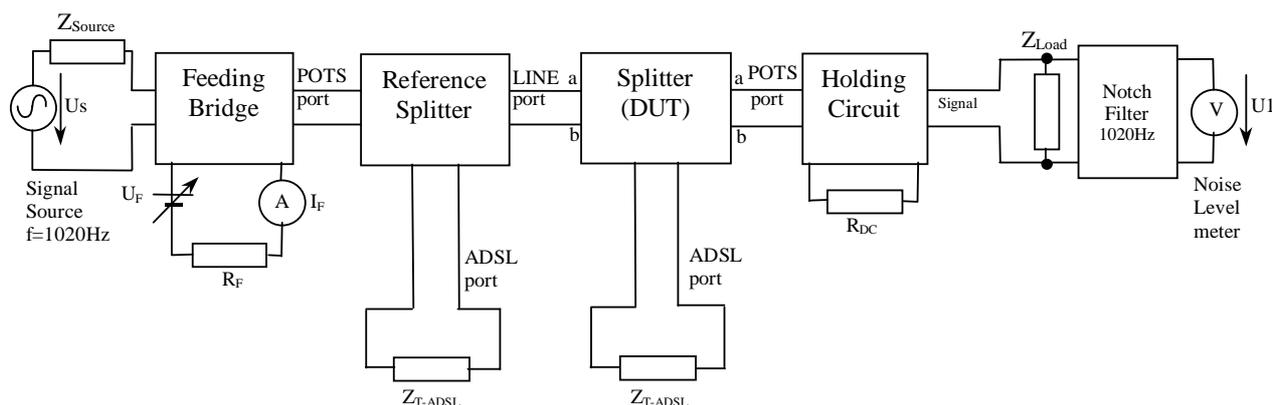
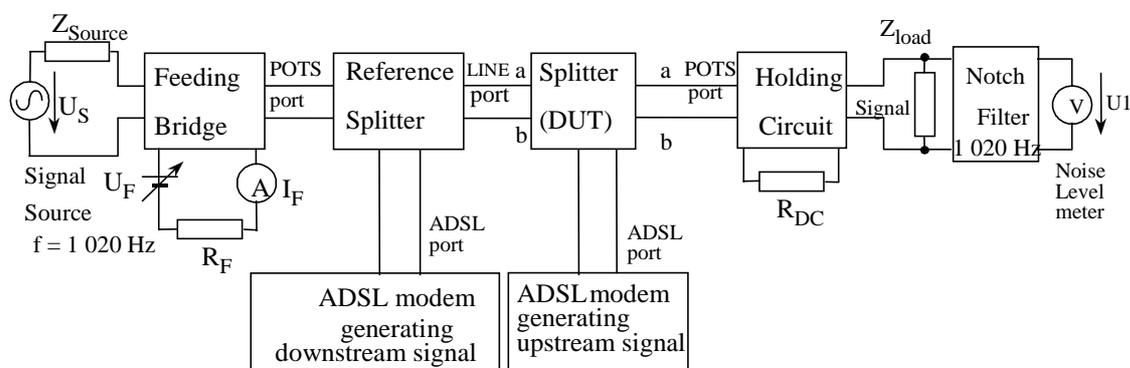
See general notes.

6.6 Distortion and intermodulation

6.6.1 Distortion

Table 13

Test case name:	Distortion
Reference:	TR 101 728 [9], clause 5.10.1
Test purpose:	To measure the harmonic distortion caused by non-linearities of the splitter
Test configuration:	See Test Set-up; DUT not configured

Test set-up:**Figure 10: Test set-up for distortion testing on a splitter without ADSL signal (verification)****Figure 11: Test set-up for distortion testing on a splitter with ADSL signal****Test parameters:****Table 14**

Parameter	Value
Level of the POTS test signal U_S	-9 dBV into Z_R at 1 020 Hz
Level of the ADSL downstream test signal	$\geq 19,9$ dBm (see note 5)
Level of the ADSL upstream test signal	$\geq 12,5$ dBm
Frequency range of test signal	300 Hz to 4 000 Hz
Source impedance Z_{Source}	Z_R
Load impedance Z_{Load}	Z_R
ADSL termination Z_{T-ADSL}	Z_{ADSL}
Level of feeding voltage	+50 V _{DC} -50 V _{DC}
Load resistance R_{DC}	470 Ω in off-hook state
DC feeding current I_F in off-hook state	13 mA 80 mA
Optional tests	None

Test matrix:**Table 15**

	TS 101 952-1-1 [10]	TR 101 728 [9]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
Level of POTS test signal -9 dBV		X		X	
Source impedance: Z_R		X		X	
Load impedance: Z_R		X		X	
Level of feeding voltage +50 V _{DC}		X		X	
Level of feeding voltage -50 V _{DC}		X		X	
Value of feeding current 13 mA		X		X	
Value of feeding current 80 mA		X		X	
Number of tests	0 Tests	2 Tests	0 Test	2 Tests	0 Tests

Test procedure notes

NOTE 1: When verifying the test set-up, a test measurement without ADSL signal with the two splitters connected and with DC-feeding should be performed. The result of the measurement shall be at least 20 dB better than the required value.

NOTE 2: Polarity of the feeding current does not impact the distortion of splitters. So the test should be performed with alternating polarity using the specified current values.

NOTE 3: If necessary, the feeding voltage can be increased to achieve the specified feeding current.

NOTE 4: For practical reasons it is suggested to use an ADSL link in normal operation to simulate the upstream and downstream signal appropriately. It is expected that the ADSL downstream signal will be reduced (because of the automatic downstream power back-off) by up to 12 dB. This will be leading to an aggregate downstream power between 8,1 dBm and 19,9 dBm. Although there is a difference of 12 dB between the values it has been shown in the validation process that this change is not going to change the result of this test significantly.

Test results:**Table 16**

Frequency range (Hz)	Maximum Total power of distortion and noise (dBV)
300 to 4 000	

Measuring notes:

See general notes.

6.6.2 Intermodulation**Table 17**

Test case name:	Intermodulation
Reference:	TS 101 952-1-1 [10], clause 6.11
Test purpose:	To measure the intermodulation products caused by non-linearities of the splitter
Test configuration:	See Test Set-up; DUT not configured

Test set-up:

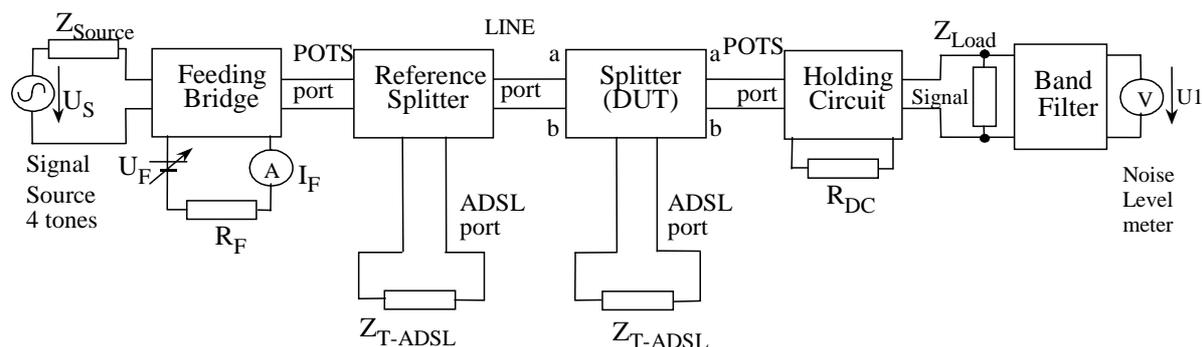


Figure 12: Test set-up for intermodulation testing on a splitter without ADSL signal (verification)

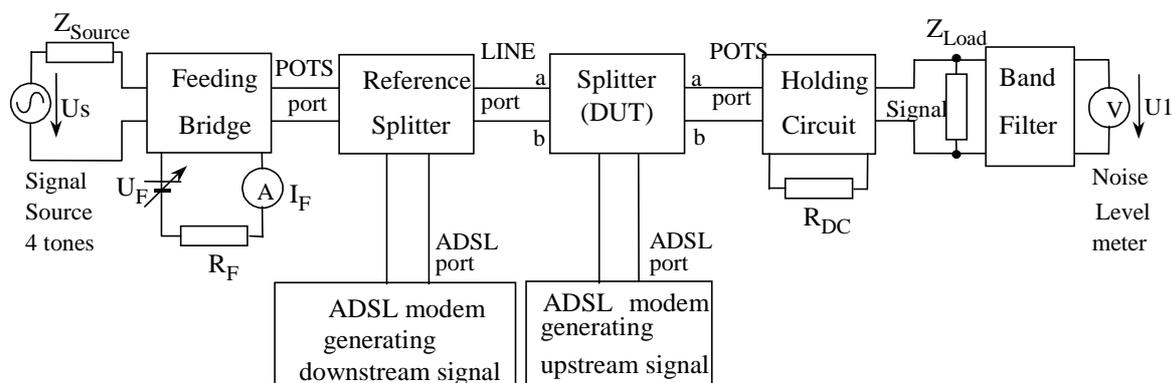


Figure 13: Test set-up for intermodulation testing on a splitter with ADSL signal

Test parameters:

Table 18

Parameter	Value
Level of the 4-tone POTS test signal U_S	-9 dBV into Z_R according to ITU-T Recommendation O.42 [11]
Frequencies of the 4-tone POTS test signal U_S	$f_1 = 857$ Hz $f_2 = 863$ Hz $f_3 = 1\,372$ Hz $f_4 = 1\,388$ Hz
Level of the ADSL downstream test signal	$\geq 19,9$ dBm (see note 5)
Level of the ADSL upstream test signal	$\geq 12,5$ dBm
Source impedance Z_{Source}	Z_R
Load impedance Z_{Load}	Z_R with filters: 1 900 Hz, 520 Hz and 2 240 Hz
ADSL termination	Z_{ADSL}
Level of feeding voltage	+50 V _{DC} -50 V _{DC}
Load resistance R_{DC}	470 Ω in off-hook state
DC feeding current I_F in off-hook state	13 mA 80 mA
Optional tests	None

Test matrix:**Table 19**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
Level of the 4-tone POTS test signal -9 dBV	X	X		X	
Source impedance: Z_R	X	X		X	
Load impedance: Z_R	X	X		X	
Level of feeding voltage +50 V _{DC} Level of feeding voltage -50 V _{DC}	X X	X X		X X	
Value of feeding current 13 mA Value of feeding current 80 mA	X X	X X		X X	
Number of tests	2 Tests	2 Tests	0 Tests	2 Tests	0 Tests

Test procedure notes

- NOTE 1: When verifying the test set-up, a test measurement without ADSL signal with the two splitters connected and with DC-feeding has to be performed. The result of the measurement should be at least 20 dB better than the required value.
- NOTE 2: Polarity of the feeding current does not impact the distortion of splitters. So the test should be performed with alternating polarity using the specified current values.
- NOTE 3: If necessary, the feeding voltage can be increased to achieve the specified feeding current.
- NOTE 4: For practical reasons it is suggested to use an ADSL link in normal operation to simulate the upstream and downstream signal appropriately. It is expected that the ADSL downstream signal will be reduced (because of the automatic downstream power back-off) by up to 12 dB. This will be leading to an aggregate downstream power between 8,1 dBm and 19,9 dBm. Although there is a difference of 12 dB between the values it has been shown in the validation process that this change is not going to change the result of this test significantly.

Test results:**Table 20**

Order of harmonic distortion	Maximum Intermodulation product (dB)
Second order harmonic distortion	
Third order harmonic distortion	

Measuring notes:

See general notes.

6.7 DC requirements

6.7.1 DC resistance to earth

Table 21

Test case name:	DC resistance to earth
Reference:	TR 101 728 [9], clause 5.1 TS 101 952-1-1 [10], clause 6.2.1
Test purpose:	To evaluate the DC resistance between a-wire and earth as well as b-wire and earth. This test only applies to splitters which provide a terminal which is connected to ground (see note)
Test configuration:	See Test Set-up; DUT not configured

NOTE: A splitter is considered to provide a earth connection, as soon as there is a specific terminal which might lead to the reasonable assumption that is could be connected to ground. Furthermore, this test is to be performed, when there are non-insulated conducting parts at the enclosure.

Test set-up:

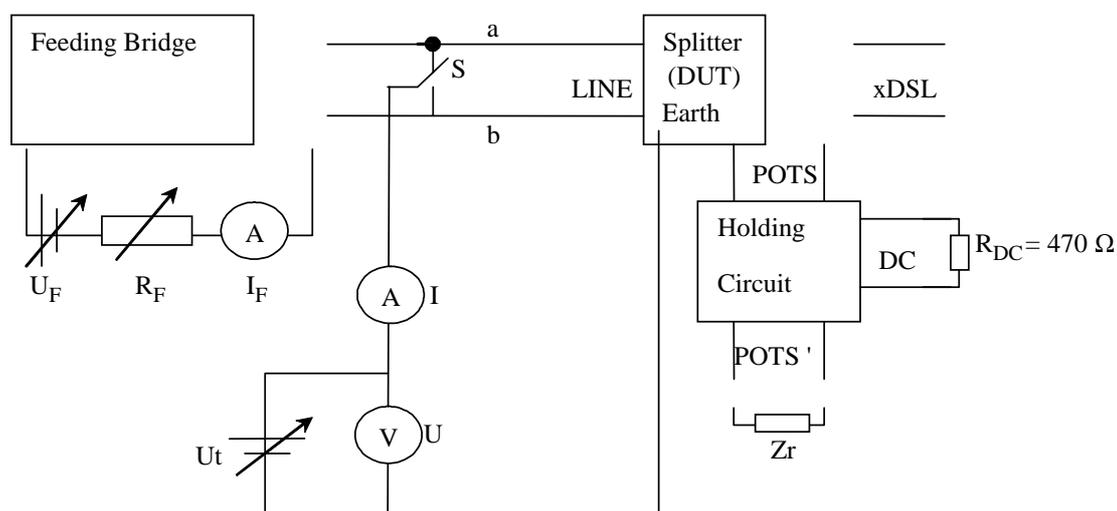


Figure 14: Test set-up for DC resistance between terminal and earth when testing LINE port

Test parameters:**Table 22**

Parameter	Value
Level of the DC test voltage U_t	100 V _{DC} -100 V _{DC}
Level of feeding voltage U_F	50 V _{DC} -50 V _{DC}
DC feeding current I_F in off-hook state	0 mA 13 mA 30 mA 60 mA 80 mA
Position of Switch S	a-wire
Termination at POTS port	Zr; R _{DC} = 470 Ω
Termination at xDSL port	open circuit
ports to be tested (probe to be connected to)	LINE POTS (only for splitters breaking the DC path in any way) xDSL

Test matrix:**Table 23**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
DC source voltage $U_t = +100$ V _{DC}	X	X	X	X	X
DC source voltage $U_t = -100$ V _{DC}	X	X	X	X	X
U_t applied to LINE	X	X	X	X	X
U_t applied to POTS (for splitters breaking the DC path only!)	X	X	X	X	X
U_t applied to xDSL	X	X	X	X	X
Switch in Position a	X	X	X	X	X
Switch in Position b	X	X	X	X	X
Feeding Voltage $U_F = +50$ V _{DC}	X	X		X	
Feeding Voltage $U_F = -50$ V _{DC}	X	X		X	
Value of feeding current 0 mA	X	X	X	X	
Value of feeding current 13 mA	X	X		X	
Value of feeding current 30 mA	X	X		X	
Value of feeding current 60 mA	X	X		X	
Value of feeding current 80 mA	X	X		X	
Termination at POTS Zr, R _{DC} = 470 Ω	X	X		X	
Termination at POTS open circuit			X		X
number of tests	24 Tests (36 for splitters breaking the DC path)	24 Tests (36 for splitters breaking the DC path)	12 Tests	24 Tests (36 for splitters breaking the DC path)	12 Tests

Test procedure notes:

NOTE 1: When a DC current is flowing, the difference in the test results between the measurements from a-wire to earth and b-wire to earth is negligible (only the R_{DC} and the series resistance of the holding circuit is added to the result). With this, at the LINE port and the POTS port testing only one wire against earth is sufficient when there is no break in the DC path.

NOTE 2: Splitters breaking the DC path should be tested completely (all three ports), splitters not breaking the DC path can use a reduced test which only requires testing at the xDSL port and the LINE port.

NOTE 3: At the xDSL port a- and b- wire should be tested separately, however, a DC current need not be applied.

NOTE 4: Verification of the test result: To verify the test result, a well-known resistor of about 5 M Ω (measured independently at an uncertainty of less than 0,1 %) should be connected to the test set-up and the resulting current should be compared with the theoretically expected result.

Test results:

Test Result has to be recorded in two ways:

- I in μA , where: I is the value of the observed current, which is flooding into the tip under test;
- $R_{\text{DC-wire-earth}}$, where $R_{\text{DC-wire-earth}} = U_t/I$.

Measuring notes:

See general notes.

6.7.2 DC Resistance between a-wire and b-wire (open ports)

Table 24

Test case name:	DC Resistance between a-wire and b-wire (open ports)
Reference:	TS 101 952-1-1 [10], clause 6.2.2; TR 101 728 [9], clause 5.1
Test purpose:	To evaluate the DC series resistance between a-wire and b-wire of the various ports when all the ports are left open
Test configuration:	See Test Set-up; DUT not configured

Test set-up:

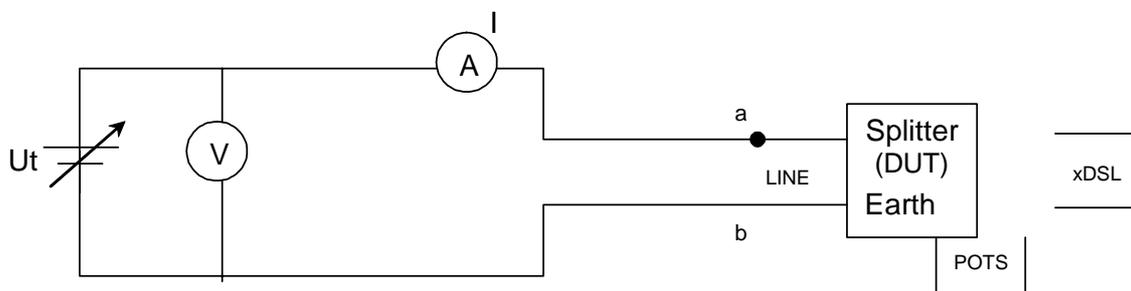


Figure 15: Test set-up for DC resistance between a- and b- terminal when testing LINE port

Test parameters:

Table 25

Parameter	Value
Level of the test voltage U_t	100 V _{DC} -100 V _{DC}
Termination at ports under test	open circuit
Termination at ports not under test (while testing at another one)	open circuit
ports to be tested (probe to be connected to)	LINE POTS (only for splitters breaking the DC path)
Optional tests	None

Test matrix:**Table 26**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
DC source voltage +100 V _{DC}	X	X	X	X	
DC source voltage -100 V _{DC}	X	X	X	X	
VDC applied to LINE	X	X	X	X	
VDC applied to POTS (for splitters breaking the DC path only!)	X	X	X	X	
VDC applied to xDSL					
Number of tests	2 Tests (4 for splitters breaking the DC path)	2 Tests (4 for splitters breaking the DC path)	2 Tests (4 for splitters breaking the DC path)	2 Tests (4 for splitters breaking the DC path)	0 Tests

Test procedure notes:

NOTE 1: If the splitter is not breaking the DC path, it is sufficient to measure at one port (the LINE port). If the splitter is breaking the DC path, both ports (LINE and POTS) should be measured.

NOTE 2: Verification of the test result: To verify the test result, a well-known resistor of about 5 MΩ (measured independently at an uncertainty of less than 0,1 %) should be connected to the test set-up and the resulting current should be compared with the theoretically expected result.

NOTE 3: Testing the xDSL port with respect to the DC resistance between open wires has been cancelled as it is not to be expected that a DC of that level occurs in normal operation at the xDSL port. Even if the DC resistance is lower than 5 MΩ this need not necessarily lead to a performance loss on the DSL path.

Test results:

Test Result has to be recorded in two ways:

- I in μA, where: I is the value of the observed current, which is flooding into the tip under test;
- $R_{\text{DC-wire-earth}}$, where $R_{\text{DC-wire-earth}} = U/I$.

Measuring notes:

See general notes.

6.7.3 DC series resistance**Table 27**

Test case name:	DC series resistance
Reference:	TS 101 952-1-1 [10], clause 6.2.3 TR 101 728 [9], clause 5.1
Test purpose:	To evaluate the DC series resistance between a-wire and b-wire of the LINE port, when a termination is connected to the POTS port and an open circuit is applied to the xDSL port
Test configuration:	See Test Set-up; DUT not configured

Test set-up:

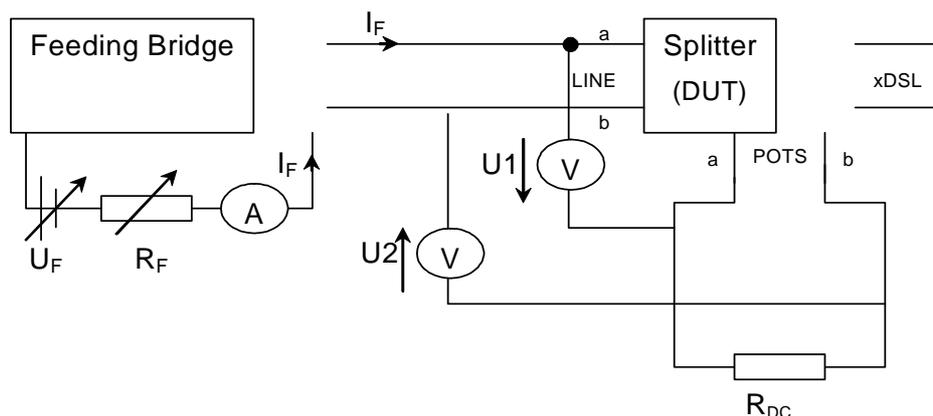


Figure 16: Test set-up for DC series resistance testing on a splitter

Test parameters:

Table 28

Parameter	Value
Level of feeding voltage	50 V _{DC}
Value of feeding current	13 mA 30 mA 60 mA 80 mA
Polarity of feeding current	Alternating
Termination at xDSL port	open circuit
Termination at POTS port	R _{DC} short circuit
ports to be tested	LINE

Test matrix:

Table 29

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
level of feeding voltage 50 V _{DC}	X	X	X	X	X
level of feeding current 13 mA	X	X	X	X	X
level of feeding current 30 mA	X	X	X	X	X
level of feeding current 60 mA	X	X	X	X	X
level of feeding current 80 mA	X	X	X	X	X
polarity of feeding current	alternating	alternating	alternating	alternating	alternating
Termination at POTS R _{DC}	X	X		X	
Termination at POTS short circuit			X		X
Termination at xDSL open circuit	X	X	X	X	X
Number of tests	4 Tests	4 Tests	4 Tests	4 Tests	4 Tests

Test procedure notes:

NOTE 1: The DC series resistance of passive splitters without current/voltage detection does not change with the value of the current. Furthermore, The DC series resistance of passive splitters without current/voltage detection does not change with the polarity of the current.

NOTE 2: The DC series resistance of passive splitters with current/voltage detection changes significantly (or at least may change significantly) with the value of the current. However, the DC series resistance of passive splitters with current/voltage detection does not change its tendency with the polarity of the current.

NOTE 3: The current leakage which is present for passive splitters with current/voltage detection and for active splitters is not defined in ETSI TS 101 952-1-1 [10], yet. A validation of the test is not possible without having specific knowledge on the splitters implementation as long as the (current/voltage dependent) power consumption of the splitter itself is not clear. Until clarification this test case does not apply for passive splitters with current/voltage detection and for active splitters.

NOTE 4: Splitters that do break the DC path cannot be assessed using this type of test. The assessment of active splitters and splitters that break the DC path in any way is for further study.

NOTE 5: Verification of the test result: To verify the test result, two well-known resistors of about 25 Ω (measured independently at an uncertainty not more than of 0,1 %) should be connected to the test set-up, simulating two DC branches of the splitter. The resulting current should be compared with the theoretically expected result.

Test results:

Test result has to be recorded in three ways:

- U1 and U2 in V, where: U1 is the voltage drop between a-wire of the LINE port and the a-wire of the POTS port and U2 is the voltage drop between b-wire of the LINE port and the b-wire of the POTS port;
- I_F in mA, where I_F is the resulting feeding current;
- $R_{DC-series}$, where $R_{DC-series} = (U1 + U2)/I_F$.

Measuring notes:

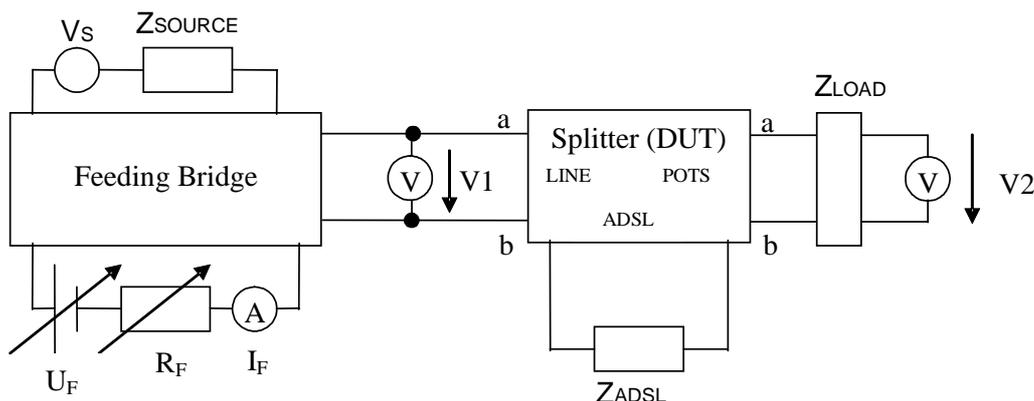
See general notes.

6.8 Ringing frequency requirements

6.8.1 Voltage drop at 25 Hz and 50 Hz

Table 30

Test case name:	Voltage drop at 25 Hz and 50 Hz (ringing frequency requirements)
Reference:	TR 101 728 [9], clause 5.3.1
Test purpose:	To measure the voltage drop at 25 Hz and 50 Hz 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 17: Test set-up for voltage drop testing on a splitter****Test parameters:****Table 31**

Parameter	Value
Frequency of the test signal	(i) 25 Hz (ii) 50 Hz
Amplitude of the test signal	(i) 60 V _{rms} superimposed on 60 V _{DC} (TR 101 728 [9], clause 5.3.1) (ii) 35 V _{rms} superimposed on 60 V _{DC} (TS 101 952-1-1 [10], clause 6.3.1)
Source impedance Z _{SOURCE}	850 Ω resistive
Load impedance Z _{LOAD}	2,7 kΩ + 2,2 μF for 25 Hz 2,7 kΩ + 1,0 μF for 50 Hz
ADSL termination	Z _{ADSL}
Optional tests	(i) 100 V rms superimposed on 100 V _{DC} (see ITU-T Recommendation G.992.1 [6], annex E1)

Test matrix:**Table 32**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
25 Hz signal frequency	X	X	X	X	X
50 Hz signal frequency	X	X	X	X	X
60 V _{rms} superimposed on 60 V _{DC}	X			X	
35 V _{rms} superimposed on 60 V _{DC}		X		X	
100 V _{rms} superimposed on 100 V _{DC}			X		X
Number of tests	2 Tests	2 Tests	2 Tests	4 Tests	2 Tests

Test procedure note:

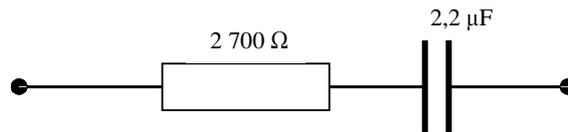
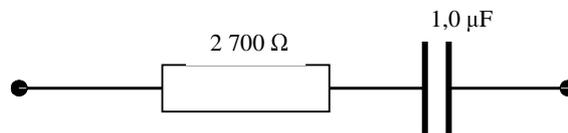
NOTE: This test should be performed for both polarities of the test signal.

Test results:

The voltage drop measured should be recorded.

Measuring Notes:

Suggested configuration for Z_{LOAD} (approx modulus 4 000 Ω, angle -45°):

Figure 18: Z_{LOAD} for 25 HzFigure 19: Z_{LOAD} for 50 Hz

6.8.2 Total harmonic distortion at 25 Hz and 50 Hz

Table 33

Test case name:	Total harmonic distortion at 25 Hz and 50 Hz (Ringing frequency requirements)
Reference:	TS 101 952-1-1 [10], clause 6.3.3
Test purpose:	To measure the total harmonic distortion at 25 Hz and 50 Hz when tested with the test parameters as given in the related standards
Test configuration:	See Test Set-up; DUT not configured

Test set-up:

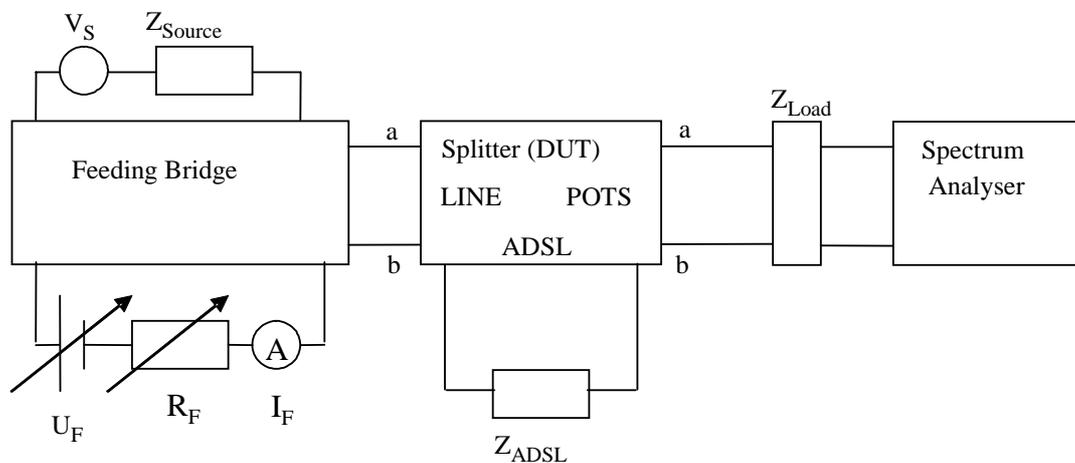


Figure 20: Test set-up for total harmonic distortion testing on a splitter

Test parameters:**Table 34**

Parameter	Value
Frequency of the test signal	(i) 25 Hz (ii) 50 Hz
Amplitude of the test signal	(i) 100 Vrms superimposed on 78 V _{DC} (TR 101 728 [9], clause 5.3.1) (ii) 100 Vrms superimposed on 50 V _{DC} (TS 101 952-1-1 [10], clause 6.3.3) (iii) 50 Vrms superimposed on 78 V _{DC} (TS 101 952-1-1 [10], clause 6.3.3)
Source impedance Z _{SOURCE}	850 Ω resistive
Load impedance Z _{LOAD}	2,7 kΩ + 2,2 μF for 25 Hz 2,7 kΩ + 1,0 μF for 50 Hz
ADSL termination	Z _{ADSL}
Optional tests	(i) 100 Vrms superimposed on 100 VDC (ITU-T Recommendation G.992.1 [6], annex E.1)

Test matrix:**Table 35**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
25 Hz signal frequency	X	X	X	X	X
50 Hz signal frequency	X	X	X	X	X
100 Vrms superimposed on 78 V _{DC}	X				
100 Vrms superimposed on 50 V _{DC}		X		X	
50 Vrms superimposed on 78 V _{DC}		X		X	
100 Vrms superimposed on 100 V _{DC}			X		X
Number of tests	2 Tests	4 Tests	2 Tests	4 Tests	2 Tests

NOTE 1: TR 101 728 [9] seems to describe the related requirement for the ringing signal distortion not sufficiently. The requirement in TR 101 728 [9] could be interpreted as an AC signal distortion test (e.g. amplitude, phase or frequency). The STF 215 has come to the conclusion that the requirement in TR 101 728 [9] should be interpreted as total harmonic distortion. This test case takes care of that suggestion.

Test procedure notes:

NOTE 2: The total harmonic distortion of the test set-up should be less or equal to 2 %.

NOTE 3: For each test case, measure the spectral amplitude in Vrms of the fundamental (ringing) frequency U_0 and all the harmonic frequencies, U_n up to the fifth harmonic, across the load impedance Z_{LOAD} .

Test results:

The harmonic distortion expressed as a percentage is calculated as follows:

$$\% \text{ Total Harmonic Distortion (THD)} = \frac{\sqrt{(U_1)^2 + (U_2)^2 + (U_3)^2 + \dots + (U_n)^2}}{\sqrt{(U_0)^2 + (U_1)^2 + (U_2)^2 + (U_3)^2 + \dots + (U_n)^2}} \times 100$$

Where terms U_1 to U_n are the levels of the harmonic frequencies term U_0 is the level of the fundamental (ringing signal) frequency.

Measuring notes:

NOTE 4: This test requires as a very pure signal source. This has to be considered when setting up the test. Note that most standard signal generators do not provide sufficiently pure sinusoidal signals for the purpose of this test. Furthermore, operational amplifiers often cause significant distortion in achieving the test levels required.

NOTE 5: Assuming standard terminal equipment it is not expected that distortion of the ringing signal do cause any problem to the TE.

6.9 Ringing Impedance

Table 36

Test case name:	Impedance at 25 Hz and 50 Hz (ringing frequency requirements)
Reference:	TR 101 728 [9], clause 5.4
Test purpose:	To evaluate the ringing impedance at 25 Hz and 50 Hz when tested with the test parameters as given in the related standards
Test configuration:	See Test Set-up; DUT not configured

Test set-up:

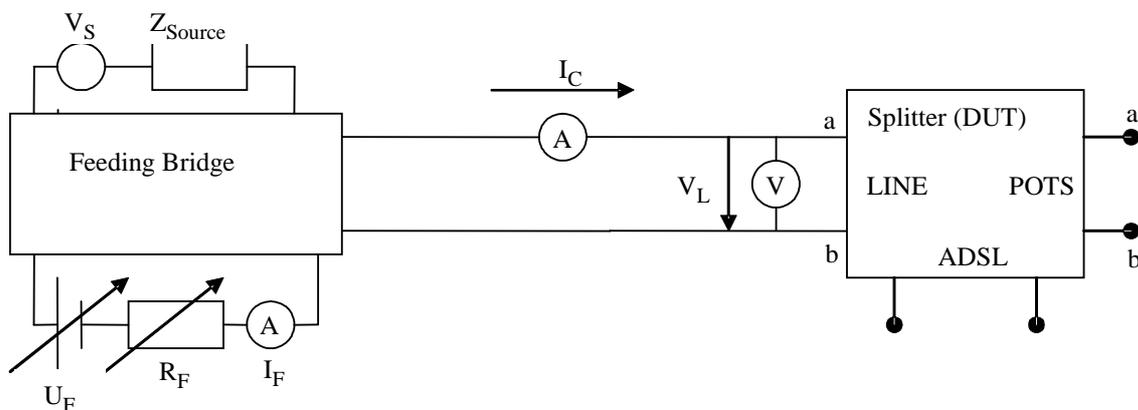


Figure 21: Test set-up for ringing impedance testing on a splitter at LINE Port

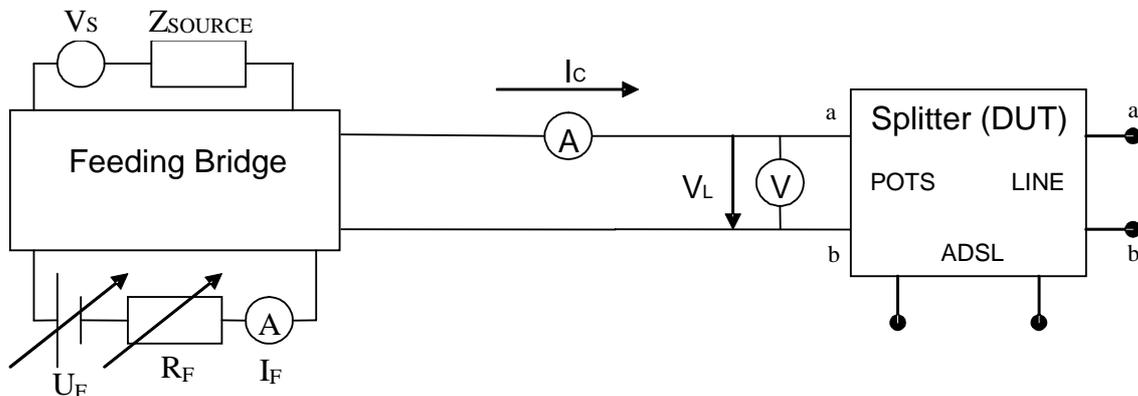


Figure 22: Test set-up for ringing impedance testing on a splitter at POTS Port

NOTE: Figure 22 requires that there is DC feeding of the splitter from the POTS port. If the splitter is sensitive to which port is power fed, feeding has to be done via the LINE port. A holding circuit is to be used to inject the test signal at the POTS port in that situation.

Test parameters:**Table 37**

Parameter	Value
Level of the test signal	(i) 25 Hz at 60 Vrms superimposed on 60 V _{DC} (ii) 50 Hz at 60 Vrms superimposed on 60 V _{DC}
Termination at ADSL port	No ADSL load
Optional tests	None

Test matrix:**Table 38**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
25 Hz at 60 Vrms, 60 VDC Line Port	X	X		X	
25 Hz at 60 Vrms, 60VDC POTS Port	X	X		X	
50 Hz at 60 Vrms, 60 VDC Line Port	X	X		X	
50 Hz at 60 Vrms, 60 VDC POTS Port	X	X		X	
Number of tests:	4 Tests	4 Tests	0 Tests	4 Tests	0 Tests

Test procedure notes:

- Ringing Impedance Circuit:
 - Configure the circuit as per figure 21 (for Line Port test) or figure 22 (for POTS Port test) as required.
 - For each test case, set the ringing signal at the signal generator in accordance with the Test Parameters.
 - Measure the current I_C and the voltage V_L dropped across the splitter port under test.

Ringing impedance is calculated thus:

$$R_L = \frac{V_L}{I_C}$$

Test results:**Table 39**

	Ringling Impedance (kΩ)
25 Hz ringing signal at Line Port	
50 Hz ringing signal at Line Port	
25 Hz ringing signal at POTS Port	
50 Hz ringing signal at POTS Port	

Measuring notes:

See general notes.

6.10 Unbalance about earth

Table 40

Test case name:	Unbalance about earth for the low pass filter
Reference:	TS 101 952-1-1 [10], clause 6.8
Test purpose:	To evaluate the Unbalance about earth of the low 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:

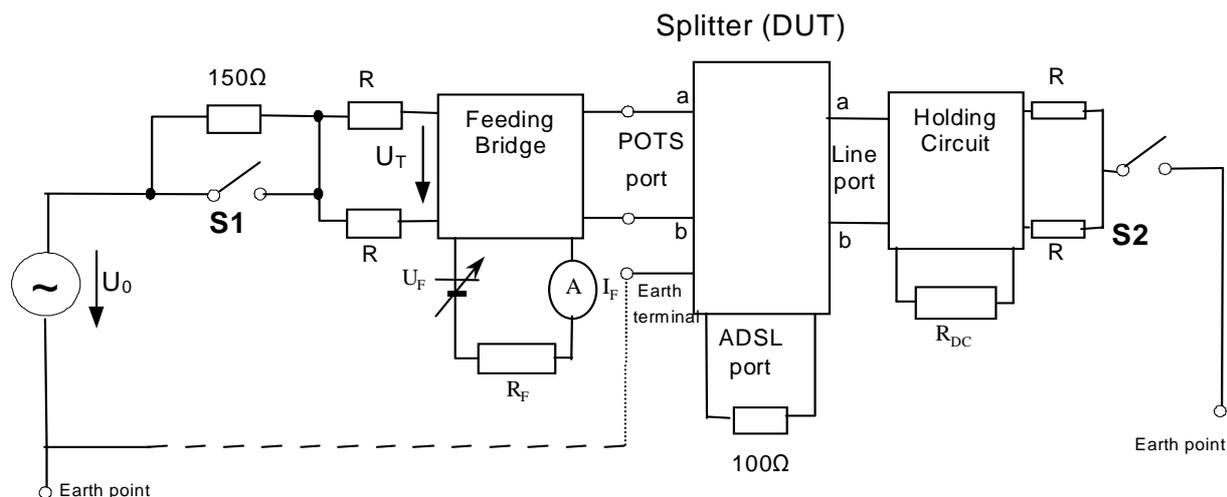


Figure 23: Test set-up for unbalance about earth testing on a splitter

Test parameters:

Table 41

Parameter	Value
Level of test signal	-4 dBm
Frequency Ranges	50 Hz to 4 kHz (600 Ω terminations) 4 kHz to 5 MHz (100 Ω terminations)
Test Combinations	Combination 1 (measurement at POTS port) S2 Open, R = 300 Ω, for 50 Hz to 4 000 Hz Combination 2 (measurement at POTS port) S2 Open, R = 50 Ω, for 4 000 Hz to 5 MHz Combination 3 (measurement at POTS port) S2 Closed, R = 300 Ω for 50 Hz to 4 000 Hz Combination 4 (measurement at POTS port) S2 Closed, R = 50 Ω, for 4 000 Hz to 5 MHz Combination 5 (measurement at LINE port) S2 Closed, R = 300 Ω for 50 Hz to 4 000 Hz Combination 6 (measurement at LINE port) S2 Closed, R = 50 Ω, for 4 000 Hz to 5 MHz
ADSL termination	100 Ω
Optional tests	None

Test matrix:**Table 42**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
Level of test signal -4 dBV	X	X	X	X	X
Test Setup Combination 1	X	X	X	X	X
Test Setup Combination 2	X	X	X	X	X
Test Setup Combination 3	X	X	X	X	X
Test Setup Combination 4	X	X	X	X	X
Test Setup Combination 5	X	X	X	X	X
Test Setup Combination 6	X	X	X	X	X
Level of feeding voltage +50 V _{DC}	X	X	X	X	X
Level of feeding voltage -50 V _{DC}	X	X	X	X	X
Value of feeding current 13 mA	X	X	X	X	
Value of feeding current 80 mA	X	X	X	X	
Value of feeding current 100 mA			X		X
Polarity of feeding current	alternating	alternating		alternating	
Number of tests	12 Tests	12 Tests	18 Tests	12 Tests	6 Tests

Test procedure notes:

NOTE 1: It was noted that in commonly used specifications (e.g. TBR 38 [7]) 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 considered. Exact specifications are for further study.

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: Care should be taken to ensure that resistors are matched. Guidance can be found in ITU-T recommendations G.117 and O.9.

Measuring notes:

On-hook feeding requirements are not applicable.

6.11 Noise

6.11.1 Noise in the band from 300 Hz to 4 000 Hz (POTS band)

Table 43

Test case name:	Noise in the Band from 300 Hz to 4 000 Hz (POTS Band)
Reference:	TR 101 728 [9], clause 5.9 TS 101 952-1-1 [10]
Test purpose:	to evaluate the unwanted noise signal which is produced in the splitter itself without any other signals applied
Test configuration:	see Test Set-up; DUT not configured
NOTE: This test only applies, if the splitter under test does contain active elements.	

No active splitter for the validation measurement could be supplied to STF 215.

However, it could be proven that the test can be performed at reasonable effort. The required accuracy to assess a system under test according to the requirements as stated in TS 101 952-1-1 [10] can be achieved.

Test set-up:

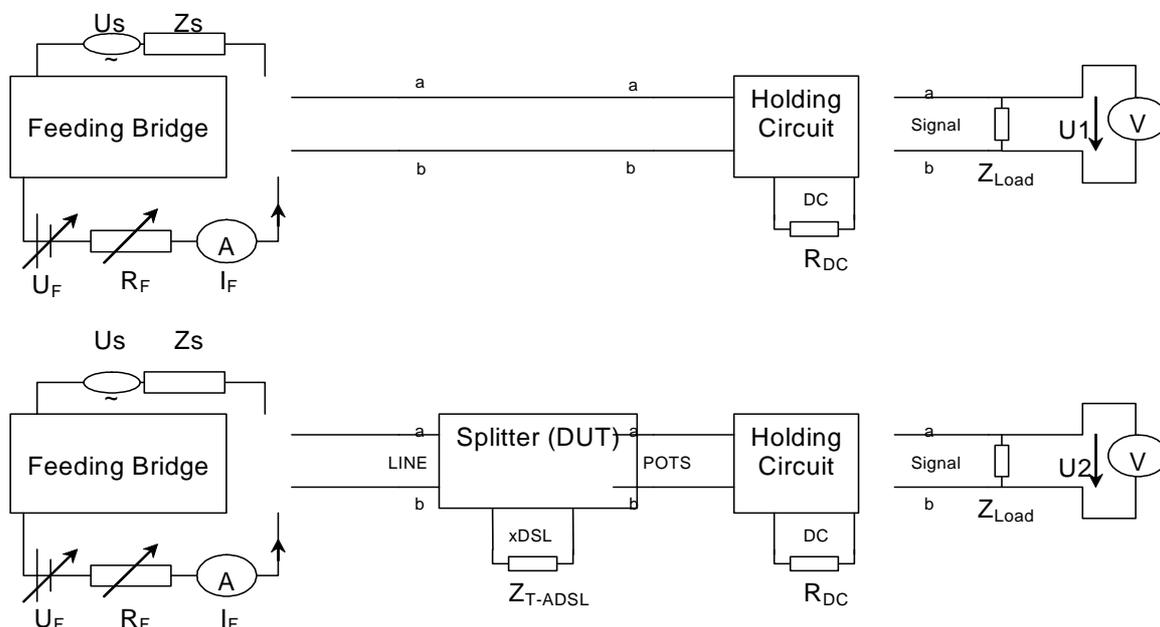


Figure 24: Test set-up for POTS band noise testing on a splitter

Test parameters:

Table 44

Parameter	Value
Level of the test signal U_s	0 V
Frequency Range of U_s	300 Hz to 4 000 Hz
Combination of Source and Load Impedances	combination 1: source: Z_R , load: Z_R , $R_{DC} = 470 \Omega$
Termination at xDSL: Z_{T-ADSL}	$Z_{T-ADSL} = Z_{ADSL}$
Level of feeding voltage	+ 50 V _{DC} - 50 V _{DC}
Value of feeding current	0 mA 13 mA 60 mA 80 mA
Ports to be tested	LINE POTS
Weighting of the measured noise	plain psophometric
Optional tests	None

Test matrix:**Table 45**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
level of the test signal 0 V	X	X		X	X
Frequency Range of Us 300 to 4 000 Hz	X	X		X	X
source/load combination 1	X	X		X	X
Level of feeding voltage +50 V _{DC}	X	X		X	X
Level of feeding voltage -50 V _{DC}	X	X		X	X
Value of feeding current 0 mA	X	X		X	X
Value of feeding current 13 mA	X	X		X	X
Value of feeding current 60 mA	X	X		X	X
Value of feeding current 80 mA	X	X		X	X
Plarity of feeding current	alternating	alternating		alternating	
$Z_{T-ADSL} = Z_{ADSL}$	X	X		X	X
measured at port POTS	X	X		X	X
Measured at port xDSL	X	X		X	X
measured with plain weighting	X	X		X	X
measured with psophometric weighting	X	X		X	X
Number of tests	16 Tests	16 Tests	0 Tests	16 Tests	0 Tests

Test procedure notes:

Before starting the measurements the test set-up has to be verified with respect to the noise present when having the DC source as well as the holding circuit present in the set-up but not having connected the splitter under test. Measuring U1 as shown in the test set-up is an appropriate way to do so. The observed value for U1 (in dBV and dBVp) should be at least 10 dB lower than the value which is to be proven.

Test results:

Test Result has to be recorded in two ways:

- U2 in dBV, where U2 is the voltage observed, when the splitter is connected as in Test Set-Up;
- U2 in dBVp, where U2 is the voltage observed and weighted psophometrically, when the splitter is connected as in Test Set-Up.

Measuring notes:

See general notes.

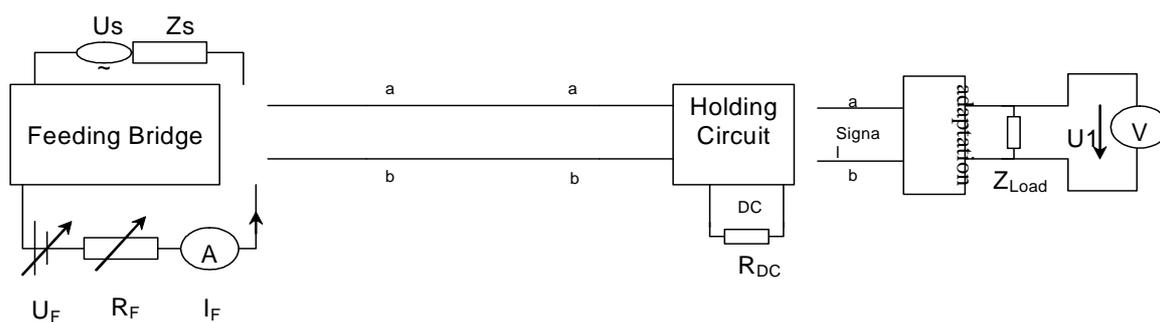
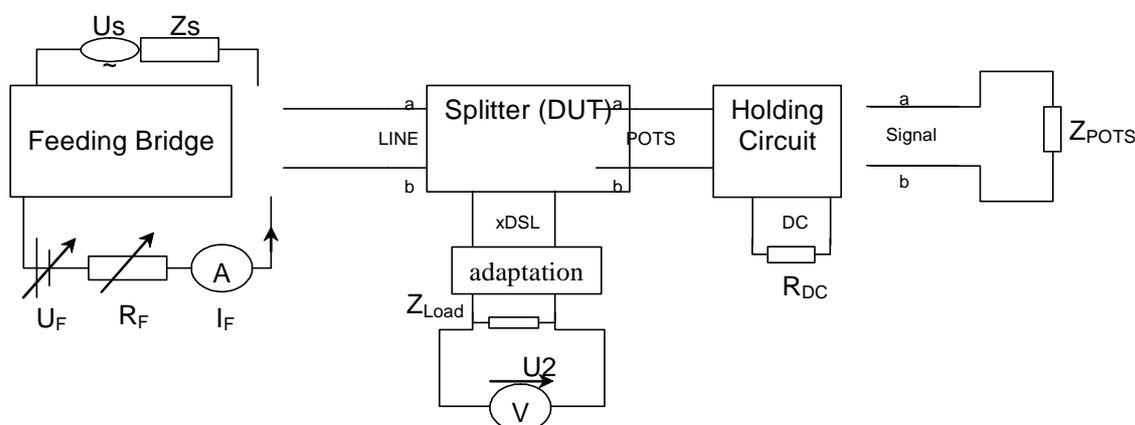
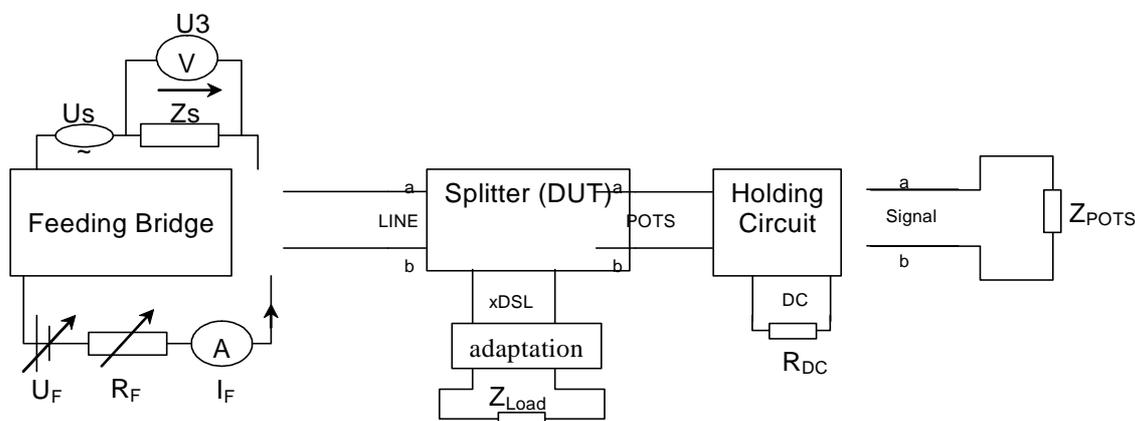
6.11.2 Noise in the band from 26 kHz to 1 100 kHz (ADSL band)**Table 46**

Test case name:	Noise in the band from 26 kHz to 1 100 kHz (ADSL band)
Reference:	TR 101 728 [9], clause 5.9
Test purpose:	To evaluate the unwanted noise signal which is produced in the splitter itself without any other signals applied.
Test configuration:	See Test Set-up; DUT not configured

NOTE This test only applies, if the splitter under test does contain active elements.

No active splitter for the validation measurement could be supplied to STF 215.

However, it could be proven that the test can be performed at reasonable effort. The required accuracy to assess a system under test according to the requirements as stated in TS 101 952-1-1 [10] can be achieved.

Test set-up:**Figure 25: Verification of the test set-up****Figure 26: Test set up for noise testing in the ADSL band on a splitter at the xDSL port****Figure 27: Test set up for noise testing in the ADSL band on a splitter at the xDSL port**

The insertion loss of Feeding Bridge and Holding Circuit in the "signal" path should be less than 1 dB in the frequency range from 26 kHz to 1 100 kHz.

Test parameters:**Table 47**

Parameter	Value
Level of the test signal U_s	0 V
Frequency Range of U_s	26 kHz to 1 100 kHz
Combination of Source and Load Impedances	combination 1: $Z_{source} = Z_{RHF}$, $Z_{POTS} = Z_{HRF}$, $Z_{load} = 100 \Omega$, $R_{DC} = 470 \Omega$, Adaptation: adaptation 1; combination 2: $Z_{source} = 100 \Omega$, $Z_{POTS} = Z_{HRF}$, $Z_{load} = 100 \Omega$, $R_{DC} = 470 \Omega$, Adaptation: adaptation 1 combination 3: $Z_{source} = 100 \Omega$, $Z_{POTS} = 100 \Omega$, $Z_{load} = 100 \Omega$, $R_{DC} = 470 \Omega$, Adaptation: adaptation 1
Level of feeding voltage	+50 V _{DC} -50 V _{DC}
Value of feeding current	0 mA 13 mA 60 mA 80 mA
Ports to be tested	LINE ADSL
Resolution Bandwidth of the Measuring Filter	10 kHz
Optional tests	None

Test matrix:**Table 48**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
level of the test signal 0 V	X	X		X	
Frequency Range of U_s 26 kHz to 1 100 kHz	X	X		X	
source/load combination 1 (for test at xDSL port only)	X	X		X	
source/load combination 2 (for test at LINE Port only)	X			X	
source/load combination 3 (for test at LINE Port only)		X		X	
Level of feeding voltage +50 V _{DC}	X	X		X	
Level of feeding voltage -50 V _{DC}	X	X		X	
Value of feeding current 0 mA	X	X		X	
Value of feeding current 13 mA	X	X		X	
Value of feeding current 60 mA	X	X		X	
Value of feeding current 80 mA	X	X		X	
Polarity of feeding current	alternating	alternating		alternating	
measured at port LINE	X	X		X	
Measured at port xDSL	X	X		X	
Number of tests	8 Tests	8 Tests	0 Tests	12 Tests	0 Tests

Test procedure notes:

Before starting the measurements the test set-up should be verified with respect to the noise present when having the DC source as well as the holding circuit present in the set-up but not having connected the splitter under test. Measuring U1 (and P1 respectively) as shown in the test set-up figure 1 is an appropriate way to do so. The observed value for P1 (in dBm) should be at least 10 dB lower than the value which is to be proven.

Test results:

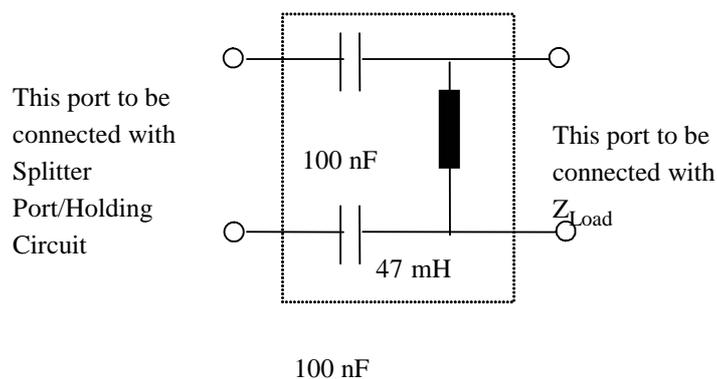
Test Result has to be recorded in two ways:

- P2 in dBm/Hz, where P2 is the noise power spectral density, when the splitter is connected as in test set-up figure 26;
- P3 in dBm/Hz, where P3 is the noise power spectral density, when the splitter is connected as in test set-up figure 27.

Measuring notes:

When testing with a selective power measurement method, at least 120 measuring points should be selected over the frequency band. When testing with a frequency sweep mode, one needs to carefully take into account of the choice of resolution bandwidth, video bandwidth and frequency range when defining the sweep time.

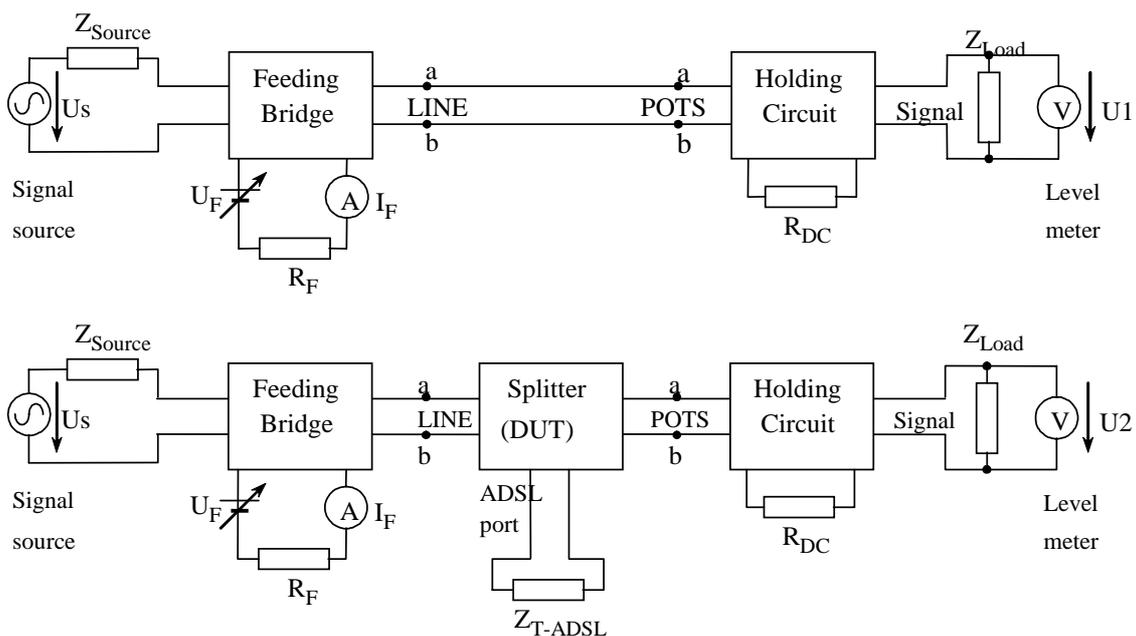
The adaptation that is given in figure 25 through figure 27 in the test set-up should be as follows:



6.12 Metering at 12 kHz or 16 kHz

Table 49

Test case name:	Metering at 12 kHz or 16 kHz
Reference:	TR 101 728 [9], clause 5.12 TS 101 952-1-1 [10], clause 6.7
Test purpose:	To measure the insertion loss at a frequency of 12 kHz or 16 kHz of metering signals
Test configuration:	See Test Set-up; DUT not configured

Test set-up:**Figure 28: Test set-up for insertion loss testing on a splitter****Test parameters:****Table 50**

Parameter	Value
Level of the test signal U_s	3,53 Vrms
Frequency of the test signal	12 kHz ± 1 % or 16 kHz ± 1 %
DC feeding current I_F in on-hook state	0,4 mA 2,5 mA
DC feeding current I_F in off-hook state	13 mA 80 mA
	NOTE: The values of I_F are set by adjusting the values of the external circuitry (U_F , R_F and R_{DC}).
Polarity of current I_F	Alternating
Source impedance Z_{Source}	200 Ω
Load impedance Z_{Load}	200 Ω
ADSL termination Z_{T-ADSL}	Z_{ADSL} open circuit
Level of feeding voltage	50 V _{DC}
Optional tests	$I_{DC} = 100$ mA; positive polarity $U_F = 60$ V, $R_F = 0$ Ω $I_{DC} = 100$ mA; negative polarity $U_F = -60$ V, $R_F = 0$ Ω

Test matrix:**Table 51**

	TR 101 728 [9]	TS 101 952-1-1 [10]	ITU-T Recommendation G.992.1 [6]	Essential Tests	Optional Tests
Source: 200 Ω	X	X	X	X	X
Load: 200 Ω	X	X	X	X	X
Level of feeding voltage 50 V _{DC} Level of feeding voltage 60 V _{DC}		X		X	
Value of feeding current 0,4 mA Value of feeding current 2,5 mA Value of feeding current 13 mA Value of feeding current 80 mA Value of feeding current 100 mA Polarity of feeding current		X X X X alternating	X X X X X	X X X X alternating	
Termination at xDSL = Z _{ADSL} Termination at xDSL = open circuit		X X		X X	
Number of tests	1 Test	8 Tests	5 Tests	8 Tests	1 Test

Test procedure notes:

- NOTE 1: The test frequency of 12 kHz or 16 kHz is dependent on the network operator specific requirement.
- NOTE 2: Polarity of the feeding current does not impact the insertion loss of splitters.
- NOTE 3: Polarity 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 4: For any kind of splitter it is sufficient to measure insertion loss in one direction (LINE to POTS).
- NOTE 5: A test case verification measurement should be taken using a flat attenuation leading to an insertion loss of about 3 dB. A simple way to set-up such an attenuation is by adding 165 Ω instead of the unit under test.
- NOTE 6: If necessary, the feeding voltage can be increased to achieve the specified feeding current.
- NOTE 7: The feeding conditions for active splitters and for passive splitters with current/voltage detection need to be determined.
- NOTE 8: Due to the possibility of receiving metering pulses a certain time after hanging-up the splitters should be tested in on-hook case as well.
- NOTE 9: There is a recognizable difference (about 0,5 dB) in the test result when measuring with and without Z_{ADSL}. Both conditions are likely to occur in real life as modems do change their input impedance when switched off. Both conditions with and without Z_{ADSL} should be tested.

Test results:

Test result has to be recorded in dB, where $I_L = 20 \log (U_2/U_1)$, where U₂ is the voltage observed when the splitter is connected as in Test Set-Up and where U₁ is the voltage observed when the splitter is replaced by a direct wire connection of less than 0,01 Ω .

Table 52

Frequency (kHz)	Maximum Insertion loss (dB)
12 \pm 1% or 16 \pm 1%	

Measuring notes:

See general notes.

History

Document history		
V1.1.1	November 2002	Publication