TECHNICAL REPORT

TR-100
ADSL2/ADSL2plus Performance Test Plan

Issue: 2
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Issue History

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2	21 August 2012	10 September 2012	Herman Verbueken, Alcatel-Lucent Bell NV	See Executive Summary

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Executive Summary

TR-100 describes performance and interoperability test cases required for ADSL2/ADSL2plus systems consisting of DSLAMs and CPE modems.

Updates for Issue 2 include:

Integrated Issue1 corrigendum 1.
Updated tests:
- Traffic tests take Padding into account
- Noise Margin Pass/Fail requirement

Added tests for:
- G.992.5 Annex-B with DPBO enabled with VDSL2 disturbers
- G.992.5 Annex-A Virtual noise
- G.992.5 Annex-J
- G.992.5 Annex-A systems supporting G.998.4 Retransmission

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1. Purpose and Scope

1.1 Purpose

This test plan facilitates ADSL2/ADSL2plus over POTS and ISDN CPE / DSLAM interoperability testing. This test plan embodies operators' definitions of ADSL2/ADSL2plus interoperability (between one DSLAM and one CPE at a time). The test plan focuses on physical layer testing, and also validation and verification of selected higher layer functionality. The test plan defines dynamic interoperability (performance) as expected by leading carriers, specifying simulated network conditions under which interoperability is required. The performance points in this test plan are based on CO equipment, capable of providing the maximum allowable power. CO equipment unable to provide this transmit power is considered to be out of the scope of this interoperability testplan. It does not replace operators' pre-deployment testing.

1.2 Scope

This test plan defines tests for various physical layer functionalities and some higher layer functionalities. A pass/fail indication result is provided for each functionality tested.

> Note: For ADSL1 operating mode, the reader is referred to TR-067[19]

> Note: The Broadband Forum has developped a specification for functional testing of ADSL2/2plus modems TR-105[7]. The user of this document should be advised that it is the intent to require that these functional tests be passed, as well as the performance tests contained herein, in order to claim interoperability.

1.3 Interoperability

A CPE modem and a DSLAM are dynamically interoperable if they implement a common and compatible set of features, functions and options and can demonstrate satisfactory mutual communication in a real network architecture environment as performance test conditions are varied and exercised. The term "compatible" is used to mean that there are no conflicting requirements that will prevent the ADSL system from achieving interoperability.

Systems are tested for Dynamic Interoperability on both standard loops and on a set of additional loops. ADSL2/ADSL2plus Termination equipment (CPE and/or CO) will be required to be tested according to the tests stated in this document. An interoperability statement with respect to this technical report is only applicable for CPE/CO combinations that have been tested against each other using the tests specified in this document.

Throughout this document, the term "DSLAM" is understood to refer to the functionality of the CO. The terms "CPE", "CPE modem" and "modem" are understood to refer to the functionality of the CPE, unless stated otherwise. CO functionality may be provided by DSLAM units or digital loop carrier based (DLC) remote terminal units.
The wording "System under test" (SUT) is used when the behaviour is applicable to the DSLAM and CPE combination.

2. References and Terminology

2.1 Conventions

In this Technical Report, several words are used to signify the requirements of the specification. These words are always capitalized. More information can be found be in RFC 2119[5]

SHALL	This word, or the term "REQUIRED", means that the definition is an absolute requirement of the specification.
SHALL NOT	This phrase means that the definition is an absolute prohibition of the specification.
SHOULD	This word, or the term "RECOMMENDED", means that there could exist valid reasons in particular circumstances to ignore this item, but the full implications need to be understood and carefully weighed before choosing a different course.
SHOULD NOT	This phrase, or the phrase "NOT RECOMMENDED" means that there could exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications need to be understood and the case carefully weighed before implementing any behavior described with this label.
MAY	This word, or the term "OPTIONAL", means that this item is one of an allowed set of alternatives. An implementation that does not include this option SHALL be prepared to inter-operate with another implementation that does include the option.

2.2 References

Listed below are standards referenced throughout this ADSL2/ADSL2plus interoperability test document.

[1] Recommendation ITU-T G.992.3 (04/2009), Asymmetric digital subscriber line transceivers 2 (ADSL2)., including all in force amendments and corrigenda.
[2] Recommendation ITU-T G.992.5 (01/2009), Asymmetric digital subscriber line (ADSL) transceivers – extended bandwidth (ADSL2plus), including all in force amendments and corrigenda.
[3] Recommendation ITU-T G.996.1 (02/2001), Test procedures for digital subscriber line (DSL) transceivers.
[4] Recommendation ITU-T G.997.1 (04/2009), Physical Layer Management for Digital Subscriber Line (DSL) Transceivers, including all in force amendments and corrigenda
[5] IETF RFC 2119, Key words for use in RFCs to Indicate Requirement Levels (1997)
[6] ANSI T1.417 Issue 2 (09/2003), Spectrum Management for Loop Transmission System
[7] TR-105 Issue 2 (11/2011), Broadband Forum Technical Report "ADSL2/ADSL2plus Functionality Test Plan"

[8] ETSI TS101388 V1.4.1 (2007-08), ADSL – European Specific Requirements.

[9] ETSI TS101952-1 V1.2.1 (2004-12) - Specification of ADSL splitters for European deployment.

[10] IEEE 802.3u, Fast Ethernet.

[11] IETF RFC 2684, Multiprotocol Encapsulation over ATM Adaptation Layer 5 (AAL5).

[12] IETF RFC 2516, Method for Transmitting PPP over Ethernet. (PPPoE).

[13] IETF RFC 2364, PPP over AAL5 (PPPoA).

[14] Recommendation ITU-T G.9954 (01/2007) Phoneline networking transceivers – Enhanced physical, media access, and link layer specifications

[15] Specification of the Access Network Frequency Plan applicable to transmission systems connected to the BT Access Network", NICC Document ND1602:2005/08, Issue 3,
http://www.nicc.org.uk/nicc-public/Public/interconnectstandards/dsltg_spec/nd1602_2005_08.pdf

[16] ANFP Issue 3 PSD masks spreadsheet
http://www.nicc.org.uk/nicc-public/Public/interconnectstandards/dsltg_spec/nd1602_2005_08.xls

[17] IETF RFC 1242, Benchmarking terminology for network interconnection devices.

[18] IETF RFC 2544, Benchmarking terminology for network interconnection devices (Test methodology).

[19] TR-067 Issue 2, Broadband Forum Technical Report "ADSL Interoperability Test Plan"

[20] ETSI TS 101 270-1 V1.4.1 (2005-10) Transmission and Multiplexing (TM); Access transmission systems on metallic access cables; Very high speed Digital Subscriber Line (VDSL); Part 1: Functional requirements

[21] Recommendation ITU-T G.998.4 (06/2010), Improved impulse noise protection for DSL transceivers, including all in force amendments and corrigenda

[22] Recommendation ITU-T G.993.2 (12/2011), Very high speed digital subscriber line transceivers 2 (VDSL2), including all in force amendments and corrigenda

2.3   Definitions

The following terminology is used throughout this Technical Report.

Net data rate	Sum of net data rates of all bearer channels in any one direction (G.992.3 [1] §3.28)
Bit rate	term used interchangeably with Net data rate
Micro-interuption	Disconnection of the loop for a very short time period
Showtime	DSLAM and CPE trained up to the point of passing data (G.992.3 [1] §3.34)
Sync State	Showtime state
Sync Rate	Net data rate achieved in Showtime
f_{delta}	The maximum frequency separation between two consecutive samples of loop attenuation or noise power during calibration

2.4   Abbreviations

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This Technical Report uses the following abbreviations:

ATM	Asynchronous Transfer Mode
ATSE	ATU Transmission System Enabling
ATU	ADSL Transceiver Unit
AWG	American Wire Gauge
AWGN	Additive White Gaussian Noise
BER	Bit Error Ratio
CO	Central office
CPE	Customer Premises Equipment
dB	decibel
dBm	decibels relative to milliwatts
DPBO	Downstream Power Backoff
DS	Downstream
DSLAM	Digital Subscriber Line Access Multiplexer
ES	Errored Second
ETSI	European Telecommunications Standards Institute
EUT	Equipment Under Test
FEXT	Far-End Crosstalk
GD	Group Delay
IS	In Service: management term indicating that a line is configured and is allowed to train
INP	Impulse Noise Protection
INPMIN	Minimum impulse noise protection for a system using 4.3125 kHz subcarrier spacing (Section 7.3.2.3/G.997.1)
ISDN	Integrated Service Digital Network
ITU	International Telecommunications Union
L0	Link state zero (G.992.3 [1] §6.8.1)
L2	Link state two (G.992.3 [1] §6.8.2)
MAC	Media Access Control
MAE	Mean Absolute Error
MAPE	Mean Average Percentage Error
MD	Medium Density
ME	Mean Error
MODEM	End user device or CPE. Concatenation of Modulator-Demodulator
NEXT	Near-End Crosstalk
PC	Personal Computer
PD	Phase Delay
PE	Polyethylene
POTS	Plain Old Telephone Service
PSD	Power Spectral Density
RA	Rate Adaptive
REIN	Repetitive impulse noise
RFI	Radio Frequency Ingress
SES	Severely Errored Second

SUT   System Under Test
UPBO   Upstream Power Backoff
US   Upstream
USB   Universal Serial Bus

2.5 G.997.1 Parameters

Parameter	Section in G.997.1
Actual Data Rate	7.5.2.1
ACTATPds	7.5.1.24, 7.5.1.25
BITSpsds, BITSpsus	7.5.1.29.1, 7.5.1.29.2
CARMASKds, CARMASKus	7.3.1.2.6, 7.3.1.2.7
CV (-C,-CFE)	7.2.2.1.1, 7.2.2.2.1
DPBO	7.3.1.2.13
ES (-L, -LFE)	7.2.1.1.2, 7.2.1.2.2
Line power management state	7.5.1.5
L0-TIME	7.3.1.1.5
L2-TIME	7.3.1.1.6
L2- ATPR	7.3.1.1.7
L2- ATPRT	7.3.1.1.8
MAXBER	7.3.2.6
MAXNOMATPds, MAXNOMATPus	7.3.1.2.3, 7.3.1.2.4
MAXNOMPSDds, MAXNOMPSDus	7.3.1.2.1, 7.3.1.2.2
MAXSNRMds, MAXSNRMus	7.3.1.3.3, 7.3.1.3.4
MINSNRMds, MINSNRMus	7.3.1.3.5, 7.3.1.3.6
MSGMINds, MSGMINus	7.3.1.5.2, 7.3.1.5.1
PMMode	7.3.1.1.4
PSDMASKds, PSDMASKus	7.3.1.2.9, 7.3.1.2.12
RFIBANDS	7.3.1.2.10
SES (-L, -LFE)	7.2.1.1.3, 7.2.1.2.3
TARSNRMds, TARSNRMus	7.3.1.3.1, 7.3.1.3.2

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3. Technical Report Impact

3.1 Energy Efficiency

TR-100 has no impact on energy efficiency.

3.2 IPv6

TR-100 has no impact on IPv6.

3.3 Security

TR-100 has no impact on security.

3.4 Privacy

TR-100 has no impact on privacy

4. Test Tools Requirements and Compensation

This testplan may require the following tools:
- Loop simulator
- Traffic simulator/analyzer with matching network interfaces
- ATM switch/router
- PC with USB/Ethernet interface
- Noise sources for both ends of the line (loop simulator integral noise sources or arbitrary waveform generators)

All these tools are part of configurations identified in figures 3, 4, 5 and 6. The ATM switch/router and PC used for throughput testing needs to have adequate performance such that they do not affect the measured throughput over the ADSL2/ADSL2plus link. The ATM Switch or Simulator may be removed if traffic simulator/analyzer in use is capable of terminating the ATM or IP traffic directly from the DSLAM.

4.1 Accuracy of Loop simulators and noise sources

4.1.1 Loop Simulators

a) Attenuation

North American region:

Loop attenuation which corresponds to the insertion loss is expressed in dB SHALL be calculated from RLCG parameters using two-port ABCD modeling methodology as specified in T1.417[6] Section B.3.1 (for both straight loops and loops with bridge taps).

The RLCG cable parameters SHALL be as specified in T1.417[6] Table B.2 "Cable model parameters for 26-AWG twisted pair cable" and Table B.6 "Cable model parameters for 24-AWG twisted pair cable".

European region:

Loop attenuation, which corresponds to the insertion loss, is expressed in dB SHALL be calculated from RLCG parameters using two-port ABCD modeling methodology as specified in T1.417[6] Section B.3.1 (for both straight loops and loops with bridge taps).

The RLCG cable parameters SHALL be as specified in TS101388[8] Table A.1 "Parameter set for generating distributed cable coefficients".

For the loop simulator used in testing, the simulated loop attenuation SHALL be measured over the frequency band [f1, f2], given by table 4-1 and 4-2 for the different annexes. At least one measurement SHALL be made per f_{delta} interval. The Mean Error (ME) and Mean Absolute Error (MAE) of the measured simulated loop attenuation values (in dB), relative to the theoretical loop attenuation values (in dB), SHALL be calculated.

Table 4-1: Compensation boundaries for ADSL2

	Annex A/L	Annex B
f1 (kHz)	25	120
f2 (kHz)	1104	1104
f_{delta} (kHz)	10	10
A_{max} (dB)	95	95

Table 4-2: Compensation boundaries for ADSL2plus

	Annex A/M	Annex B	Annex J
f1 (kHz)	25	120	10
f2 (kHz)	2208	2208	2208
f_{delta} (kHz)	10	10	10
A_{max} (dB)	Note1	Note1	Note1

Note 1: the A_{max} for ADSL2plus SHALL be the inverse function of the ADSL2plus PSD mask, as specified in table 4-3

Table 4-3: Definition of A_{max} for ADSL2plus

Frequency (kHz)	Annex-A/M	Annex-B	Annex-J	Level dB
f1	25	120	10	95
f2	1104	1104	1104	95
f3	1622	1622	1622	85
f4	2208	2208	2208	83.7
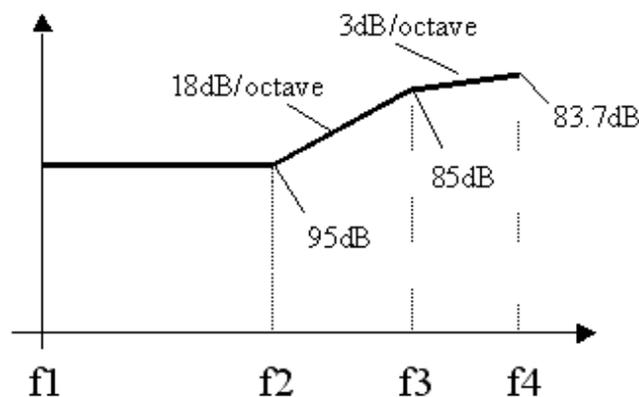
Figure 1: Amax vs. frequency for ADSL2plus

Mean Absolute Error (MAE) and Mean Error (ME) for loop X are given by Equation 1 and Equation 2:

$$\text{MAE}_{\text{Loop X}} = \frac{1}{N_i + N_j} \cdot \left[\sum_{i \in \{A_{Ti} \leq A_{\max j}\}} |A_{Ri} - A_{Ti}| + \sum_{j \in \left\{ \substack{A_{Tj} > A_{MAXj} \\ A_{Rj} - A_{MAXj} < -0.5} \right\}} |A_{Rj} - A_{MAX_j}| \right]$$

Equation 1

$$\text{ME}_{\text{Loop X}} = \frac{1}{N_i + N_j} \cdot \left[\sum_{i \in \{A_{Ti} \leq A_{\max j}\}} (A_{Ri} - A_{Ti}) + \sum_{j \in \left\{ \substack{A_{Tj} > A_{MAXj} \\ A_{Rj} - A_{MAXj} < -0.5} \right\}} (A_{Rj} - A_{MAX_j}) \right]$$

Equation 2

[positive error = too much attenuation]

A_{Ri} = Attenuation sample, in dB, of the measured loop X
A_{Ti} = Attenuation sample, in dB, of the theoretical loop X

The index "i" belongs to a set defined by the points necessary to measure the attenuation in steps of f_{delta} or less and taking into account only those points between f1 and f2 for which $AT <= A_{\text{Max}}$ dB.
Ni is the number of elements in the above set.
The index "j" belongs to a set defined by the points necessary to measure the attenuation in steps of f_{delta} or less and taking into account only those points between f1 and f2 for which

$A_T > A_{\text{Max}}$ dB and $A_R - A_{\text{Max}} < $ -0.5 dB.

N_j is the number of elements in the above set.

The loop simulator SHALL be compensated by adjusting the loop length such that the absolute value of ME is minimized while maintaining an MAE less than 0.5 dB. This accuracy requirement SHALL apply for all test loops.

b) Average noise floor

The average noise floor in the Wireline Simulator SHALL be lower than -150dBm/Hz within the ADSL2/ADSL2plus band, measured on the device when powered on.

c) Impedance

North American region:

Input impedance SHALL be calculated from RLCG parameters using two-port ABCD modeling methodology as specified in T1.417[6] Section B.3.1 (for both straight loops and loops with bridge taps).

The RLCG cable parameters SHALL be as specified in T1.417[6] Table B.2 "Cable model parameters for 26-AWG twisted pair cable" and Table B6 "Cable model parameters for 24-AWG twisted pair cable".

European region:

Input impedance SHALL be calculated from RLCG parameters using two-port ABCD modeling methodology as specified in T1.417[6] Section B.3.1 (for both straight loops and loops with bridge taps).
The RLCG cable parameters SHALL be as specified in TS101388[8] Table A.1 "Parameter set for generating distributed cable coefficients".

Compensation method:

The impedance compensation SHALL be based on a difference in injected noise power (captures the impact on the datarate).
The difference in injected noise power due to the variance of the input impedance of the wireline simulator SHALL have a mean absolute error (MAE) of less than 0.5 dB from the injected noise power using the theoretical input impedance, measured with the same appropriate termination impedance in each case.

For North American noises the termination impedance is 100 Ohm, for European noises, this SHALL be according to TS101388[8], section 5.1.

The difference in injected noise power is calculated in dB according to Equation 3

$$\Delta p_i = 10 \cdot \log_{10}(p_{out}^{sim}) - 10 \cdot \log_{10}(p_{out}^{loop})$$

$$= 10 \cdot \log_{10}\left(\left| \frac{Z_{in,sim}^{R}(f_i) \cdot Z_L(f_i)}{Z_{in,sim}^{R}(f_i) + Z_L(f_i)} \right|^2 \right) - 10 \cdot \log_{10}\left(\left| \frac{Z_{in,loop}^{R}(f_i) \cdot Z_L(f_i)}{Z_{in,loop}^{R}(f_i) + Z_L(f_i)} \right|^2 \right) \quad \text{dB}$$

<div align="center">Equation 3</div>

where
   f_i are the frequency bins.

The mean absolute error is defined in Equation 4

$$MAE(\Delta p) = \frac{1}{N_{bins}} \sum_i |\Delta p_i|$$

<div align="center">Equation 4</div>

and the sum is over those bins in the passband where the insertion loss is less than 90 dB.

d) Phase

North American region:

Phase SHALL be calculated from RLCG parameters using two-port ABCD modeling methodology as specified in T1.417[6] Section B.3.1 (for both straight loops and loops with bridge taps).

The RLCG cable parameters SHALL be as specified in T1.417[6] Table B.2 "Cable model parameters for 26-AWG twisted pair cable" and Table B.6 "Cable model parameters for 24-AWG twisted pair cable".

European region:

Phase SHALL be calculated from RLCG parameters using two-port ABCD modeling methodology as specified in T1.417[6] Section B.3.1 (for both straight loops and loops with bridge taps). The RLCG cable parameters SHALL be as specified in TS101388[8] Table A.1 "Parameter set for generating distributed cable coefficients".

The Mean Average Percentage Error for Phase delay SHALL be defined as in Equation 5

$$MAPE(PD) = 100 \cdot \frac{1}{N} \cdot \left[\sum_N \left\{ \left| \left| \frac{PD_{cable} - PD_{sim}}{PD_{cable}} \right| \right| \right\} \right]$$

Equation 5

where:
  Phase Delay(f) = unwrapped(phase(f))/ (2*pi*f)
  f is the frequency,
  PDcable is the Phase delay for a theoretical loop,
  PDsim is the measured Phase delay for the simulator,
  N is the number of frequencies used in the averaging.

The Mean Average Percentage Error for Group Delay SHALL be defined as in Equation 6

$$MAPE(GD) = 100 \cdot \frac{1}{N} \cdot \left[\sum_N \left\{ \left| \left| \frac{GD_{cable} - GD_{sim}}{GD_{cable}} \right| \right| \right\} \right]$$

Equation 6

where:
  GDcable is the Group delay for a theoretical loop,
  GDsim is the measured Group delay for the simulator,
  N is the number of frequencies used in the averaging.

Points where $|GD_{cable}|$ is <= 0.1 microseconds SHALL not be included in the sum and N SHALL be adjusted accordingly.

The maximum MAPE(PD) SHALL be 7%
The maximum MAPE(GD) SHALL be 7%

The measurement of the PD and GD used above SHALL made over a frequency range of ± one bin, or 8.625kHz, starting at the lowest used channel frequency for the PDs in question and ending at the channel below which EITHER the insertion loss exceeds 90dB OR the frequency is the highest used frequency, whichever comes first.

The Group Delay is defined using the
Equation 7

$$GD_i = \frac{phase_{i-1} - phase_{i+1}}{2 \cdot \pi \cdot (f_{i+1} - f_{i-1})}$$

Equation 7

where:

phase is the unwrapped phase in radians,
the difference in frequency between f_{i+1} and f_i SHALL be 4.3125 kHz,.

GD is not calculated or used at the two end frequency points.

4.1.2 Noise Sources

Each noise SHALL be measured independently at the ATU terminal. This SHALL be done for one noise source at a time, using a zero-length loop. For North American cases both ATUs are replaced by a 100 Ohm (±1%) resistor. For European cases the methodology in TS101388[8] section 5.1.4.1 SHALL be used. The measured noise will be impacted by the noise generator tolerance, the coupling circuit tolerance, cabling tolerance and noise pickup.

The noise compensation frequency range [f1, f2] for testing of the various annexes SHALL be identical to the frequencies specified in Table 4-1 and Table 4-2 for the loop compensation. At least one measurement SHALL be made per 10 kHz interval. The Mean Error (ME) and Mean Absolute Error (MAE) of the measured simulated noise level values (in dBm/Hz), relative to the theoretical noise level values (in dBm/Hz), SHALL be calculated.

The Mean Absolute Error (MAE) and Mean Error (ME) for noise X are given by Equation 8 and Equation 9:

$$\text{MAE}_{\text{noise X}} = \frac{1}{M} \sum_{i \in \left\{ P_{Ti} \geq -140 dBm/Hz \right\}} \left| P_{Ri} - P_{Ti} \right|$$

Equation 8

$$\text{ME}_{\text{noise X}} = \frac{1}{M} \sum_{i \in \left\{ P_{Ti} \geq -140 dBm/Hz \right\}} \left(P_{Ri} - P_{Ti} \right)$$

Equation 9

[positive error = too much noise power]

P_{Ri} = power sample, in dBm/Hz, of the generated noise X
P_{Ti} = power sample, in dBm/Hz, of the theoretical noise X

The index "i" belongs to a set defined by the points necessary to measure the noise power in steps of 10 kHz or less and taking into account only those points for which $PTi >= -140$ dBm/Hz.
M is the number of elements in the above set.

4.1.2.1   Noise Impairment Accuracy

All noise impairments used in this specification SHALL comply with the following specifications. The theoretical noise level SHALL have a Gaussian amplitude distribution to 5 sigma.

The noise generator SHALL be compensated such that the absolute value of ME is minimized while maintaining an MAE less than 0.5 dB.

Note: For noise calibration, there is measurement uncertainty that can not be compensated for, consisting of the following contributions:
- absolute amplitude accuracy, vertical linearity and frequency response of the measurement equipment used;
- tolerance of the calibration impedance.

4.1.3   Cabling

Cabling, switches and other equipment are needed to connect the DSLAM, the loop simulator, the noise generator and the CPE. Care needs to be taken in order that the minimum noise is coupled into this cabling, so the wiring should be kept short as practically possible. Recommended cables should be Category 5 or better.
For all loops with bridged taps at modem side, the modem interconnect cable SHALL be included in the calculations. The modem cable used for these tests SHALL have an attenuation of 6ft 26AWG or 2m PE04.
For straight loops the length of this cable section is not important, as it is taken into account during the compensation procedure.

Computer screens and power supplies radiate in the frequency bands used by ADSL2/ADSL2plus. These devices should be placed at a distance from the setup or even be switched off. This noise may be generated by either internal or external power supplies. When the pickup noise levels are greater than -150 dBm/Hz, they will limit the ADSL2/ADSL2plus performance and influence the test results.

The CPE and CO and their wiring should be physically separated, since when testing on long loops, crosstalk can occur between the cabling. Generally, starting from attenuation levels of 70 dB and greater, care should be taken for the wiring to avoid crosstalk.

To obtain the maximum accuracy the cables, switches and any other equipment used in the link between the DSLAM and the Remote modem SHALL be contained within the compensation process described above in section 3.1.1 (Loop Simulators).

5. Common Test Information

5.1 Net data rates for DSLAMs

Throughout this document, the variable "net data rate" is used. This parameter is equal to the 'actual data rate' of G.997.1[4] section 7.5.2.1 and is defined in section 3.28 of G.992.3[1]. The "sync rate" is the net data rate achieved in showtime.

5.2 Compatibility Matrix/Definitions

A modem needs to achieve at least the minimum required performance in each test to claim interoperability with the DSLAMs it is tested against. When a modem is tested against a set of DSLAMs, it needs to achieve the minimum required performance in each test against each DSLAM.

5.3 Recording Temperature and Humidity

The ranges of temperature and humidity of the test facility over the entire time of all the tests herein SHALL be recorded in a manner similar to table 5-1. The acceptable range of temperatures SHALL be between 15 °C/59 °F and 35 °C/95 °F. The humidity SHALL be between 5% and 85%.

Table 5-1: Temperature and Humidity

Parameter	High	Low
Temperature		
Humidity		

5.4 Sync State Definition

The modem sync state SHALL be defined as achieving showtime and capable of transferring data.

5.5 Recording Performance Statistics

During testing the reported information SHALL be retrieved from the DSLAM. For some tests it MAY be needed to retrieve the information from the CPE.

6. Equipment Features

The listed tables 6-1 and 6-2 SHALL be filled with the requested information before starting the tests in order to have all the information about the EUT and to have a reproducible test environment.

6.1 DSLAM

Table 6-1: DSLAM Features (Informative)

Test Item	Results
DSLAM General Information	
Vendor information (product name and revision)	
HW Version	
SW Version	
Line Card Type, Version	
Industry Standards Supported	
Chipset (Vendor, HW and Firmware)	
ADSL2/ADSL2plus Characteristics	
supported max rates - downstream	
supported max rates - upstream	
possible coding options	
Used duplex procedure (FDD, EC)	
frequency usage (bin allocation) downstream	
allowed usage Upstream bins (option below #33)	
Support of extended framing parameters	
Support of minimum INP control above INP=2	
Dying Gasp detection	
Power Cut Back implemented? (yes/no)	
ATM Characteristics	
Maximum Number of VCCs per DSLAM port	
F5 OAM Support	
VPI/VCI Ranges	
Splitter Characteristics	
Vendor information	
Type (POTS, 2B1QISDN, 4B3T ISDN,…)	
HW version	

6.2 CPE

Table 6-2: CPE Features Tables (Informative)

Test Item	Results
CPE General Information	
vendor information (product name and revision)	

Test Item	Results
Industry Standards Supported	
HW version	
SW version	
serial number	
Modem form (interfaces)	
PCI/USB driver version	
Chipset (Vendor, HW and Firmware)	
ADSL2/ADSL2plus Characteristics	
supported max net data rate - downstream	
supported max net data rate – upstream	
possible coding options	
used duplex procedure (FDD, EC)	
allowed frequency usage downstream	
used Upstream bins (option below #33)	
Support of extended framing parameters	
Support of minimum INP control above INP=2	
Power Cut Back implemented? (yes/no)	
dying gasp (yes/no)	
ATM Characteristics	
Maximum No. of VC's	
VPI/VCI Ranges	
F4/F5 OAM Loopback, optional CC, AIS, RDI	
supported QoS classes	
ILMI supported (yes/no)	
Protocols	
RFC 2684 IP Bridging	
RFC 2684 IP Routing	
Bridge Filter	
LLC-SNAP	
VC-MUX	
DHCP Client / Server	
NAT	
PAT	
RFC 2364 PPPoA	
RFC 2516 PPPoE	
PAP / CHAP	
Classical IP RFC 1577	
Max number of active connections	
Other supported protocols	
Splitter Characteristics	
Vendor information	
Type (POTS, 2B1QISDN, 4B3T ISDN,…)	
HW version	

7.   Test Configurations

Test configurations used in this Test Plan are represented below.

Note: for Figures 2 through 6: high-impedance couplings may be integrated in noise sources, and high impedance is defined as in G.996.1[3] Figure 3.
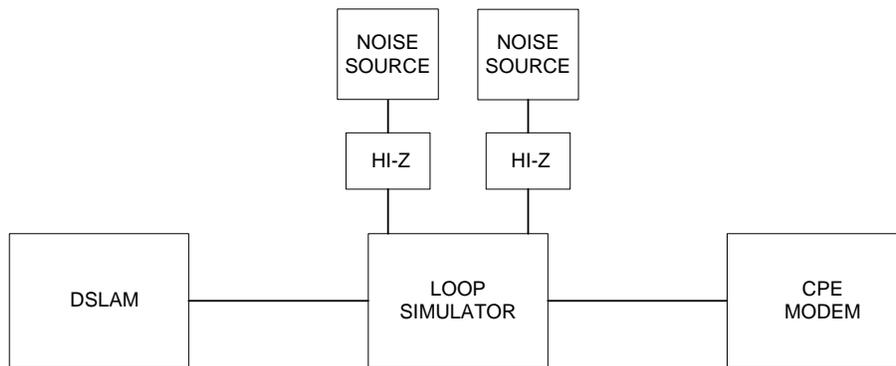
Figure 2: Test setup for loop tests for ADSL2/ADSL2plus external modems
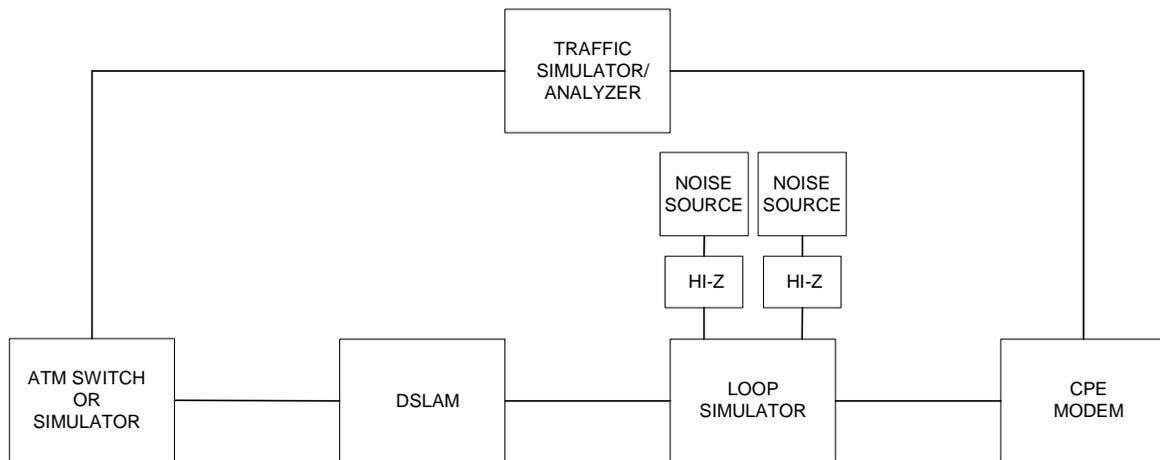
Figure 3: Test setup for throughput tests for ADSL2/ADSL2plus external modems with Ethernet interfaces

Note for Figure 3:
The ATM Switch or Simulator may be removed if traffic simulator/analyzer in use is capable of terminating the ATM traffic directly from the DSLAM.
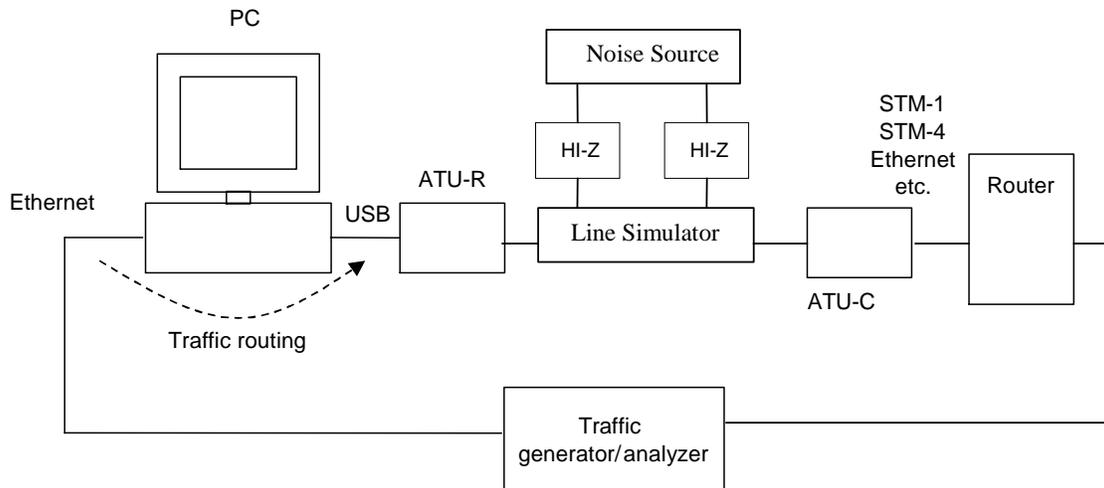
Figure 4: Test set-up for USB modems
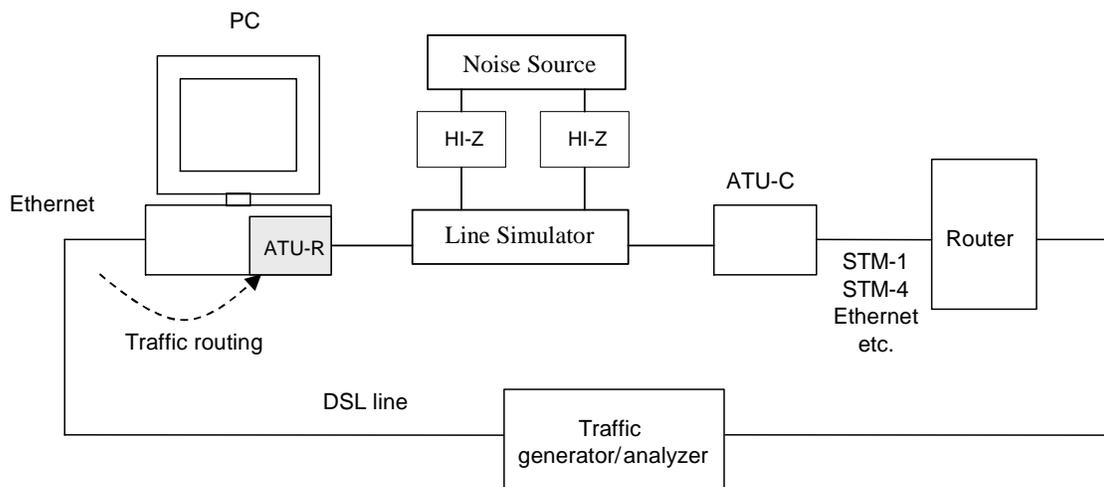
Figure 5: Test set-up for internal modems

Notes for Figure 4 and Figure 5:

- The PC needs to have a separate Ethernet interface or Ethernet card installed.

- The Ethernet card and the corresponding port on the traffic generator/analyzer should be configured with IP addresses on the same network.

- The PC should be set-up to route traffic between the Ethernet interface and the USB interface (see below). Note that the PPP session through the modem needs to be initiated before this can be done, if PPP is to be used.

- With suitable choice of PC it is assumed that its effects on performance are negligible.

- The traffic generator/analyzer is used to measure end to end throughput, latency and packet loss in exactly the same way as for other modem types (e.g., Ethernet).

- The PC setup examples below only apply to Windows PCs: (Note that the choice of PC impacts performance and that this impact should be restricted.)
    - On the PC, enable IP routing

- Add a route on the PC to the traffic generator/analyzer port which is connected to the router. Add a static route on the router to the Ethernet port of the traffic generator/analyzer connected to the PC.
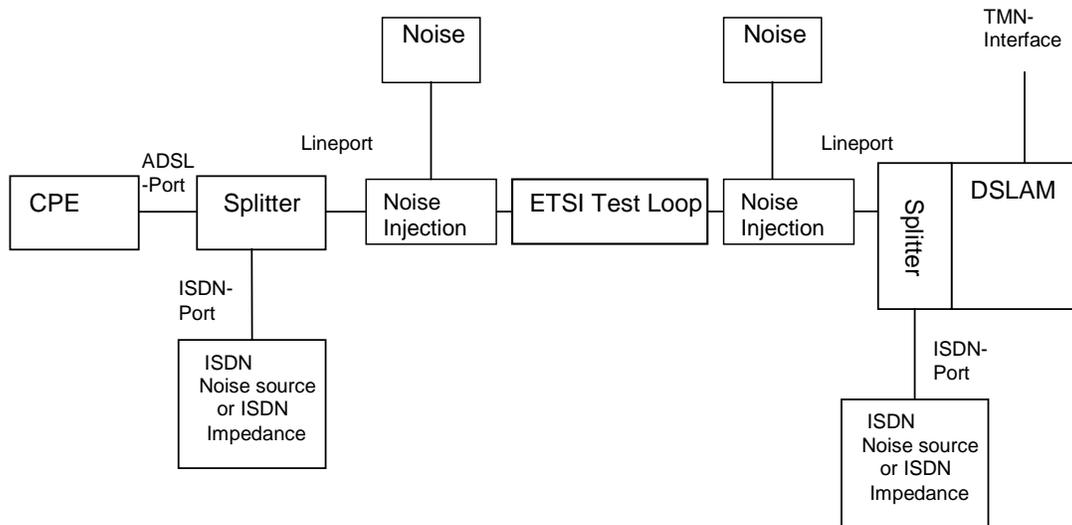
Figure 6: Test set-up for European Annex B tests with splitters

8. Physical Layer Test Cases

The loop simulators SHALL be calibrated relative to the nominal attenuation as defined in section 4.1.1. Noise SHALL be injected through a high impedance network as specified in G996.1[3], with simultaneous noise injection at both ends of the loop. The noise injection SHALL be calibrated as defined in section 4.1.2.

Note: Although crosstalk models are intended for injection at a single end of the loop, noise in this document is injected on both ends simultaneously, except for some testcases in table A.1-13 and A.1-20, in order to reduce testing time. It is understood that noise levels on short loops can be significantly higher.

Configuration is based on a set of common line settings as defined in table 8-1
General testprofiles define latency and INP settings as shown in table 8-2.
Specific testprofiles additionally define settings for DS/US net data rates, Operating mode(ATSE) and RA-Mode. These setting are shown in table 8-3.
Deviations from these testprofiles and/or common line settings are indicated in the description of each test or testsection.

Table 8-1: Common Line Settings

Parameter	Setting	Description
PMMode	all off	no automatic transition to low power states
Latency/Bearer	Single latency/one Bearer	Single latency path and Single Frame Bearer operation
MSGMINds/us	6 kbps	
TARSNRMds/us	6 dB	standard value
MAXSNRMds/us	no limitation or at least 31dB	no additional power reduction in these tests
MINSNRMds/us	0 dB	no influence on pass/fail criteria
MAXNOMPSDds	-40 dBm/Hz	G.992.3 default value
MAXNOMPSDus	-38 dBm/Hz	G.992.3 default value
NOMPSDds	-40 dBm/Hz	G.992.3 default value
NOMPSDus	-38 dBm/Hz	G.992.3 default value
MAXNOMATPds	19.9 dBm	Annex-A G.992.3/5 default value (A.1.3.2)
	19.3 dBm	Annex-B/J G.992.3/5 default value (B.1.3.2/J.1.3.2)
MAXNOMATPus	12.5 dBm	Annex-A G.992.3/5 default value (A.2.2.2)
	13.3 dBm	Annex-B G.992.3/5 default value (B.2.2.2)
	13.4 dBm	Annex-J G.992.3/5 default value (J.2.2.2)
CARMASKds	default	Testcase dependant
CARMASKus	default	Testcase dependant
PSDMASKds	default	only applicable for G.992.5

Parameter	Setting	Description
RFIBANDSds	none	only applicable for G.992.5
MAXBER	1e-7	

Table 8-2: General Testprofiles

General Testprofile	Parameter	Setting	Description
"F-1/0"	Minimum INP	0 symbols	No impulse noise protection
	Maximum delay	S1	[G.997.1] 7.3.2.2 : The value S1 indicates the Fast Latency Path shall be used in the G.992.1 operating mode and S and D shall be selected such that $S \leq 1$ and $D = 1$ in ITU-T Recommendations G.992.2, G.992.3, G.992.4, G.992.5 and G.993.2 operating modes.
"L-2/0"	Minimum INP	0 symbols	No impulse noise protection
	Maximum delay	2 ms	One way interleaving delay $\lceil S*D \rceil/4$
"I-16/2"	Minimum INP	2 symbols	
	Maximum delay	16 ms	One way interleaving delay $\lceil S*D \rceil/4$
"I-16/0.5"	Minimum INP	0.5 symbols	
	Maximum delay	16 ms	One way interleaving delay $\lceil S*D \rceil/4$
"I-8/2"	Minimum INP	2 symbols	
	Maximum delay	8 ms	One way interleaving delay $\lceil S*D \rceil/4$

Table 8-3: Specific Testprofiles

Specific Testprofile	General test profile DS	General test profile US	ATSE	RA-Mode	DS net datarate (kbit/s) (max-min)	US net datarate (kbit/s) (max-min)
AU_RA_L_30000k	L-2/0	L-2/0	Automode G.992.3 An.A G.992.3 An.L mask M1 G.992.5 An.A	AT_INIT	30000-32	1048-32
AU_RA_I_30000k	I-16/2	I-16/2	Automode G.992.3 An.A G.992.3 An.L Mask M1 G.992.5 An.A	AT_INIT	30000-32	1048-32
A2_RA_F_16000k	F-1/0	F-1/0	G.992.3 An.A	AT_INIT	16000-32	2016-32

Specific Testprofile	General test profile DS	General test profile US	ATSE	RA-Mode	DS net datarate (kbit/s) (max-min)	US net datarate (kbit/s) (max-min)
A2_RA_I1/2_16000k	I-16/0.5	I-16/0.5	G.992.3 An.A	AT_INIT	16000-32	2016-32
A2L_RA_I_16000k	I-16/2	I-16/2	G.992.3 An.L, mask M1	AT_INIT	16000-32	2016-32
A2_Fix_F_7288k	F-1/0	F-1/0	G.992.3 An.A	MANUAL	7288-7288	800-800
A2_Fix_I_7288k	I-16/2	I-16/2	G.992.3 An.A	MANUAL	7288-7288	800-800
A2_Fix_F_5952k	F-1/0	F-1/0	G.992.3 An.A	MANUAL	5952-5952	640-640
A2_Fix_I_5952k	I-16/2	I-16/2	G.992.3 An.A	MANUAL	5952-5952	640-640
A2_Fix_F_2400k	F-1/0	F-1/0	G.992.3 An.A	MANUAL	2400-2400	352-352
A2_Fix_I_2400k	I-16/2	I-16/2	G.992.3 An.A	MANUAL	2400-2400	352-352
A2_Fix_I_1200k	I-16/2	I-16/2	G.992.3 An.A	MANUAL	1200-1200	224-224
B2_RA_F_16000k	F-1/0	F-1/0	G.992.3 An.B	AT_INIT	16000-32	2016-32
B2_RA_I_16000k	I-16/2	I-16/2	G.992.3 An.B	AT_INIT	16000-32	2016-32
B2_Fix_F_7288k	F-1/0	F-1/0	G.992.3 An.B	MANUAL	7288-7288	800-800
B2_Fix_I_7288k	I-16/2	I-16/2	G.992.3 An.B	MANUAL	7288-7288	800-800
B2_Fix_F_3456k	F-1/0	F-1/0	G.992.3 An.B	MANUAL	3456-3456	448-448
B2_Fix_I_3456k	I-16/2	I-16/2	G.992.3 An.B	MANUAL	3456-3456	448-448
B2_Fix_F_864k	F-1/0	F-1/0	G.992.3 An.B	MANUAL	864-864	160-160
B2_Fix_I_864k	I-16/2	I-16/2	G.992.3 An.B	MANUAL	864-864	160-160
A2P_RA_F_30000k	F-1/0	F-1/0	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P RA_I_30000k	I-16/2	I-16/2	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P RA_I1/2_30000k	I-16/0.5	I-16/0.5	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P_Fix_F_10000k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	10000-10000	832-832
A2P_Fix_I_10000k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	10000-10000	832-832
A2P Fix_F_7288k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	7288-7288	800-800
A2P Fix_I_7288k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	7288-7288	800-800
A2P Fix_F_5952k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	5952-5952	640-640
A2P Fix_I_5952k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	5952-5952	640-640
A2P_Fix_F_2400k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	2400-2400	352-352
A2P Fix_I_2400k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	2400-2400	352-352
A2P_Fix_F_600k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	600-600	128-128
A2P Fix_I_600k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	600-600	128-128
B2P_RA_F_30000k	F-1/0	F-1/0	G.992.5 An.B	AT_INIT	30000-32	2016-32
B2P RA_I_30000k	I-16/2	I-16/2	G.992.5 An.B	AT_INIT	30000-32	2016-32
B2P_Fix_F_10000k	F-1/0	F-1/0	G.992.5 An.B	MANUAL	10000-10000	832-832
B2P_Fix_I_10000k	I-16/2	I-16/2	G.992.5 An.B	MANUAL	10000-10000	832-832
B2P Fix_F_7288k	F-1/0	F-1/0	G.992.5 An.B	MANUAL	7288-7288	800-800
B2P Fix_I_7288k	I-16/2	I-16/2	G.992.5 An.B	MANUAL	7288-7288	800-800
B2P Fix_F_3456k	F-1/0	F-1/0	G.992.5 An.B	MANUAL	3456-3456	448-448

Specific Testprofile	General test profile DS	General test profile US	ATSE	RA-Mode	DS net datarate (kbit/s) (max-min)	US net datarate (kbit/s) (max-min)
B2P Fix_I_3456k	I-16/2	I-16/2	G.992.5 An.B	MANUAL	3456-3456	448-448
B2P_Fix_F_864k	F-1/0	F-1/0	G.992.5 An.B	MANUAL	864-864	160-160
B2P Fix_I_864k	I-16/2	I-16/2	G.992.5 An.B	MANUAL	864-864	160-160

Two basic band-profiles are defined in table 8-4 for ADSL2plus operation with DPBO. These are named **B2P_CAB27** and **B2P_CAB72** which are used respectively for FTTCab and FTTB/Curb deployments.

Table 8-4: Common Line Settings with DPBO for band-profiles B2P_CAB27, B2P_CAB72

Parameter	B2P_CAB27	B2P_CAB72	Description
All parameters but those below	G.992.5 Annex B as per Table 8-1		
DPBOEPSD	ADSL2plus Annex B	ADSL2plus Annex B	PSD mask at the exchange
DPBOESEL	27dB@1MHz	72dB@1MHz	E-side electrical length
DPBOESCMA	0.1924	0.1924	Model of loss of E-side cable (NOTE)
DPBOESCMB	0.5960	0.5960	
DPBOESCMC	0.2086	0.2086	
DPBOMUS	-95 dBm/Hz	-95 dBm/Hz	Minimum usable receive PSD
DPBOFMIN	254 kHz	254 kHz	Minimum frequency from which the DPBO is applied
DPBOFMAX	2208 kHz	2208 kHz	Maximum frequency up to which the DPBO is applied

NOTE: the values of DPBOESCMA, B and C are referred to a PE 0.4mm loop model.

Table 8-5: Specific Test profiles with configured DPBO

Profile name	B2P_CAB27_RA_F_30000k	B2P_CAB27_RA_I_30000k
Common Line Setting	B2P_Cab27	B2P_Cab27
General Profile	F-1/0	I-8/2
Operation mode (ATSE)	G.992.5 Annex B only	G.992.5 Annex B only
RA-MODE	AT_INIT	AT_INIT
DS rate [kbit/s] (max-min)	30000-32	30000-32
US rate [kbit/s] (max-min)	2016-32	2016-32
Profile name	B2P_CAB72_RA_F_30000k	B2P_CAB72_RA_I_30000k
Common Line Setting	B2P_Cab72	B2P_Cab72
General Profile	F-1/0	I-8/2
Operation mode (ATSE)	G.992.5 Annex B only	G.992.5 Annex B only
RA-MODE	AT_INIT	AT_INIT
DS rate [kbit/s] (max-min)	30000-32	30000-32
US rate [kbit/s] (max-min)	2016-32	2016-32

All operating modes are non-overlapped operation and only the mentioned operating mode is enabled in to CO MIB.

The CO splitter used SHALL be the splitter integral to the DSLAM, if that option exists. Otherwise, an external CO splitter as specified in Annex E of G.992.3[1] or ETSI TS101952-1 [9] SHALL be used.

An ATM or Ethernet switch may be included for DSLAM termination and IP return traffic.

General procedures for performance testing:
Tests will be performed at consecutive loops lengths identified in tables of the region-specific annexes. The tests are initiated by placing the line from the DSLAM out of service (OOS). Then the loop simulator is set with the appropriate noise impairments and loop length, after which the line from the DSLAM is placed in-service (IS).
At each test point, the SUT SHALL train within **a total of**
* 60 seconds, for single mode operation
* 120 seconds, for automode operation
starting from the time that the line was placed IS.

Following at least 60 seconds after the train has occurred, the bi-directional net data rates and noise margins SHALL be recorded. After it has reached its final train state, the modem SHALL remain in showtime for the duration of the tests.

The line from the DSLAM SHALL then be placed OOS, the loop simulator loop length incremented to the next test point loop length, the line from the DSLAM placed back IS,

modem trained, and the data SHALL be recorded. This sequence SHALL continue until all loop lengths defined in the table are complete.

The modem SHALL not be power cycled, rebooted or otherwise reinitialized between loop length increments.

It is required that the SUT trains in every loop reach test. A failure to train in any test will result in a failure of that section. This is required to eliminate the possibility of any modem with interoperability 'holes' from passing the requirements contained within this document.

At times, the training process may result in a "False Train" condition. This situation occurs when the modem initially indicates that it is trained but within a short time frame (< allowed startup) goes into a retrain sequence.

If a false train occurs and the second train has not completed within the initial allowed startuptime, a result of zero will be recorded into the result for that test point and the whole section will be marked as a fail.

To obtain a result for each individual test, each test SHALL be performed once. In rate-adaptive testing, any test point that fails to meet the net data rate requirement in downstream direction by 96 kbps or less or in the upstream direction by 32 kbps or less SHALL be re-tested 3 times. If a re-test is performed, then the maximum downstream value achieved during testing, along with the associated upstream net data rate, SHALL be recorded. If the SUT fails to sync within the allowed startup time, a result of zero will be recorded into the result for that test point and the whole section will be marked as a fail.

ADSL2/ADSL2plus systems SHALL be tested according to tests specified for the different regions and annexes. See Table 8-6 for reference.

Table 8-6: Pointer to physical layer testcases

ITU annex [1][2]	Annex A/L		Annex B/J	Annex C
	North America	Europe	Europe	Japan
TR-100 annex	A1	A2/A3/A4	B/J	C

8.1   Bitswap performance test

Table 8-7 describes a test that replicates the very rapid increases in amplitude of RFI that occur on real circuits. When the RFI is applied it is expected the bits will be swapped away from the tone affected by the RFI signal. In this test the RFI signal is modelled as a single frequency Sine wave.

Note: Though the used signal has some similarity to RFI signals that can be found in the field, the user of this test SHALL bear in mind that real narrow band interference arising in the copper plant may significantly differ with respect to its time and frequency statistical behavior.

If the BITSpsds is not available from the DSLAM and is retrieved from the CPE, the values from the CPE SHALL be used. If the BITSpsds is not available, the expected result {1} does not apply.

Table 8-7: Bitswap performance test

Test Configuration	(1) See Figure 3
	(2) Configure the DSLAM for testprofile A2_RA_F_16000k or B2_RA_F_16000k with the maximum downstream net data rate set to 6432kbits/s and the maximum upstream net data rate set to 800kbits/s.
	(3) Connect the CO and CPE with either
	      a. 9000 ft 26AWG (annex-A1)
	      b. 2.5 km ETSI loop #1 (annex-A2)
	      c. 2 km ETSI loop #1 (annex-B)
	(4) Inject –140dBm/Hz AWGN noise at both the CO and CPE ends.
	(5) All single frequency tone amplitudes that are applied are referenced in terms of power levels (dBm) at the injection point on the loop, calibrated with the CO and CPE replaced with calibrated 100 Ohm ±1% resistors. Measurements performed into a 1kHz resolution bandwidth.
	
	Note that with a 1kHz resolution bandwidth the power spectral density value will be 30dB (in dBm/Hz) less than the power level (in dBm), limited by the noise floor of the test equipment used for calibration.

Method of Procedure	(1) Randomly select an integer value, n, in the range 70-100, ensuring that the tone selected has assigned bits as described in the downstream bits per tone map. Avoid the use of the pilot tone or any unpopulated tones. (2) Record and report the value of n used. (3) The frequency of the interfering tone SHALL be set to n × 4.3125 kHz. The power of the interfering tone SHALL be -110 dBm or less. (4) Train the link and wait 1 minute after initialisation. (5) Record the downstream bits per tone map (BITSpsds). (6) Increase the power of the interfering tone to -50 dBm. (7) Observe any downstream bit swap operation without retraining of the modems or change in the downstream net data rate. After 2 minutes verify the payload or CRC errors have stopped. (There may be some initial errors seen when the signal is first inserted on the line.) (8) Randomly select an integer value, n, in the range 10 – 20 for Annex A or 40 – 50 for Annex B, ensuring that the tone n has assigned bits as described in the upstream bits per tone map. Avoid the use of any unpopulated tones. (9) Record and report the value of n used. (10) The frequency of the interfering tone SHALL be set to n × 4.3125 kHz. The power of the interfering tone SHALL be -110 dBm or less. (11) Train the link and wait 1 minute after initialisation. (12) Record the upstream bits per tone map (BITSpsus). (13) Increase the tone power to -50dBm. (14) Observe any upstream bit swap operation without retraining of the modems or change in the upstream net data rate. After 2 minutes verify the payload or CRC errors have stopped. (There may be some initial errors seen when the signal is first inserted on the line.)
Expected Result	(1) The bit swap protocol re-deploys the allocation of bits among the sub-carriers. (2) If the BER is not better than 1e-7 after 2 minutes, or a retrain occurred, the Modem-DSLAM pair will be declared to fail the test.

8.2 DSL Noise Spikes/Surges Tests

The purpose of these tests is to verify that the xDSL functionality is not impacted by sudden spikes or surges of noise on the line.
It also includes tests to verify that the xDSL functionality is not impacted by the presence of repetitive impulse noise (REIN).

8.2.1 Isolated noise burst test

When an AWGN noise burst described in this section is applied to the modem under test during Showtime, the modem SHALL not re-initialize within an observation period of 2 minutes. At most one test noise burst SHALL be applied within a 2 minute interval. The noise SHALL be inserted at the customer-end of the line.
Test settings are given in Table 8-8.

Table 8-8: Isolated noise burst test setting

Parameter	Value
Loop Length (26AWG)	3, 5, and 15kft
Target Noise Margin	6 dB
Downstream/Upstream test profile	AU_RA_L_30000k

At the end under test, bursts of band-limited white noise are coupled to the line using a high-impedance coupler with nominal noise PSD levels as indicated below. These levels are as measured into a 100Ω measuring set with another 100Ω in parallel.

The test noise burst SHALL be AWGN with amplitude of -86 dBm/Hz from 138kHz up to 2.2 MHz.

The out-of-band noise SHALL not be higher than –86 dBm/Hz.

A background noise level of -140dBm/Hz AWGN + 12 self-NEXT and FEXT simulated noise SHALL be applied during modem start-up and throughout this test.

The burst length should be controllable with a resolution of ten milliseconds and the DSL SHALL be monitored for re-initialization for 2 minutes after application of each burst. The burst length changes by the loop length according to Table 8-9. The loops for these tests are 26 AWG.

Table 8-9: Isolated noise burst testloop and burst lenght

Loop Length (kft)	Burst length (msec)
3	3500
5	1000
15	100

8.2.2 Repetitive Electrical Impulse Noise (REIN) test

The REIN test SHALL use a "Burst of pseudo random AWGN" of 100μs duration at a level of –90dBm/Hz differential mode. The repetition rate is defined in the regional annexes.
The system under test SHALL be tested for Interleaved rate adaptive and Interleaved fixed rate profiles with an INP=2 and a delay=8ms.
The testprocedures are described in Tables 8-10 and 8-11.

Table 8-10: REIN test procedure Rate Adaptive mode

Test Configuration	(1) The CO and CPE are connected in turn through each loop as specified in the REIN section of the regional annex A.1.8 for North America and A.2.8 for Europe. (2) The ADSL2/ADSL2plus profile SHALL be configured using the Interleaved Rate Adaptive profile with INP=2 and delay=8ms as specified in the REIN section of the regional annex. (3) The target margin is set according to the table in the relevant regional annex. (4) The crosstalk noise impairment as defined in the REIN section of the regional annex SHALL be applied at both CO and CPE. (5) The REIN noise impairment SHALL be applied at the CPE in addition to the crosstalk noise.
Method of Procedure	(1) The link is trained in the presence of the crosstalk noise and REIN impairments. (2) Wait for 3 minutes after initialization for bitswaps to settle. (3) Record the net data rate R(kbps) and count the number of errored seconds in next period of 2min.
Expected Result	(1) The broadband link SHALL operate in the presence of the REIN. (2) If the link fails to train within 2min or the connection is dropped before the end of the test, the result SHALL be declared a fail. (3) The number of errored seconds measured in this 2 min period SHALL be <= 1 for the test to pass. (4) The expected results in the regional tables A.1.8 for North America and in A.2.8 for Europe SHALL be met.

Table 8-11: REIN test procedure - Fixed Rate mode

Test Configuration	(1) The CO and CPE are connected in turn through each loop as specified in the REIN section of the regional annex[2]. The ADSL2/ADSL2plus profile SHALL be configured using the Interleaved Fixed Rate profile with INP=2 and delay=8ms as specified in the REIN section of the regional annex. (2) The crosstalk noise impairment as defined in the REIN section of the regional annex SHALL be applied at both CO and CPE. (3) The REIN noise impairment SHALL be applied at the CPE in addition to the crosstalk noise.
Method of Procedure	(1) The link is trained in the presence of the crosstalk noise and REIN impairments. (2) Wait for 3 minutes after initialization for bitswaps to settle. (3) Record the net data rate R(kbps) and count the number of errored seconds in the next period of 2min.
Expected Result	(1) The broadband link SHALL operate in the presence of the REIN. (2) If the link fails to train within 2min or the connection is dropped before the end of the test, the result SHALL be declared a fail. (3) The number of errored seconds measured in this 2 min period SHALL be <= 1 for the test to pass. (4) The expected results in the regional tables SHALL be met.

8.2.3 Common mode noise susceptibility test

For further study.

8.3 Stress Test

The purpose of the test described in Table 8-12 is to verify the stability of the CPE/Drivers.

1 individual test – 1 SHALL be passed

Table 8-12: Stress Test

Test Configuration	(1) The test configuration SHALL be as shown in figures 4 to 6 in Section 6.
	(2) The CPE may be set up for RFC 2684 bridging/routing, or PPP bridging/routing.
	(3) Configure the DSLAM with testprofiles A2_RA_F_16000k (Annex A) or B2_RA_F_16000k (Annex B).
	(4) Set up the loop simulators for either
	    a. 26 AWG at 12000 feet (annex-A.1).
	    b. ETSI loop#1 at 3600m (annex-A.2).
	    c. ETSI loop#1 at 2500m (annex-B).
	On this loop, the modems are expected to train without excess margin.
	(5) Inject –130 dBm/Hz white noise disturber at both ends of the loop.

Method of Procedure	(1) Train the CPE with the DSLAM. (2) Wait for 1 minute after initialization. (3) Check reported margin and document as initial_reported_margin. (4) Increase the noise level by MIN(initial_reported margin (dB) – 1 dB, target margin (dB)) at CPE side. (5) Configure the traffic generator/analyzer to provide MAC frames as a payload source for the duration of the test. The engineer will need to adjust the rate of the MAC frames to an acceptable level such that dropped frames due to LAN-based collisions or otherwise are negligible. Record these rates and the MAC frame size used for the test (suggested default 1024 bytes including FCS). (6) Run one over night BER test (8 hour minimum).
Expected Result	(1) The CPE SHALL not lose sync with the DSLAM at any time during the overnight test. Any retrain will constitute a failure for this section. (2) The BER SHALL be less than 1e-7 for the entire test.

Note: The Bit Error Rate (BER) will be approximated using the CRC error count method as defined in section 7.5, Table 8-14 Fast path.

8.4 Verification of CRC error reporting by CPE (Basic CRC Functionality Test)

The purpose of this test described in table is to verify that the CPE correctly reports CRC errors. CRC error counts are the basis of margin verification tests; it is necessary to verify if the CPE accurately counts and reports CRC errors.

Table 8-13: Verification of CRC reporting by CPE

Test Configuration	(1) The common line settings SHALL be according to Table 7.1. (2) For Annex A.1 use the testprofile AU_RA_L_30000k. For Annex A.2 use the test profile A2_RA_F_16000k and A2P_RA_F_30000k. For Annex B use the test profile B2_RA_F_16000k and B2P_RA_F_30000k. (3) Testloops for Annex A.1: a) 0.4 kft, -140 dBm/Hz AWGN b) 5 kft, NEXT – 5T1 (adj), -140 dBm/Hz AWGN c) 13 kft, NEXT – 24HDSL, -140 dBm/Hz AWGN d) 15 kft with 400 ft BT (24AWG), -140 dBm/Hz AWGN Test loops for Annex A.2: a) 750m, noise FB ADSL2 impairment, A2_RA_F_16000k b) 4750m, -140 dBm/Hz AWGN, A2_RA_F_16000k c) 250m, noise FB ADSL2+ impairment, A2P_RA_F_30000k d) 1750m, -140 dBm/Hz AWGN, A2P_RA_F_30000k Test loops for Annex B: a) 750m, noise FB ADSL2 impairment, B2_RA_F_16000k b) 3500m, -140 dBm/Hz AWGN, B2_RA_F_16000k c) 250m, noise FB ADSL2+ impairment, B2P_RA_F_30000k d) 1500m, -140 dBm/Hz AWGN, B2P_RA_F_30000k
Method of Procedure	(1) Connect CPE and DSLAM under the first required loop for the regional annex and noise condition. (2) Force a new initialization and wait for modems to sync. Wait for 2 minutes after initialization for bitswaps to settle. (3) Force a "micro-interruption" of the loop at the CPE side with duration of 10ms. Record the number of CRC errors reported. It is expected that a micro-interruption will result in at least one reported downstream CRC error. (4) Repeat step 3 every 10 seconds, for a total test time of 120 seconds (i.e. a total of 12 micro-interruptions are issued). (5) Repeat steps 2 to 4 for all remaining testloops required for the regional annex.
Expected Result	If each micro-interruption does not result in at least one reported downstream CRC error, then the CPE has **failed** the basic CRC error reporting test.

8.5 Margin verification test procedure

The measurement time is based on the occurrence of 10 error events and a confidence interval of 0.9.

With this confidence interval the required BER limit for a 1e-7 target bit error rate is 1.5e-7.

To accelerate testing for some of the testcases, the desired number of observed error events is reduced to a lower number, leading to higher required BER limits. When this is done, a note is added under the table.

Also due to this confidence interval, one out of 10 margin verification test can result in a false FAIL. Therefore when the first margin verification test fails, the test SHALL be redone once, so that the confidence interval becomes 0.99.

Because of the significant dependency of achievable data rates on the noise margin, margin verification tests are performed across several loop and noise scenarios of TR-100 to ensure that there is no optimization of margin or modem performance for some specific test loops.

Table 8-14 shows how the BER SHALL be derived from the CRC count. Table 8-15 contains the testprocedure on margin verification.

Table 8-14: The equations for estimating BER

Modem configuration	Equations for estimating BER
Fast path (maximum delay = S1)	$BER = \dfrac{\text{Number of bit errors}}{\text{Number of transmitted bits}} \cong \dfrac{15 * CRC\_error\_count}{data\_rate * 1000 * test\_time * 60}$
Interleaved path (maximum delay $\neq$ S1)	$BER = \dfrac{\text{Number of bit errors}}{\text{Number of transmitted bits}} \cong \dfrac{40 * CRC\_error\_count}{data\_rate * 1000 * test\_time * 60}$

Since CRC error counts are the basis of margin verification tests, it is necessary to verify if the CPE accurately counts and reports CRC errors. A mandatory test procedure to verify CRC error reporting is required and defined in section 8.4

Table 8-15: Test procedure on Margin verification.

Test Configuration	(1) Configure the DSLAM according to the testprofile as indicated in the regional annexes. (2) The loop and noise conditions for the individual margin verification tests are described in the regional annexes. (3) The pass/fail criterion is the bit error ratio (BER) at the physical layer. CRC error counts are used to estimate BER at the physical layer. Table 8-14 shows how the BER SHALL be derived from the CRC count.
Method of Procedure	(1) Connect CO and CPE to first test loop option, with the noise injected at the specified reference power level. This power level is considered the 0 dB noise power level for that type of noise. (2) Force a new initialization and wait for modems to sync. (3) Wait for 3 minutes for bitswaps to settle. (4) Check reported margin and document as initial_reported_margin. (5) For CPE margin verification tests increase the noise power level by 1 dB at CPE side only. (6) For CO margin verification tests increase the noise power level by 1 dB at CO side only. (7) Wait for 1 minute. (8) Repeat steps 5 or 6 and 7 until the noise power is increased by min(initial_reported_margin – 1, target margin) dB. (9) Execute a BER test for the duration as specified in each testcase. Record the CRC and SES counts at the start and the end of the BER test. Actual number of CRCs and SESs is the difference between these two counts. Document the measured BER. (10) Repeat steps 2 to 9 for every test loop. In order for the BER result to be valid, the modems should not have re-initialized during steps 3 to 9. If a re-initialization has occurred, the test for that loop option SHALL be repeated once. If the margin verification test case fails with a BER less than 2.5e-7 and higher than the BER limit in the table, the test for that loop option SHALL be repeated once.
Expected Result	The CPE modem passes the margin verification test, if (1) for every test loop: Estimated BER is less than the limit value in the margin verification table of that loop option. (2) No SES has been reported.

An explanation of the regional margin verification tables is given below.

Each test is specified by the type and level of the injected noise and by the type and length of the loop.
The **title** of each test specifies the type and level of the injected noise, the loop option and the used testprofile.
Column 1 of each table specifies the loop type (e.g. 26AWG) and loop length (e.g. 3kft).
Column 2 specifies the required test time in order to observe approximately 10 CRC error events at a target BER of 1e-7. These test times are calculated based on the data rates in the corresponding performance requirements section. To allow for modem connections with slightly lower than the anticipated data rates, the test durations are rounded up in increments of 5 minutes.

Column 3 It is required that the achieved DS(US) net data rate SHALL be recorded twice: first at the start of the margin verification test and also at the end of the margin verification test. This captures a potential modem retrain and connection at lower DS net data rates due to the increase in injected noise level.

It is expected that the actual datarate is close to the anticipated one. If the actual datarate is significantly lower then the anticipated one, the test results may not be valid.

The actual net data rate is not a pass/fail criteria of this test.

Column 4 asks for the insertion of the measured DS(US) CRC count after the injected noise level has been increased by min(initial_reported_margin – 1, target margin) dB.

Measurement of initial_reported_margin SHALL be done from the DSLAM.

Column 5 asks for the computation of the estimated BER from the number of observed CRC error events according to Table 8-14. If the estimated BER is smaller than the BER limit in this column, then the test PASSES, else it FAILS.

Column 6 asks for the insertion of "PASS" or "FAIL".

9.   Higher Layer Test Cases

9.1   RFC2684 [11] Layer 3 Ethernet or USB Interface bridged mode

The throughput tests specified satisfy the terminology criteria of RFC 1242 [17] and the test methodology specified in RFC 2544 [18].

- From RFC 1242 [17], throughput is "the maximum rate at which none of the offered frames are dropped by the device."
- From RFC 2544 [18], the methodology to measure throughput is to "Send a specific number of frames at a specific rate through the DUT and then count the frames that are transmitted by the DUT."
- If the count of offered frames is equal to the count of received frames, the rate of the offered stream is raised and the test is rerun. If fewer frames are received than were transmitted, the rate of the offered stream is reduced and the test is rerun.

In this test specification, the number of frames transmitted from one end of the ADSL2/ADSL2plus link is compared with the number of frames received at the far end of the ADSL2/ADSL2plus link. The method used for computing the maximum number of frames per second is given in Appendix II.

9.1.1 Packet Throughput Test

The purpose of the test contained in table 9-2 is to verify the throughput for a selected list of provisioned line rates (down/up) using IP Frame transfers of varying length.

The packet or frame size is defined in RFC 1242 [17], section 3.5, Data Link Frame Size, and states "The number of octets in the frame from the first octet following the preamble to the end of the FCS, if present, or to the last octet of the data if there is no FCS". This means that the LAN FCS (4 octets) is considered to be useful data i.e. part of the "frame size" as used in the tables below. This specifically defines the packet or frame size in terms of the MAC frame, and hence is not the IP packet size.

> Note: Care needs to be taken for the configuration of the test equipment transmitted frame size, with respect to the inclusion of the 4 octets of the FCS in the frame length configuration and how this frame length relates to the preservation of the LAN frame FCS for the bridge implementation as described below.

Throughput SHALL be measured for MAC frame length (see RFC 1242 [17] Section 3.5). The packet throughput requirements in the tables 9-3, 9-4 and 9-5 includes trailer overhead for AAL5 CPCS-PDU with and without preservation of the Ethernet FCS.

- If the LAN FCS is preserved then the values in column 'Max FPS (with PAD added)' SHALL apply
- If the LAN FCS is not preserved and padding is added then the values in column 'Max FPS (with PAD added)' SHALL apply
- If the LAN FCS is not preserved and padding is omitted then the values in column 'Max FPS (without PAD added)' SHALL apply
- If the LAN FCS is not preserved and it is unclear from the documentation of the implementation of whether or not the 2 bytes of PAD are included in the SNAP

header, the calculation SHALL assume that padding is added. The values in column 'Max FPS (with PAD added)' SHALL apply.

Appendix II explains how the FPS values in the tables are calculated.

The DSLAM is configured similar to the fixed profile A2P_Fix_F_10000k, but with the bitrates configured as in table 9-1.

Table 9-1: Packet Throughput Test bitrates

DS bitrate (kbps)	US bitrate (kbps)
12000	800
18000	800
24000	800

42 individual tests – 42 tests SHALL be passed

Table 9-2: Packet Throughput Test

Test Configuration	(1) The configuration SHALL be as shown in figures 4 to 6, depending on the customer interface of the modem. (2) Set up the loop simulators for a loop of 2kft 26 AWG cable, or a loop of 600m 0.4 mm cable, with white noise (–140 dBm/Hz) injected at **both** the upstream and downstream ends of the loop. (3) Setup the traffic generator/analyzer to send frames in one direction with destination MAC address equal to the unicast source MAC address of frames sent in the opposite direction. (4) Set the CPE modem for bridged mode with LLC encapsulation. (5) Configure the DSLAM similar to the fixed profile A2P_Fix_F_10000k, but with the bitrates configured as in table 9-1 for each of the throughput tables 9-3 to 9-5.
Method of Procedure	(1) Let the CPE train. (2) Setup traffic generator/analyzer to perform throughput test for selected frame length and connect rate. (3) Set the throughput rate of the upstream direction to 50% of the maximum theoretical value sustainable by the ADSL2/ADSL2plus net data rate. (4) Test for the throughput in the downstream direction. Record the downstream throughput rate as frames per second. The test SHALL be run for 60 seconds. (5) Set the throughput rate of the downstream direction to 50% of the maximum theoretical value sustainable by the ADSL2/ADSL2plus net data rate. (6) Repeat the test for throughput in the upstream direction. Record the upstream throughput rate as frames per second. The test SHALL be run for 60 seconds. (7) Divide the analyzer frames per second by the maximum FPS for the connect rate and frame size. (8) Record as percentage of maximum connect rate.
Expected Result	Based on the throughput tables: The percentage of frames achievable for all DSL modems (Ethernet and USB) SHALL be 85%.

Note: This 85% also assumes the downstream connect rate does not exceed the USB bus maximum. In that case, the USB bus maximum will dictate the Max FPS recorded

Table 9-3: Throughput Test Results: Connect Rates DS: 12000 kpbs US: 800 kbps.

Analyzer Recorded FPS			Max FPS (with PAD added) (Note 2)		Max FPS (without PAD added) (Note 1)		% of Max		Pass/Fail (85% limit)	
Frame Size	DS	US	DS	US	DS	US	DS	US	DS	US
64			14150	943	14150	943				
128			7075	471	9433	628				
256			4716	314	4716	314				
512			2358	157	2572	171				
1024			1286	85	1286	85				
1280			1010	67	1048	69				
1514			884	58	884	58				

Note 1: Based on formula II.1 in Appendix II.

Note 2: Based on formula II.2 in Appendix II.

Table 9-4: Throughput Test Results: Connect Rates DS: 18000 kbps US: 800 kbps.

Analyzer Recorded FPS			Max FPS (with PAD added) (Note 2)		Max FPS (without PAD added) (Note 1)		% of Max		Pass/Fail (85% limit)	
Frame Size	DS	US	DS	US	DS	US	DS	US	DS	US
64			21226	943	21226	943				
128			10613	471	14150	628				
256			7075	314	7075	314				
512			3537	157	3859	171				
1024			1929	85	1929	85				
1280			1516	67	1572	69				
1514			1326	58	1326	58				

Note 1: Based on Equation 14 in Appendix II.

Note 2: Based on Equation 15 in Appendix II.

Table 9-5: Throughput Test Results: Connect Rates DS: 24000 kbps US: 800kbps.

Analyzer Recorded FPS			Max FPS (with PAD added) (Note 2)		Max FPS (without PAD added) (Note 1)		% of Max		Pass/Fail (85% limit)	
Frame Size	DS	US	DS	US	DS	US	DS	US	DS	US
64			28301	943	28301	943				
128			14150	471	18867	628				
256			9433	314	9433	314				
512			4716	157	5145	171				
1024			2572	85	2572	85				
1280			2021	67	2096	69				
1514			1768	58	1768	58				

Note 1: Based on Equation 14 in Appendix II.

Note 2: Based on Equation 15 in Appendix II.

9.2   RFC2516 [12] PPPoE Throughput Test

Table 9-6 describes the testprocedure for the PPPoE packet throughput test
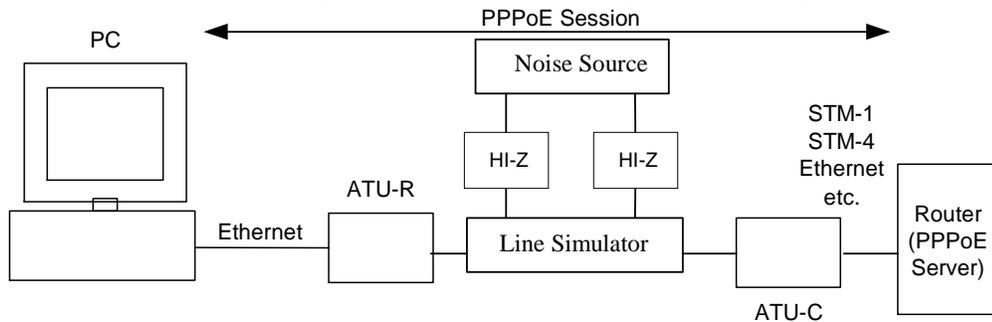
Figure 7: Test setup for PPPoE testing with Ethernet modems
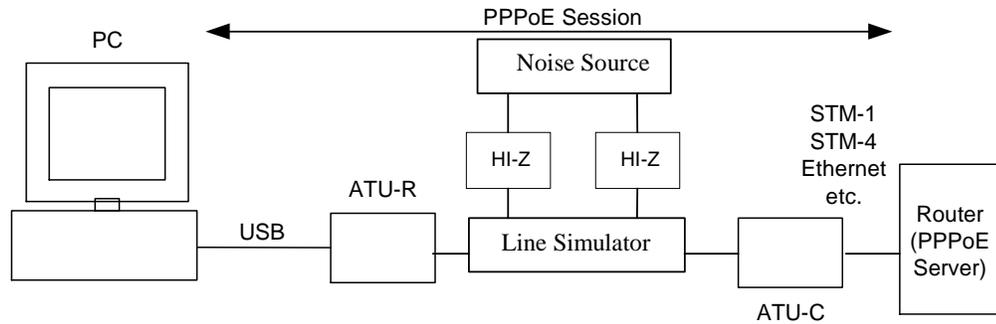
Figure 8: Test setup for PPPoE testing with USB modems

The throughput, at the PPPoE layer, is assessed by measurement at the throughput at the TCP layer. The ratio, of the throughput at the TCP layer to the data rate made available to ATM cells, is determined. This ratio is then compared to a figure that is slightly below the ideal value of 85.4%. The frame size indicated below is the length of the IP frame.

2 individual tests – 2 tests SHALL be passed

Table 9-6: PPPoE Packet Throughput Test

Test Configuration	(1) The configuration SHALL be as shown in figure 8 or 9, depending on the customer interface of the modem. (2) Set up the loop simulators for a NULL loop. (3) The buffer size (used by the measurement software) SHALL be at least 64 kB (4) Configure the DSLAM with testprofile AU_RA_I_30000k and the maximum delay set to 8 ms (5) Set the CPE modem for PPPoE mode.
Method of Procedure	(1) Using software capable of measuring throughput at the TCP layer, initiate a download, in the downstream direction, of a file having length of 50 Mbytes. Complete 10 such transactions. (2) Record the average throughput rate result in units of bits per second. (3) Calculate the ratio of the downstream throughput to the downstream data rate. (4) Using software capable of measuring throughput at the TCP layer, initiate an upload, in the upstream direction, of a file having length of 1.0 Mbytes. (5) Record the average throughput rate results in units of bits per second. (6) Calculate the ratio of the upstream throughput to the upstream date rate.
Expected Result	In both the upstream and downstream directions, the ratio SHALL be $>= 0.84$.

9.3   RFC2364 [13] PPPoA End-to-End Connectivity Test

Table 9-7 describes the testprocedure for the PPPoA end-to-end connectivity test.

1 individual test – 1 SHALL be passed
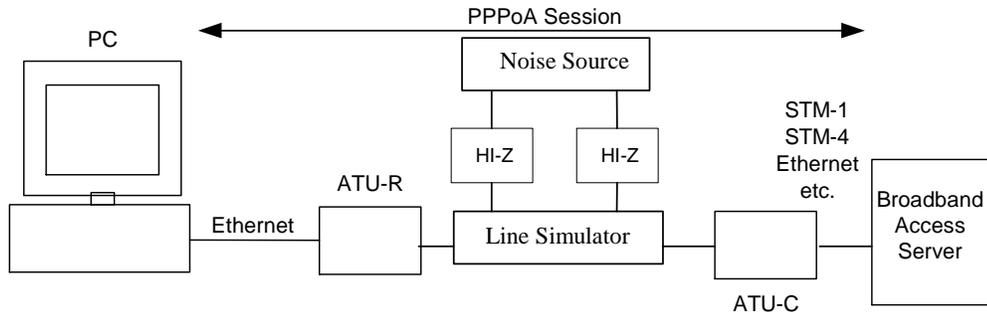
Figure 9: Test setup for PPPoA testing with Ethernet modems
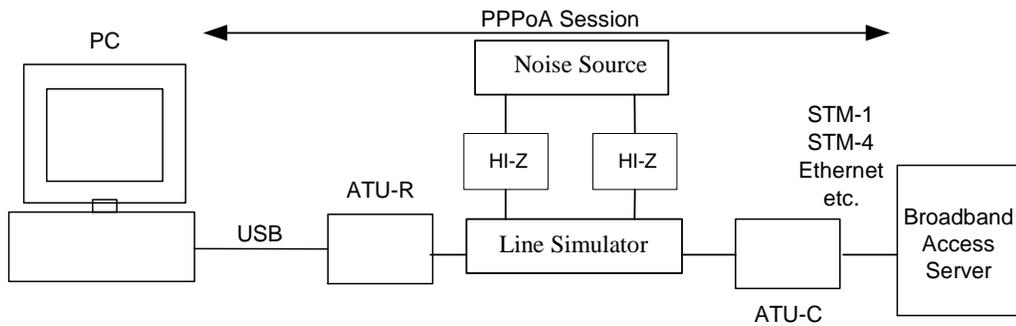
Figure 10: Test setup for PPPoA testing with USB modems

Table 9-7: PPPoA

Test Configuration	(1) See Figure 10 or 11 (as applicable)
Method of Procedure	(1) Terminate PPPoA session between the computer and the broadband access server. (2) Verify connectivity by passing traffic over this PPPoA session. (3) Tear Down the PPPoA session.
Expected Result	(1) Transmitted packets are received. (2) The PPPoA session has been torn down correctly.

9.4   RFC2684 [11] IP Bridged End-to-End Connectivity Test

Table 9-8 describes the testprocedure for the IP Bridged connectivity test.

1 individual test – 1 SHALL be passed

Table 9-8: Verify IP Bridged RFC 2684 [11]

Test Configuration	(1) See Figure 4, applicable to Ethernet modem only. (2) Configure the test environment including the CPE and the computer such that the CPE Ethernet port terminates a bridge section.
Method of Procedure	(1) The second termination of the bridge section should be implemented at an appropriate device within the testing environment (e.g. DSLAM, PoP). (2) Pass IP packets over the complete bridge section and verify the proper reception at the destination (e.g. PoP, Host PC).
Expected Result	Transmitted packets are received.

9.5 Power Cycle Test

Table 9-9 describes the testprocedure for the power cycle test.

1 individual test - 1 SHALL be passed

Table 9-9: Power Cycle Test

Test Configuration	(1) The configuration SHALL be as shown in Figures 5 - 7, depending on customer interface of modem (no loop length, bridge tap nor noise injected) (2) Connect Modem to test setup. (3) Configure the DSLAM with testprofile AU_RA_I_30000k and the maximum delay set to 8 ms.
Method of Procedure	(1) Train modem. (2) Follow procedure to establish a data link, if necessary. (3) Send arbitrary data (verify received). (4) Disconnect power from modem for 30 seconds. (5) Allow modem to train. (6) Follow procedure to re-establish the data link. (7) Send arbitrary data (verify received).
Expected Result	(1) Modem re-powers. (2) Link re-covers and modem passes data.

Annex A   Physical Layer Test Cases for systems using G.992.3[1] and G.992.5[2] Annex A.

A.1   North American Test set

Listed are three known sources of variability that need to be taken into account when verifying the interoperability of a CPE and DSLAM combination.

1. CPE Variability

   For a modem type to be considered compliant, unit(s) submitted for compliance testing SHALL pass the performance requirements in this section. Taking into account the statistical variability in the manufacturing process, it is expected that the large majority of randomly-selected units will pass these requirements. (See Appendix I)

2. Test Environment Variability

   The rate requirements in this section take into account a 0.5dB variability in the test environment.

3. Bridged Tap Noise Injection Variability

   The noise injection method of the present version of the document for bridged tap sections may lead to:
   - results differing from those on real loops,
   - lower repeatability of results (due to, for example, varying noise floor and impedance) from test environment to test environment even if they are compliant to this document.

   The impact on the rate requirements contained herein and ways to improve test conditions are under study. A future version of this document may address this issue.

Tests SHALL be performed according to the general procedure described in section 7.
CO and CPE ends SHALL operate over POTS, using the FDM spectral mask.

The ADSL2plus near-end and far-end self-crosstalk (NEXT and FEXT) SHALL be based on the template PSD masks from G.992.5[2] and the loop transfer functions from T1.417[6]
   - NEXT SHALL be calculated using the "Simplified Next Equation" from T1.417[6] section A.3.2.1.1. and G.992.5[2] PSD for the specified loop configuration, gauge, length and number of disturbers.
   - FEXT will be calculated using the "Far end crosstalk" equation from T1.417[6] section A.3.2.2 and the G.992.5[2] PSD for the specified loop configuration, gauge, length and number of disturbers.

Following loops SHALL be used (T1.417[6] cable models) :
   - 26awg variable length straight loop
   - 26awg loop with 24awg bridge tap segment at the customer end of the loop (at CPE side)

Straight loop tests SHALL use the loop configuration shown in Figure 11. A 0ft bridge tap may be attached to the CPE end of the straight loop during testing. Bridged Tap loops SHALL use the loop configuration shown in Figure 12.
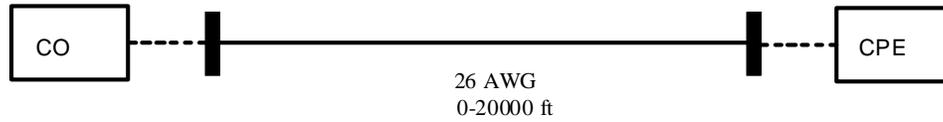
Figure 11: Straight Loop Configuration

Figure 12: Bridged Tap Loop Configuration

All tests for section A.1 SHALL be executed with configured RFI band notching.
Table A.1-1 shows the HAM band that SHALL be notched. Other HAM bands may or may not be notched as well.

The Ham band is specified according G.997.1 section 7.3.1.2.10 'RFI bands (RFIBANDSds)', using two breakpoints [ti;ti+1], corresponding to the low level of the notch. These breakpoints are referred to as points t(i+2) and t(i+3) in G.992.5 section 8.5.1 item 5 'RFI band specification' (where the index i represents the i-th RFI band)

Table A.1-1: Ham band specification

Band start	Band stop	PSD level
kHz	kHz	(dBm/Hz)
1800	2000	-80

Note: Modems passing this test are not necessarily meeting the spectrum compatibility as defined by T1.417 for North America, or any other similar requirement specification. Users of this document should carry on additional testing to ensure spectral compatibility before deployment.

A.1.1 CPE Margin verification tests

Section 7.5 gives a description and test procedure for the margin verification tests in tables A.1-2 up to A.1-8.

Table A.1-2: Margin Verification (3000 ft 26awg, 12 ADSL2plus DN Fext, -140dBm/Hz AWGN), testprofile AU_RA_L_30000k

Loop length (kft) 26AWG	Test time (minutes)	Anticipated DS net data rate: >= 12254 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by min(initial_reported_margin – 1, target margin) dB	Estimated BER, based on equations in Table 8-14, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
3	10				

Table A.1.3: Margin Verification (5000 ft, NEXT – 5 T1 adjacent, -140dBm/Hz AWGN) , testprofile AU_RA_L_30000k

Loop length (kft) 26AWG	Test time (minutes)	Anticipated DS net data rate: >= 9648 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by min(initial_reported_margin – 1, target margin) dB	Estimated BER, based on equations in Table 8-14, interleaved path If: Estimated BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
5	10				

Table A.1-4: Margin Verification (12000 ft, 750 ft BT (24AWG), -140dBm/Hz AWGN), testprofile AU_RA_L_30000k

Loop length (kft) 26AWG	Test time (minutes)	Anticipated DS net data rate: >= 3842 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by min(initial_reported_margin – 1, target margin) dB	Estimated BER, based on equations in Table 8-14, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
12 with 750ft BT (24AWG)	55				

Table A.1-5: Margin Verification (13000 ft, NEXT - 24 HDSL, -140dBm/Hz AWGN), testprofile AU_RA_L_30000k

Loop length (kft) 26AWG	Test time (minutes)	Anticipated DS net data rate: >= 1624 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by min(initial_reported_margin – 1, target margin) dB	Estimated BER, based on equations in Table 8-14, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
13	45				

Table A.1-6: Margin Verification (15000 ft, 400 ft BT (24AWG), -140dBm/Hz AWGN), testprofile AU_RA_L_30000k

Loop length (kft) 26AWG	Test time (minutes)	Anticipated DS net data rate: >= 1252 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by min(initial_reported_margin – 1, target margin) dB	Estimated BER, based on equations in Table 8-14, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
15 with 400ft BT (24WG)	55				

Table A.1-7: Margin Verification (17000 ft, -140dBm/Hz AWGN), testprofile AU_RA_L_30000k

Loop length (kft) 26AWG	Test time (minutes)	Anticipated DS net data rate: >= 799 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by min(initial_reported_margin – 1, target margin) dB	Estimated BER, based on equations in Table 8-14, interleaved path If: Estimated_BER < 1.75e-7 then PASS else FAIL	Pass / Fail
17	45				

Note: Due to the low, achievable DS data rates under this loop and noise condition, the observation of 10 error events would require approximately 85 minutes (at BER ~ 1e-7). To accelerate testing, the desired number of observed error events is reduced to 5. To remain consistent with previous confidence levels of estimated BER, the range of allowed estimated BER is increased from 1.5-e7 to 1.75e-7

Table A.1-8: Margin Verification (400 ft, -140dBm/Hz AWGN) , testprofile AU_RA_L_30000k

Loop length (kft) 26AWG	Test time (minutes)	Anticipated DS net data rate: >= 23768 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by min(initial_reported_margin – 1, target margin) dB	Estimated BER, based on equations in Table 8-14, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
0.4	5				

A.1.2 Operation in the Presence of Impulse Noise Events

Table A.1-9 describes the testprocedure for the verification of the INP capability of a CO or CPE modem by testing the operation in the presence of impulse noise events.

Table A.1-9: Operation in the Presence of Impulse Noise Events

Test Configuration	(1) Connect the CPE to the DSLAM through a loop simulator. (2) Set the loop simulator to CSA Loop #6 (9000 feet of 26 AWG wire). (3) Configure the DSLAM with the testprofile AU_RA_I_30000k.
Method of Procedure	(1) Inject –110 dBm/Hz white noise disturber at the CO end of the loop. (2) Train the modems using test AU_RA_I_30000k profile. (3) Wait for 3 minutes after initialization. (4) Inject 15 impulses spaced at least 1 second apart into the circuit at the CO end of the loop simulator over a maximum of a one minute period. Each impulse SHALL be a "Burst of pseudo random AWGN" of 100us duration at a level of -90dBm/Hz differential mode. (5) Test the CPE modem by repeating the steps above, injecting the white noise and impulses at the customer end of the loop.
Expected Result	The number of errored seconds measured after the 3 minute initial period SHALL be ≤ 1 for the test to pass.

A.1.3 Verification of downstream bi/gi values

Table A.1-10 describes the testprocedure for the verification of downstream bi/gi values .

Table A.1-10: Verification of downstream bi/gi values

Test Configuration	The CO and CPE are connected in turn through 3 randomly selected loops (one from each of the sets below)

	Testloops:
	Set 1 (short loops):
	  a) 1 kft, FEXT – 12 ADSL2Plus, -140 dBm/Hz AWGN
	  b) 2 kft, -140 dBm/Hz AWGN
	  c) 9 kft, NEXT + FEXT - 12 ADSL2Plus, -140 dBm/Hz AWGN
	  d) 9 kft, NEXT - 5 T1 adjacent, -140 dBm/Hz AWGN
	  e) 9 kft, NEXT – 24HDSL, -140dBm/Hz AWGN
	Set 2 (long loops):
	  a) 12 kft, NEXT + FEXT - 12 ADSL2Plus, -140 dBm/Hz AWGN
	  b) 12 kft, -140 dBm/Hz AWGN
	  c) 13kft, NEXT – 24HDSL, -140dBm/Hz AWGN
	  d) 15 kft, NEXT - 5 T1 adjacent, -140 dBm/Hz AWGN
	  e) 18 kft, -140 dBm/Hz AWGN
	Set 3 (bridge tap loops)
	  a) 3 kft with 100 ft BT (24AWG), -140 dBm/Hz AWGN
	  b) 5 kft with 50 ft BT (24AWG), NEXT + FEXT - 12 ADSL2Plus, -140 dBm/Hz AWGN
	  c) 5 kft with 200 ft BT (24AWG), NEXT + FEXT - 12 ADSL2Plus, -140 dBm/Hz AWGN
	  d) 5 kft with 200 ft BT (24AWG), -140 dBm/Hz AWGN
	  e) 9 kft with 100 ft BT (24AWG), -140 dBm/Hz AWGN
	  f) 11 kft with 200 ft BT (24AWG), -140 dBm/Hz AWGN

Method of Procedure	(1) Select randomly one testloop from the set 1 above. (2) Train the modem using the testprofile AU_RA_L_30000k. (3) From the DSLAM read the bi and gi values requested during initialization (4) Repeat steps {1} to {3} for one other randomly selected loop from set 2. (5) Repeat steps {1} to {3} for one other randomly selected loop from set 3.
Expected Result	The RMSGIds SHALL be calculated in linear scale with g_i values as contained in the BiGi table and then rounded to nearest 100th of a dB. The b_i and g_i values rounded to the nearest 100th of a dB in the bits-and-gains table SHALL comply with the following requirements (Sections 8.5.2 and 8.6.4 of G.992.3[1]) (1) All bi values SHALL be in the [0 to BIMAXds] (bits) range, where $8 \leq BIMAXds \leq 15$. (2) If bi > 0, then gi SHALL be in the [–14.54 to +2.50 + EXTGIds] (dB) range where $0 \leq EXTGIds \leq MAXNOMPSDds - NOMPSDds$. (3) RMSGIds $\leq$ EXTGIds + 1/16th of a dB (4) If bi > 0, then gi SHALL be in the [RMSGIds – 2.60 to RMSGIds + 2.60] (dB) range. (5) If bi = 0, then gi SHALL be equal to 0 (linear) or in the [–14.54 to RMSGIds + 0.10] (dB) range.

BIMAXds, EXTGIds, MAXNOMPSDds, NOMPSDds, RMSGIds are defined in G.992.3[1] Sections 8.5.1 and 8.5.2.

A.1.4 Loop tests with ports set for adaptive rate, automode operation

Tests SHALL be performed according to the general procedure described in section 7. In addition to achieving the required rate, both downstream and upstream noise margin values are to be considered in determining the result of an individual section. It is acknowledged that achieving a desired noise margin is primarily the responsibility of the receiver. That is, the DSLAM is primarily responsible for achieving desired upstream noise margins, while the CPE (modem) is primarily responsible for achieving desired downstream noise margins. Table A.1-11 outlines the pass/fail criteria on the reported noise margin.

Table A.1-11: Noise Margin Chart

Reported Noise Margin (dB)	Requirement
< 4	On no test point
>= 4 and < 5	On at most 10% of the test points
>= 5	On at least 90% of the test points
>= 5.8	On at least 75% of the downstream test points

All measurements SHALL be from the DSLAM.

Violation of any of the requirements in the Noise Margin Chart SHALL constitute a test section failure. Overall pass/fail criteria for each adaptive rate test section is then as follows:
- If any reported noise margin is less than 4dB, then the CO/CPE pair fails the *noise margin* requirements of that section.
- If more than 10% of the reported noise margins are less than 5dB in a section, then the CO/CPE pair fails the *noise margin* requirements of that section.
- If more than 25% of the reported downstream noise margins are less than 5.8dB in a section, then the CO/CPE pair fails the *noise margin* requirements of that section.
- If more than 10% of the net data rates are less than the data rate requirements in a section, then the CO/CPE pair fails the *data rate* requirements of that section.
- If a testpoint fails on the performance requirement for the following loops:
  - Table A.1-14: Loops 13, 14, 15, 16, and 17kft
  - Table A.1-15: Loops 13, 14, 15, 16, and 17kft
  - Table A.1-16: 15kft Loop with 400ft, 1000ft, and 1500ft Bridged Tap
  - Table A.1-17: 13kft Loop
  - Table A.1-18: Loops 13, 14, and 15kft

an additional check is done on the sum of measured upstream and downstream net data rates. If this sum is greater than or equal to the sum of the target upstream and downstream net data rates, the testpoint is considered a pass. This passing is indicated in the report as "Testpoint passed due to performance sum passing."

If the CO/CPE pair passes both the *data rate and noise margin* requirements, it passes the section; otherwise, it fails the section.

Table A.1-12 lists the number of test points per section corresponding to the 10% and 25% limits mentioned above.

Table A.1-12: Reported Margin Requirements

Section number	Number of test cases	10% limit	25% limit (applies to down-stream margins only)
A.1.4.1	22	2	3
A.1.4.2.1	44	4	6
A.1.4.2.2	44	4	6
A.1.4.2.3	40	4	5
A.1.4.3	20	2	3
A.1.4.4	22	2	3

A.1.4.1   12 ADSL2plus self NEXT and FEXT noise impairment

Set the noise generator to apply 12 ADSL2plus self NEXT and FEXT and –140dBm/Hz AWGN noise at both ends of the loop.
For self FEXT only noise, the self FEXT noise SHALL be injected at the side under test only.

22 individual tests – 20 tests SHALL be passed

Table A.1-13: ADSL2plus self-next and fext and -140dBm/Hz AWGN noise

Loop length 26 AWG (kft)	Bridge tap length 24 AWG (ft)	Noise Applied on CO side	Noise Applied on Remote side	testprofile AU_RA_I_30000k								Reported Operating Mode
				Upstream				Downstream				
				Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
				Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
1	0	12 ADSL2plus Up Fext, -140 dBm/Hz AWGN	-140 dBm/Hz AWGN	900				n/a	n/a	n/a	n/a	
1	0	-140 dBm/Hz AWGN	12 ADSL2plus Dn Fext, -140 dBm/Hz AWGN	n/a	n/a	n/a	n/a	13700				
3	0	12 ADSL2plus Up Fext, -140	-140 dBm/Hz	900				n/a	n/a	n/a	n/a	

Loop length 26 AWG (kft)	Bridge tap length 24 AWG (ft)	Noise Applied on CO side	Noise Applied on Remote side	testprofile AU_RA_I_30000k								Reported Operating Mode
				Upstream				Downstream				
				Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
				Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
		dBm/Hz AWGN	AWGN									
3	0	-140 dBm/Hz AWGN	12 ADSL2plus Dn Fext, -140 dBm/Hz AWGN	n/a	n/a	n/a	n/a	12254				
5	0	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	900				11001				
7	0	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	900				9284				
9	0	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	888				6969				
10	0	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	800				5712				
12	0	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	800				3576				

Loop length 26 AWG (kft)	Bridge tap length 24 AWG (ft)	Noise Applied on CO side	Noise Applied on Remote side	testprofile AU_RA_I_30000k								Reported Operating Mode
				Upstream				Downstream				
				Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
				Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
5	50	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	913				10796				
5	100	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	900				10947				
5	150	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	900				11001				
5	200	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	900				10790				

A.1.4.2   AWGN –140 dBm/Hz noise impairment

Set the noise generator to apply –140dBm/Hz AWGN noise at both ends of the loop.

A.1.4.2.1 26AWG loop with testprofile AU_RA_L_30000k

44 individual tests – 40 tests SHALL be passed

Table A.1-14: -140dBm/Hz AWGN noise, 26awg loop, testprofile AU_RA_L_30000

Loop length 26 AWG (kft)	testprofile AU_RA_L_30000								Reported Operating Mode
	Upstream				Downstream				
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
0.1	1000				23412				
0.4	1000				23768				
1	1000				23616				
2	1000				22740				
3	1000				21551				
4	1000				20287				
5	1000				18186				
6	1000				16456				
7	1000				14368				
8	1000				11236				
9	994				9080				
10	976				6734				
11	954				5521				
12	900				4167				
13	846				3264				
14	779				2717				
15	516				1952				
16	430				1387				
17	344				799				
18	328				464				
19	239				235				
20	150				212				

A.1.4.2.2   26AWG loop with testprofile AU_RA_I_30000k

44 individual tests – 40 tests SHALL be passed

Table A.1-15: -140dBm/Hz AWGN noise, 26awg loop, testprofile AU_RA_I_30000k

Loop length 26 AWG (kft)	testprofile AU_RA_I_30000k								Reported Operating Mode
	Upstream				Downstream				
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
0.1	900				18526				
0.4	900				18732				
1	900				18314				
2	900				18200				
3	900				17123				
4	900				16392				
5	900				15613				
6	900				14095				
7	900				13300				
8	900				11308				
9	850				9188				
10	800				6704				
11	750				5364				
12	700				4496				
13	650				3496				
14	600				2292				
15	550				2022				
16	500				1318				
17	376				464				
18	356				355				
19	336				246				
20	227				178				

A.1.4.2.3   26AWG loop with 24AWG bridge taps and testprofile AU_RA_L_30000k

40 individual tests – 36 tests SHALL be passed

Table A.1-16: -140dBm/Hz AWGN noise, 26awg loop with 24awg bridge taps

Loop length 26 AWG (kft)	Bridge tap length 24 AWG (ft)	testprofile AU_RA_L_30000k									Reported Operating Mode
		Upstream				Downstream					
		Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)		
		Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail			
0.5	100	1000				21971					
3	100	1000				19423					
5	100	1000				16631					
7	100	1000				12862					
9	100	900				8125					
11	100	900				5270					
3	200	1000				20932					
5	200	1000				17812					
7	200	1000				13156					
9	200	1000				8221					
11	200	893				4179					
12	250	803				3293					
12	750	763				3842					
12	1500	492				3460					
15	400	516				1252					
15	1000	491				1469					
15	1500	336				1748					
17.5	150	336				428					
17.5	800	240				524					
17.5	1500	24				508					

A.1.4.3   24 HDSL NEXT impairment

Set the noise generator to apply 24 HDSL NEXT impairment and –140dBm/Hz AWGN noise at both ends of the loop.

20 individual tests – 18 tests SHALL be passed

Table A.1-17: 24HDSL NEXT and -140dBm/Hz AWGN noise

Loop length 26 AWG (kft)	Bridge tap length 24 AWG (ft)	testprofile AU_RA_L_30000								Reported Operating Mode
		Upstream				Downstream				
		Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
		Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
1	0	1000				20000				
3	0	1000				19484				
5	0	879				17506				
7	0	588				12988				
9	0	560				7184				
11	0	366				3619				
13	0	192				1624				
5	100	867				15443				
5	200	807				17173				
6	500	665				14443				

A.1.4.4   5 T1 NEXT adjacent binder impairment

Set the noise generator to apply 5 T1 Next(adjacent binder) impairment and –140dBm/Hz AWGN noise at both ends of the loop.

22 individual tests – 20 tests SHALL be passed

Table A.1-18: 5 T1(adj) NEXT and -140dBm/Hz AWGN noise

Loop length 26 AWG (kft)	Bridge tap length 24 AWG (ft)	Testprofile AU_RA_L_30000k								
		Upstream				Downstream				Reported Operating Mode
		Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
		Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
1	0	1000				20321				
3	0	1000				16235				
5	0	1000				9648				
7	0	1000				4702				
9	0	994				2626				
13	0	846				796				
14	0	620				515				
15	0	456				86				
5	100	1000				8243				
5	200	1000				10082				
6	500	1000				7447				

A.1.5 Loop tests with ports set for adaptive rate, single operating mode

Tests SHALL be performed according to the general procedure described in section 7.
CO and CPE ends SHALL operate in singlemode over POTS using the FDM spectral mask.
The specific testprofiles are changed to enable only the operating mode indicated in each table for that specific test.
In addition to achieving the required rate, both downstream and upstream noise margin values are to be considered in determining the result of an individual section. It is acknowledged that achieving a desired noise margin is primarily the responsibility of the receiver. That is, the DSLAM is primarily responsible for achieving desired upstream noise margins, while the CPE (modem) is primarily responsible for achieving desired downstream noise margins. Table A.1-11 outlines the reported noise margin pass/fail criteria.

All measurements SHALL be from the DSLAM.

Violation of any of the requirements in the Noise Margin Chart SHALL constitute a test section failure. Overall pass/fail criteria for each adaptive rate test section is then as follows:
- If any reported noise margin is less than 4dB, then the CO/CPE pair fails the *noise margin* requirements of that section.
- If more than 10% of the reported noise margins are less than 5dB in a section, then the CO/CPE pair fails the *noise margin* requirements of that section.
- If more than 25% of the reported downstream noise margins are less than 5.8dB in a section, then the CO/CPE pair fails the *noise margin* requirements of that section.
- If more than 10% of the net data rates are less than the data rate requirements in a section, then the CO/CPE pair fails the *data rate* requirements of that section.
- If the CO/CPE pair passes *both the data rate and noise margin* requirements, it passes the section; otherwise, it fails the section.

Table A.1-19 lists the number of test points per section corresponding to the 10% and 25% limits mentioned above.

Table A.1-19: Reported Margin Requirements (single operating mode)

Section number	Number of test cases	10% limit	25% limit (applies to downstream margins only)
A.1.5.1	8	1	1
A.1.5.2	16	2	2
A.1.5.3	6	1	1
A.1.5.4	6	1	1

A.1.5.1 12 Self NEXT and FEXT noise impairment

8 individual tests – 7 tests SHALL be passed

Table A.1-20: 12 Self NEXT and FEXT and –140dbm/Hz AWGN noise

Loop length 26 AWG (kft)	Noise Applied on CO side	Noise Applied on Remote side	testprofile AU_RA_I_30000k								Operating Mode
			Upstream				Downstream				
			Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
			Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
1	12 ADSL2plus Up Fext, -140 dBm/Hz AWGN	-140 dBm/Hz AWGN	900				n/a	n/a	n/a	n/a	ADSL2plus
1	-140 dBm/Hz AWGN	12 ADSL2plus Dn Fext, -140 dBm/Hz AWGN	n/a	n/a	n/a	n/a	13700				ADSL2plus
5	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	900				11001				ADSL2plus
12	12 ADSL2plus Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2plus Up Next+Dn Fext, -140 dBm/Hz AWGN	800				3576				ADSL2
15	12 ADSL2 Annex-L Up Fext+Dn Next, -140 dBm/Hz AWGN	12 ADSL2 Annex-L Up Next+Dn Fext, -140 dBm/Hz AWGN	464				1348				ADSL2 AnnexL (wide US PSD)

A.1.5.2   AWGN –140 dBm/Hz noise impairment

Set the noise generator to apply –140dBm/Hz AWGN noise at both ends of the loop.

16 individual tests – 14 tests SHALL be passed

Table A.1-21: -140dBm/Hz AWGN noise, testprofile AU_RA_L_30000k

Loop length 26 AWG (kft)	Bridge tap length 24 AWG (ft)	Testprofile AU_RA_L_30000k								Operating Mode
		Upstream				Downstream				
		Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
		Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
1	0	1000				23616				ADSL2plus
5	0	1000				18186				ADSL2plus
12	0	846				4167				ADSL2
17.5	800	240				524				ADSL2 AnnexL (wide US PSD)

Table A.1-22: -140dBm/Hz AWGN noise, testprofile AU_RA_I_30000k

Loop length 26 AWG (ft)	testprofile AU_RA_I_30000k								Operating Mode
	Upstream				Downstream				
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
1	900				18314				ADSL2plus
5	900				15613				ADSL2plus
12	700				4496				ADSL2
18	356				355				ADSL2 AnnexL (wide US PSD)

A.1.5.3   24 HDSL NEXT impairment

Set the noise generator to apply 24 HDSL NEXT impairment and –140dBm/Hz AWGN noise at both ends of the loop.

6 individual tests – 5 tests SHALL be passed

Table A.1-23: 24HDSL NEXT and -140dBm/Hz AWGN noise

Loop length 26 AWG (kft)	testprofile AU_RA_L_30000								Operating Mode
	Upstream				Downstream				
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
1	1000				20000				ADSL2plus
5	879				17506				ADSL2plus
13	192				1624				ADSL2

A.1.5.4   5 T1 NEXT adjacent binder impairment

Set the noise generator to apply 5 T1 Next(adjacent binder) impairment and –140dBm/Hz AWGN noise at both ends of the loop.

6 individual tests – 5 tests SHALL be passed

Table A.1-24: 5 T1(adj) NEXT and -140dBm/Hz AWGN noise

Loop length 26 AWG (kft)	testprofile AU_RA_L_30000								Operating Mode
	Upstream				Downstream				
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)	
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail		
1	1012				20321				ADSL2plus
8	922				3953				ADSL2
15	456				86				ADSL2 AnnexL (wide US PSD)

A.1.6 Loop Tests with Ports Set For Fixed Rate

This section is for further study.

A.1.7 ADSL2plus Coexistence with Phoneline Networking

The test case described in table A.1-25 is intended to verify compatibility when ADSL2plus and a phoneline networking system as defined in G.pnt/G.9954[14], when both use the same inside wire pair

The test is to be performed on three different loop length of 26AWG pairs: 3kft, 5kft, and 7kft.

The pass/fail criterion is the bit error ratio (BER) at the physical layer. CRC error counts are used to estimate BER at the physical layer.

The injected G.pnt noise SHALL have the PSD as defined in G.9954 [14] spectral Mask #3. The PSD breakpoints are defined in [14] Table 7-14/G.9954 and is shown in [14] Figure 7-19/G.9954
SRA (seamless rate adaptation) capability SHALL be switched off during the test.

Table A.1-25: ADSL2plus and G.pnt coexistence

Test Configuration	The test set up is as shown in Figure 13.
Details of Test Procedure	{1} Configure CPE and DSLAM according to the testprofile AU_RA_I_30000k. {2} Configure a testloop of 3kft 26AWG. Connect CPE and DSLAM to the testloop. Apply the G.pnt noise at the CPE, {3} Force initialization and wait for modem to sync. {4} Wait for 3 minutes after initialization for bitswaps to settle. {5} Record the net data rate R(kbps). {6} Switch the noise to -140dBm/Hz AWGN and wait for 1 minute. {7} Record the net data rate R1(kbps) and count the number of CRC errors (C1) in the period of T, calculated using the following formula: $T = 400/(R*1000*1e\text{-}7*60)$ (min) and estimate the BER (P1) using Table 8-14, interleaved path. {8} Switch the noise back to G.pnt and wait for 1 minute. {9} Record the net data rate R2(kbps) and count the number of CRC errors (C2) in the period of T and estimate the BER (P2) using Table 8-14, interleaved path. {10} Repeat steps [2] to [9] for testloops 5kft 26Awg and 7 kft 26AWG
Expected Result	The CPE modem passes the G.pnt co-existence test, if for each testloop, (a) The modem does not re-initialize during the test (b) The estimated BER P1 and P2 are $< 1.5e\text{-}7$ (c) R = R1 = R2

Figure 13: G.pnt test setup

A.1.8 REIN noise impairment

This section is for further study.

A.2   European Test set

The specific testprofiles as defined in table 7.3 SHALL be used.
The performance on short loops is based on the ADSL-like (G.992.1) power cutback mechanism.
Two performance classes based on the support of optional extended framing parameters for the use of high delay profile with INP = 2 are defined.

> Class A: The DSLAM – modem combination **does** support the optional extended framing parameters acc. G.992.3[1] and G.992.5[2]

> Class B: The DSLAM – modem combination **does not** support the optional extended framing parameters acc. G.992.3[1] and G.992.5[2]

The performance tests have to be performed once and after filling in the results table the DSLAM – modem combination is allocated to the one or the other performance class.

A.2.1 Noise and noise injection

Noise SHALL be injected as specified in ETSI TS101388[8], with simultaneous noise injection at both ends of the loop.
The noise injection SHALL be calibrated as defined in ETSI TS101388[8].

The simultaneous used generators SHALL be G1 (NEXT noise), G2 (FEXT noise), G4 (white noise).

For **white noise** set generator G4 at both ends of the total loop at –140 dBm/Hz.

A.2.1.1   Noise Generator settings G1, G2 and G4 for ADSL2 noise FA or FD impairment

All measurements with noise model FA and FD SHALL be done with the noise model calculated for the corresponding length of the ETSI loop selected as indicated in the applicable testsection. Set noise generator G4 to apply a white noise disturber at both ends of the loop at -140 dBm/Hz.
Set noise generator G1 and G2 for ETSI FA noise:
At CO side:
- G1 = X.LT.FA/FD as defined in TS 101 388 [8], section. 5.3.4.1.3, table 12, with NEXT coupling function.
- G2 = X.NT.FA/FD as defined in TS 101 388 [8], section. 5.3.4.1.3, table 13, with FEXT coupling function.

At CPE side:
- G1 = X.NT.FA/FD as defined in TS 101 388 [8], section. 5.3.4.1.3, table 13, with NEXT coupling function.
- G2 = X.LT.FA/FD as defined in TS 101 388 [8], section. 5.3.4.1.3, table 12, with FEXT coupling function.

A.2.1.2   Noise Generator settings G1, G2 and G4 for ADSL2 noise FB impairment

All measurements with noise model FB SHALL be done with the noise model FB calculated for 3000 m ETSI loop #1.

Set noise generator G4 to apply a white noise disturber at both ends of the loop at -140 dBm/Hz.

Set noise generator G1 and G2 for ETSI FB noise:

At CO side:

- G1 = X.LT.FB as defined in TS 101 388 [8], section. 5.3.4.1.3, table 12, with NEXT coupling function.
- G2 = X.NT.FB as defined in TS 101 388 [8], section. 5.3.4.1.3, table 13, with FEXT coupling function.

At CPE side:

- G1 = X.NT.FB as defined in TS 101 388 [8], section. 5.3.4.1.3, table 13, with NEXT coupling function.
- G2 = X.LT.FB as defined in TS 101 388 [8], section. 5.3.4.1.3, table 12, with FEXT coupling function.

A.2.1.3   Noise Generator settings G1, G2 and G4 for ADSL2plus noise FA, FB and FD impairment

The ADSL2plus noise FA, FB and FD SHALL be calculated using the "Definition of the cross-talk coupling functions" from TS101388[8] section 5.3.2 table 5.

The template PSD masks for ADSL2plus noise FA, FB and FD SHALL be as defined in annex D table D.1-1 for NT side and table D.1-2 for LT side.

Set noise generator G4 to apply white noise disturber at both ends of the total loop at -140 dBm/Hz.

All measurements with noise model FA, FB and FD SHALL be done with the noise model calculated for the corresponding length of ETSI loop #1.

Set noise generator G1 and G2 for ETSI FA/FB/FC ADSL2plus noise:

At CO side:

- G1 = X.LT. FA/FB/FD for ADSL2plus, with NEXT coupling function.
- G2 = X.NT. FA/FB/FD for ADSL2plus, with FEXT coupling function.

At CPE side:

- G1 = X.NT. FA/FB/FD for ADSL2plus, with NEXT coupling function.
- G2 = X.LT. FA/FB/FD for ADSL2plus, with FEXT coupling function.

A.2.2 CPE Margin verification tests

Section 7.5 gives a description and testprocedure for the margin verification tests in tables A.2-1 up to A.2-7

A.2.2.1   Noise FB ADSL2 impairments at 750 m.

 Noise FB settings as defined in section A.2.1.2, using testprofile A2_RA_F_16000k

Table A.2-1: Noise FB ADSL2 impairment, testprofile A2_RA_F_16000k, at 750 m

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 8932 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, fast path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
750	5				

A.2.2.2   Noise FB ADSL2 impairments at 2750 m.

Noise FB settings as defined in section A.2.1.2, using testprofile A2_RA_I1/2_16000k

Table A.2-2: Noise FB ADSL2 impairment, testprofile A2_RA_I1/2_16000k, at 2750 m.

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 2156 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1. 5e-7 then PASS else FAIL	**Pass / Fail**
2750	35				

A.2.2.3   ADSL2 Random selected loop (Optional test)

Select one test loop from: ETSI Loop #3-7 with either Noise Impairment FA or FD for ADSL2 as defined in sections A2.1.1, using testprofile A2_RA_I1/2_16000k.

Table A.2-3: Selected Test Loop, testprofile A2_RA_I1/2_16000k

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved DS net data rate (test start) Achieved DS net	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If:	**Pass / Fail**

				Estimated_BER < 1.5e-7 then PASS else FAIL	
Loop Selected					

Note: The table for section A.2-3 is an example table. The specific test loop selected and noise shape used should be indicated in the table. The connect rate and also test time calculated should be indicated in the table A.2-3.

A.2.2.4   Noise FD ADSL2 impairments at 5250m (optional test).

Noise FD settings as defined in section A.2.1.1, using test profile A2L_RA_I_16000k

Table A.2-4: Noise FD ADSL2 impairment, test profile A2L_RA_I_16000k, at 5250 m.

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 448 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1. 85e-7 then PASS else FAIL	**Pass / Fail**
5250	60				

NOTE: Due to the low, achievable DS data rates under this loop and noise condition, the observation of 10 error events would require approximately 150 minutes (at BER ~ 1e-7). To accelerate testing, the desired number of observed error events is reduced to 4. To remain consistent with previous confidence levels of estimated BER, the range of allowed estimated BER is increased from 1.5-e7 to 1.85e-7

A.2.2.5   Noise FB ADSL2plus impairments at 250 m.

Noise FB settings as defined in section A.2.1.3, using testprofile A2P_RA_F_30000k

Table A.2-5: Noise FB ADSL2plus impairment, testprofile A2P_RA_F_30000k, at 250 m

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 14648 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, fast path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
250	5				

A.2.2.6   Noise FB ADSL2plus impairments at 1750 m.

Noise FB settings as defined in section A.2.1.3, using testprofile A2P_RA_I_30000k for Class A implementations and A2P_RA_I1/2_30000k for Class B implementations.

Table A.2-6: Noise FB ADSL2plus impairment, testprofile A2P_RA_I_30000k (Class A) or A2P_RA_I1/2_30000k (Class B), at 1750 m.

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 9296 kbps (Class A) >= 9488 kbps (Class B) Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin - 1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1. 5e-7 then PASS else FAIL	**Pass / Fail**
1750	10				

A.2.2.7   ADSL2plus Random selected loop (Optional test)

Select one test loop from: ETSI Loop #3-7 with either Noise Impairment FA or FD for ADSL2plus as defined is section A.2.1.3, using testprofile A2P_RA_I_30000k

Table A.2-7: Margin Tests for Selected ETSI Loop #3 – 7, testprofile A2P_RA_I_30000k

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
Loop Selected					

> Note: The table is an example table. The specific test loop selected and noise shape used SHALL be indicated in table A.2-7. The connect rate and also test time calculated SHALL also be indicated in table A.2-7

A.2.3 CO Margin Verification (Optional)

Section 7.5 gives a description and testprocedure for the margin verification tests in tables A.2-8 up to A.2-11.

A.2.3.1   Noise FB ADSL2 impairment at 750m.

Noise FB settings as defined in section A.2.1.2, using test profile A2_RA_F_16000k

Table A.2-8: Upstream margin test with noise FB ADSL2 impairment, test profile A2_RA_F_16000k, at 750 meters

Loop length (m) 0.4mm	Test time (minutes)	Anticipated US net data rate: >= 1048 kbps Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, fast path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
750	25				

A.2.3.2   Noise FB ADSL2 impairment at 2750m.

Noise FB settings as defined in section A.2.1.2, using test profile A2_RA_I1/2_16000k

Table A.2-9: Upstream margin tests with noise FB ADSL2 impairment, test profile A2_RA_I1/2_16000k, at 2750 meters

Loop length (m) 0.4mm	Test time (minutes)	Anticipated US net data rate: >= 536 kbps Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.75e-7 then PASS else FAIL	**Pass / Fail**
2750	60				

NOTE: Due to the low achievable US data rates under this loop and noise condition, the observation of 10 error events would require approximately 85 minutes (at BER ~ 1e-7). To accelerate testing, the desired number of observed

error events is reduced to 5. To remain consistent with previous confidence levels of estimated BER, the range of allowed estimated BER is increased from 1.5-e7 to 1.75e-7

A.2.3.3   Noise FB ADSL2plus impairment at 250m.

Noise FB Settings as defined in section A.2.1.3, using test profile A2P_RA_F_30000k

Table A.2-10: Upstream margin test with noise FB ADSL2plus impairment, test profile A2P_RA_F_30000k, at 250 meters

Loop length (m) 0.4mm	Test time (minutes)	Anticipated US net data rate: >= 1048 kbps Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, fast path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
250	25				

A.2.3.4   Noise FB ADSL2plus impairment at 1750m.

FB noise settings as defined in section A.2.1.3, using test profile A2P_RA_I_30000k

Table A.2-11: Upstream margin tests with noise FB ADSL2plus impairment at 1750 meters, test profile A2P_RA_I_30000k

Loop length (m) 0.4mm	Test time (minutes)	Anticipated US net data rate: >= 804 kbps Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.75e-7 then PASS else FAIL	**Pass / Fail**
1750	45				

NOTE: Due to the low, achievable DS data rates under this loop and noise condition, the observation of 10 error events would require approximately 85 minutes (at BER ~ 1e-7). To accelerate testing, the desired number of observed

error events is reduced to 5. To remain consistent with previous confidence levels of estimated BER, the range of allowed estimated BER is increased from 1.5-e7 to 1.75e-7

A.2.4 Verification of downstream bi/gi values

A.2.4.1   ADSL2

Table A.2-12 describes the testprocedure for the verification of downstream bi/gi values in ADSL2 operating mode.

Table A.2-12: Verification of downstream bi/gi values for ADSL2

Test Configuration	The CO and CPE are connected in turn through the following loops: a) ETSI loop #1, 1250 m, -140 dBm/Hz AWGN, testprofile A2_RA_F_16000k b) ETSI loop #1, 3250 m, -140 dBm/Hz AWGN, testprofile A2_RA_I1/2_16000k c) ETSI loop #1, 750 m, noise FB, testprofile A2_RA_I1/2_16000k d) ETSI loop #1, 2750 m, noise FB, testprofile A2_RA_F_16000k
Method of Procedure	(1) Select test loop 1 from the set above. (2) Train the modem in the test profile defined for the selected loop. (3) From the DSLAM read the b_i and g_i values requested during initialization (4) Repeat steps 1 to 3 for other test loops in the set.
Expected Results	The RMSGIds SHALL be calculated in linear scale with g_i values as contained in the BiGi table and then rounded to nearest 100th of a dB. The b_i and g_i values rounded to the nearest 100th of a dB in the bits-and-gains table SHALL comply with the following requirements (Sections 8.5.2 and 8.6.4 of G.992.3[1]) (1) All b_i values SHALL be in the [0 to BIMAXds] (bits) range, where $8 \leq$ BIMAXds ≤ 15. (2) If $b_i > 0$, then g_i SHALL be in the [–14.54 to +2.50 + EXTGIds] (dB) range where $0 \leq$ EXTGIds $\leq$ MAXNOMPSDds – NOMPSDds. (3) RMSGIds $\leq$ EXTGIds + 1/16th of a dB. (4) If $b_i > 0$, then g_i SHALL be in the [RMSGIds – 2.60 to RMSGIds + 2.60] (dB) range. (5) If $b_i = 0$, then g_i SHALL be equal to 0 (linear) or in the [–14.54 to RMSGIds + 0.10] (dB) range. BIMAXds, EXTGIds, MAXNOMPSDds, NOMPSDds, RMSGIds are defined in G.992.3[1] Sections 8.5.1 and 8.5.2.

A.2.4.2   ADSL2plus

Table A.2-13 describes the testprocedure for the verification of downstream bi/gi values in ADSL2plus operating mode.

Table A.2-13: Verification of downstream bi/gi values for ADSL2plus

Test Configuration	(1) The CO and CPE are connected in turn through the following loops: (2) ETSI loop #1, 250 m, -140 dBm/Hz AWGN, testprofile

	A2P_RA_F_30000k (3) ETSI loop #1, 1750 m, -140 dBm/Hz AWGN, testprofile A2P_RA_I_30000k (4) ETSI loop #1, 250 m, noise FB, testprofile A2P_RA_I_30000k (5) ETSI loop #1, 1750 m, noise FB, testprofile A2P_RA_F_30000k
Method of Procedure	(1) Select test loop 1 from the set above. (2) Train the modem in the test profile defined for the selected loop. (3) From the DSLAM read the b_i and g_i values requested during initialization (4) Repeat steps 1 to 3 for other test loops in the set.
Expected Results	The RMSGIds SHALL be calculated in linear scale with g_i values as contained in the BiGi table and then rounded to nearest 100th of a dB. The b_i and g_i values rounded to the nearest 100th of a dB in the bits-and-gains table SHALL comply with the following requirements (Sections 8.5.2 and 8.6.4 of G.992.3[1]) (1) All b_i values SHALL be in the [0 to BIMAXds] (bits) range, where $8 \leq BIMAXds \leq 15$. (2) If $b_i > 0$, then g_i SHALL be in the [–14.54 to +2.50 + EXTGIds] (dB) range where $0 \leq EXTGIds \leq MAXNOMPSDds – NOMPSDds$. (3) RMSGIds $\leq$ EXTGIds + $1/16^{th}$ of a dB (4) If $b_i > 0$, then g_i SHALL be in the [RMSGIds – 2.60 to RMSGIds + 2.60] (dB) range. (5) If $b_i = 0$, then g_i SHALL be equal to 0 (linear) or in the [–14.54 to RMSGIds + 0.10] (dB) range. BIMAXds, EXTGIds, MAXNOMPSDds, NOMPSDds, RMSGIds are defined in G.992.3[1] Sections 8.5.1 and 8.5.2.

A.2.5 Loop Tests with Ports Set for Adaptive Rate

The same pass/fail criteria as defined in section A.1-4 apply.
Table A.2-14 lists the number of test points per section corresponding to the 10% and 25% reported margin requirements limits mentioned above.

Table A.2-14: Reported Margin Requirements

Section number	Number of test cases	10% limit	25% limit (applies to down-stream margins only)
A.2.5.1	32	3	4
A.2.5.2	28	3	4
A.2.5.3	32	3	4
A.2.5.4	36 (class A) 28 (class B)	4 (class A) 3 (class B)	5 (class A) 4 (class B)

A.2.5.1   ADSL2 white noise impairment

Set noise generator G4 to apply a white noise disturber at both ends of the loop at -140 dBm/Hz.

16 individual tests – 14 tests SHALL be passed

Table A.2-15: White noise testprofile A2_RA_F_16000k

Loop Length (m, ETSI loop #1)	A2_RA_F_16000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
250	1048				12232			
1250	1048				12232			
1750	1048				11952			
2500	1048				9968			
3250	1004				6280			
4000	800				3292			
4750	576				1688			
5500	378				604			

16 individual tests – 14 tests SHALL be passed

Table A.2-16: White noise, testprofile A2_RA_I1/2_16000k

Loop Length (m, ETSI loop #1)	A2_RA_I1/2_16000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
250	1048				12184			
1250	1048				12184			
1750	1048				11892			
2500	1048				10276			
3250	1004				6700			
4000	820				3576			
4750	592				1868			
5500	384				760			

A.2.5.2   ADSL2 noise FB impaiment

FB noise settings as defined in section A.2.1.2

> Note: Short loop power cutback in ADSL2 can be determined on request by either
> side (DSLAM and CPE), depending on the receiver front-end capabilities. I.e. a
> short loop power cutback requested by CPE determines downstream aggregate

transmit power, which mainly impacts downstream performance. Downstream performance targets defined in Table A.2-17 and A.2-18 take into account a maximum power cutback of 12 dB.

14 individual tests – 12 tests SHALL be passed

Table A.2-17: Noise FB impairment, testprofile A2_RA_F_16000k

Loop Length (m, ETSI loop #1)	A2_RA_F_16000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
250	1048				7960			
750	1048				8932			
1250	964				8096			
1750	828				6592			
2250	672				4272			
2750	504				1596			
3250	340				64			

14 individual tests – 12 tests SHALL be passed

Table A.2-18: Noise FB impairment, testprofile A2_RA_I1/2_16000k

Loop Length (m, ETSI loop #1)	A2_RA_I1/2_16000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
250	1048				8052			
750	1048				9244			
1250	972				8348			
1750	836				6912			
2250	696				4616			
2750	536				2156			
3250	376				96			

A.2.5.3   ADSL2plus white noise impairment

Set noise generator G4 to apply white noise disturber at both ends of the total loop at -140 dBm/Hz.

16 individual tests – 14 tests SHALL be passed

Table A.2-19: White noise impairment, testprofile A2P_RA_F_30000k

Loop Length (m, ETSI loop #1)	A2P_RA_F_30000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
250	1048				23800			
1250	1048				22048			
1750	1048				17340			
2500	1048				10432			
3250	1004				6100			
4000	800				3292			
4750	576				1688			
5500	378				604			

16 individual tests – 14 tests SHALL be passed (applies to Class A implementations only)

Table A.2-20: White noise impairment, testprofile A2P_RA_I_30000k

Loop Length (m, ETSI loop #1)	A2P_RA_I_30000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
250	944				20600			
1250	944				18800			
1750	944				16000			
2500	944				10100			
3250	944				6100			
4000	820				3200			
4750	592				1800			
5500	384				700			

16 individual tests – 14 tests SHALL be passed (optional for class A implementations)

Table A.2-21: White noise impairment, testprofile A2P_RA_I1/2_30000k

Loop Length (m, ETSI loop #1)	A2P_RA_I1/2_30000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
250	1048				23296			
1250	1048				21984			
1750	1048				17444			
2500	1048				10964			
3250	1004				6480			
4000	820				3576			
4750	592				1868			
5500	384				760			

A.2.5.4   ADSL2plus FB noise impairment

FB noise settings as defined in section A.2.1.3

14 individual tests – 12 tests SHALL be passed

Table A.2-22: Noise FB ADSL2plus impairment testprofile A2P_RA_F_30000k

Loop Length (m, ETSI loop #1)	A2P_RA_F_30000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
100	1048				16084			
250	1048				14648			
750	1048				13548			
1250	910				11552			
1750	776				8600			
2500	560				2820			
3250	308				78			

14 individual tests – 12 tests SHALL be passed (applies to Class A implementations only)

Table A.2-23: Noise FB ADSL2plus impairment, testprofile A2P_RA_I_30000k

Loop Length (m, ETSI loop #1)	A2P_RA_I_30000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
100	944				14296			
250	944				14296			
750	944				13600			
1250	928				11800			
1750	804				9296			
2500	588				3330			
3250	348				200			

14 individual tests – 12 tests SHALL be passed

If the last six test points are not performed, as being optional, the tests to be passed SHALL be: 8 individual tests – 7 tests SHALL be passed

Table A.2-24: Noise FB ADSL2plus impairment, testprofile A2P_RA_I1/2_30000k

Loop Length (m, ETSI loop #1)	A2P_RA_I1/2_30000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
100	1048				16640			
250	1048				15476			
750	1048				14304			
1250	928				12444			
1750*	804				9488			
2500*	588				3330			
3250*	348				200			

*: optional testpoints for class A implementations

A.2.6 Loop Tests with Ports Set for Fixed Rate

Pass/fail criteria in this section:
- If upstream or downstream reported noise margin on any test point is >= 4dB and < 5.8dB, then this test point SHALL be re-tested 3 times. If a re-test is performed, then

the maximum reported downstream noise margin achieved during testing SHALL be recorded as reported noise margin for this test point, along with the associated upstream noise margin provided that this is >=5.8dB.

- If the final upstream or downstream reported noise margin (from step 1 above) is less than 5.8dB on any test point, then the CO/CPE pair fails that section.

A.2.6.1   ADSL2 FB noise impairment

The ADSL2 FB noise SHALL be calculated and injected as defined in section A.2.1.2.

a) Testprofile A2_Fix_F_7288k

4 individual tests – 4 SHALL be passed

Table A.2-25: Fixed rate, ADSL2 FB noise, testprofile A2_Fix_F_7288k

loop length (m, loop#1)	A2_Fix_F_7288k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
250			
750			
1250			
1500			

b) Testprofile A2_Fix_F_5952k

4 individual tests – 4 SHALL be passed

Table A.2-26: Fixed rate, ADSL2 FB noise, testprofile A2_Fix_F_5952k

loop length (m, loop#1)	A2_Fix_F_5952k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
1850			

c) Testprofile A2_Fix_F_2400k

5 individual tests – 5 SHALL be passed

Table A.2-27: Fixed rate,ADSL2 FB noise, testprofile A2_Fix_F_2400k

loop length (m, loop#1)	A2_Fix_F_2400k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
2000			
2550			

d) Testprofile A2_Fix_I_7288k

4 individual tests – 4 SHALL be passed

Table A.2-28: Fixed rate, ADSL2 FB noise, testprofile A2_Fix_I_7288k

loop length (m, loop#1)	A2_Fix_I_7288k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
1600			

e) Testprofile A2_Fix_I_5952k

4 individual tests – 4 SHALL be passed

Table A.2-29: Fixed rate,ADSL2 FB noise, testprofile A2_Fix_I_5952k

loop length (m, loop#1)	A2_Fix_I_5952k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
1950			

f) Testprofile A2_Fix_I_2400k

5 individual tests – 5 SHALL be passed

Table A.2-30: Fixed rate,ADSL2 FB noise, testprofile A2_Fix_I_2400

loop length (m, loop#1)	A2_Fix_I_2400		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
2000			
2650			

A.2.6.2   ADSL2plus FB noise impairment

The ADSL2plus FB noise SHALL be calculated and injected as defined in A.2.1.3.

a) Testprofile A2P_Fix_F_10000k

4 individual tests – 4 SHALL be passed

Table A.2-31: Fixed rate, ADSL2plus FB noise, testprofile A2P_Fix_F_10000k

loop length (m, loop#1)	A2P_Fix_F_10000k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported
0			
750			
1250			
1500			

b) Testprofile A2P_Fix_F_7288k

4 individual tests – 4 SHALL be passed

Table A.2-32: Fixed rate, ADSL2plus FB noise, testprofile A2P_Fix_F_7288k

loop length (m, loop#1)	A2P_Fix_F_7288k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
1800			

c) Testprofile A2P_Fix_F_5952k

4 individual tests – 4 SHALL be passed

Table A.2-33: Fixed rate, ADSL2plus FB noise, testprofile A2P_Fix_F_5952k

loop length (m, loop#1)	A2P_Fix_F_5952k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
2000			

d) Testprofile A2P_Fix_F_2400k

5 individual tests – 5 SHALL be passed

Table A.2-34: Fixed rate, ADSL2plus FB noise, testprofile A2P_Fix_F_2400k

loop length (m, loop#1)	A2P_Fix_F_2400k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
2000			
2550			

e) Testprofile A2P_Fix_I_10000k

4 individual tests – 4 SHALL be passed (applies to Class A implementations only)

Table A.2-35: Fixed rate, ADSL2plus FB noise, testprofile A2P_Fix_I_10000k

loop length (m, loop#1)	A2P_Fix_I_10000k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
1600			

f) Testprofile A2P_Fix_I_7288k

4 individual tests – 4 SHALL be passed

Table A.2-36: Fixed rate, ADSL2plus FB noise, testprofile A2P_Fix_I_7288k

loop length (m, loop#1)	A2P_Fix_I_7288k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
1900			

g) Testprofile A2P_Fix_I_5952k

4 individual tests – 4 SHALL be passed

Table A.2-37: Fixed rate, ADSL2plus FB noise, testprofile A2P_Fix_I_5952k

loop length (m, loop#1)	A2P_Fix_I_5952k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
2150			

h) Testprofile A2P_Fix_I_2400k

5 individual tests – 5 SHALL be passed

Table A.2-38: Fixed rate, ADSL2plus FB noise, testprofile A2P_Fix_I_2400k

loop length (m, loop#1)	A2P_Fix_I_2400k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0			
750			
1250			
2000			
2650			

A.2.7 Loop Tests with Ports Set for ADSL2 Annex L operating mode

The same pass/fail criteria as defined in section A.1-4 apply.
Table A.2-39 lists the number of test points per section corresponding to the 10% and 25% reported margin requirements limits mentioned above.

Table A.2-39: Reported Margin Requirements

Section number	Number of test cases	10% limit	25% limit (applies to down-stream margins only)
A.2.7.1	12	1	2
A.2.7.2	12	1	2

A.2.7.1   White noise impairment

Set noise generator G4 to apply white noise disturber at both ends of the total loop at -140 dBm/Hz.

12 individual tests – 10 tests SHALL be passed

Table A.2-40: White noise Impairment ADSL 2Annex L test profile A2L_RA_I_16000k

Loop Length (m, ETSI loop #1)	A2L_RA_I_16000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
4000	560				3360			
4500	504				2296			

5000	424			1480			
5500	304			912			
5800	240			608			
6000	200			400			

A.2.7.2   ADSL2 FD noise impairment

FD noise settings as defined in section A.2.1.1 for a loop length of 4500m

12 individual tests – 10 tests SHALL be passed

Table A.2-41: ADSL2 Noise FD 4500 m Impairment, ADSL 2 Annex L test profile A2L_RA_I_16000k

Loop Length (m, ETSI loop #1)	A2L_RA_I_16000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
4000	520				2096			
4500	448				1248			
4750	416				952			
5000	360				680			
5250	312				448			
5500	280				232			

A.2.8 REIN noise impairment

Configure the test setup as specified in section 7.2.2.
The noise models for 19 ADSL2plus disturbers, to be used with the crosstalk coupling functions defined in section 5.3.2 table 5 of ETSI TS 101 388[8], to generate simulated crosstalk noise for the corresponding length of ETSI loop #1, are defined in Annex-D tables D.1-3 and D.1-4.
The crosstalk noise SHALL be injected at both the CO and CPE
In addition to the crosstalk noise at CPE, the REIN noise is injected with a repetition frequency of 100Hz.

Set noise generator G4 to apply white noise disturber at both ends of the total loop at -140 dBm/Hz.

Set noise generator G1 and G2 for 19 FD ADSL2plus noise:

At CO side:

- G1 = X.LT.FD19 for ADSL2plus, with NEXT coupling function.
- G2 = X.NT.FD19 for ADSL2plus, with FEXT coupling function.

At CPE side:

- G1 = X.NT.FD19 for ADSL2plus, with NEXT coupling function.
- G2 = X.LT.FD19 for ADSL2plus, with FEXT coupling function.

The target margin for rate adaptive profile test SHALL be configured as indicated in table A.2-42

If an individual test is failed it may be repeated. An individual test may be repeated several times, but the total number of test attempts required to pass the 8 individual tests SHALL not exceed 16.

8 individual tests – 7 tests SHALL be passed

Table A.2-42: REIN noise impairment, rate adaptive profile

loop length (m, ETSI_loop #1)	Target Margin dB	Modem trained and did not lose sync? (Y/N)	Expected DS sync rate	Measured DS sync rate (kbps)	Downstream Noise Margin, Reported (dB)	Measured D/S Errored Seconds	Pass / Fail
A2P_RA_I_30000k with max delay=8ms							
1050	6		7644				
1750	9		3900				
2450	9		1900				
3150	9		600				

Table A.2-43: REIN noise impairment, fixed rate profile

Loop lenght (m, ETSI loop #1.)	Testprofile, with delay set to 8 ms.	Modem Trained and did not loose sync? (Y/N)	Downstream Noise Margin, Reported (dB)	Measured D/S Bit Rate	Measured D/S Errored Seconds	Pass / Fail
Testprofile A2(P)_FIX_I_X, with max delay= 8ms						
1300	A2P_Fix_I_7288k			7288		
1500	A2P_Fix_I_5952k			5952		
2000	A2P_Fix_I_2400k			2400		
2400	A2_Fix_I_1200k			1200		

Note: the ADSL2plus disturber noise model is used even when operating in ADSL2 mode since it can be assumed that the 19 disturbers are on shorter lines than the long line forced to use ADSL2.

A.3   ADSL2plus European tests operating with DS-PSD mask above ADSL

The ADSL2plus over ADSL tests SHALL be performed with crosstalk noise representing 19 disturbers with the same upstream and downstream PSD as the units under test.

CAL is the Cabinet Assigned Loss. The CAL parameter describes the electrical length of the cable between the Exchange and the Cabinet.

The tests SHALL be performed with three different downstream PSD mask shapes, calculated using the methods described in reference [15] Part B "ANFP PSD Mask Definition for SDF", for three CAL values: 12, 36, and 52 respectively.
The template PSD's are given in [16] sheet "Part B".
The upstream PSD mask SHALL be independent of the CAL value under test.

The ADSL2plus over ADSL FD noise SHALL be calculated using the "Definition of the cross-talk coupling functions" from TS101388[8] section 5.3.2 table 5, for the corresponding length of ETSI loop #2.

The downstream PSDs and downstream equivalent 19 disturber level X.LT.C12, X.LT.C36 and X.LT.C52 ADSL2plus over ADSL are shown in Annex-D tables D.2-1, D.2-2 and D.2-3. The upstream PSD and the upstream equivalent disturber level X.NT.FD19 ADSL2plus over ADSL for 19 disturbers are shown in Annex-D table D.1-4.

Set noise generator G4 to apply white noise disturber at both ends of the total loop at -140 dBm/Hz.
Set noise generator G1 and G2 for FD ADSL2plus over ADSL noise:

At CO side:

- G1 = X.LT.Cxx for ADSL2plus over ADSL, for appropriate CAL, with NEXT coupling function.
- G2 = X.NT.FD19 for ADSL2plus over ADSL, with FEXT coupling function.

At CPE side:

- G1 = X.NT.FD19 for ADSL2plus over ADSL, with NEXT coupling function.
- G2 = X.LT.Cxx for ADSL2plus over ADSL, for appropriate CAL, with FEXT coupling function.

The same pass/fail criteria as defined in section A.1-4 apply.
Table A.3-1 lists the number of test points per section corresponding to the 10% and 25% margin requirements limits mentioned above.

Table A.3-1: Reported Margin Requirements

Section number	Number of test cases	10% limit	25% limit (applies to down-stream margins only)
A.3.1.1	10	1	1
A.3.1.2	10	1	1
A.3.2.1	28	3	4
A.3.2.2	28	3	4

A.3.1 Noise ADSL2plus over ADSL FD (rate adaptive)

A.3.1.1   Noise FD ADSL2plus over ADSL Impairment, interleaved profiles

Interleaved profiles SHALL be tested with testprofile A2P_RA_I_30000k with DelayMax set to 8ms

10 individual tests – 8 tests SHALL be passed

Table A.3-2: Noise FD ADSL2plus over ADSL Impairment testprofile A2P_RA_I_30000k, CAL=12

Loop Length (m, ETSI loop #2)	A2P_RA_I_30000k CAL=12							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
1000	820				11460			

Table A.3-3: Noise FD ADSL2plus over ADSL Impairment, testprofile A2P_RA_I_30000k, CAL=36

Loop Length (m, ETSI loop #2)	A2P_RA_I_30000k CAL=36							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
1000	840				7250			
2000	860				6100			
2400	850				3960			

Table A.3-4: Noise FD ADSL2plus over ADSL Impairment testprofile A2P_RA_I_30000k, CAL=52

Loop Length (m, ETSI loop #2)	A2P_RA_I_30000k CAL=52							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
1000	880				11360			

A.3.1.2   Noise FD ADSL2plus over ADSL Impairment, fast profiles

10 individual tests – 8 tests SHALL be passed

Table A.3-5: Noise FD ADSL2plus over ADSL Impairment testprofile A2P_RA_F_30000k, CAL=12

Loop Length (m, ETSI loop #2)	A2P_RA_F_30000k CAL=12							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
1000	990				11850			

**Table A.3-6: Noise FD ADSL2plus over ADSL Impairment, testprofile
A2P_RA_F_30000k, CAL=36**

Loop Length (m, ETSI loop #2)	A2P_RA_F_30000k CAL=36							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
1000	930				6860			
2000	960				5720			
2400	940				3600			

**Table A.3-7: Noise FD ADSL2plus over ADSL Impairment testprofile
A2P_RA_F_30000k, CAL=52**

Loop Length (m, ETSI loop #2)	A2P_RA_F_30000k CAL=52							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
1000	920				10600			

A.3.2 Noise ADSL2plus over ADSL FD (fixed rate)

A.3.2.1   Noise FD ADSL2plus over ADSL impairment, interleaved profiles

The tests specified in tables A.3-11 up to A.3-16 SHALL be tested with test profile A2P_Fix_I_X, with X=600k, 2400k and 5952k, and maximum delay set to 8ms.

28 individual tests – 26 tests SHALL be passed

Table A.3-8: Noise FD ADSL2plus over ADSL Impairment testprofile
A2P_Fix_I_2400k, CAL=12

Loop Length (m, ETSI loop #2)	A2P_Fix_I_2400k CAL=12							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
50	352				2400			
1250	352				2400			
2750	352				2400			

Table A.3-9: Noise FD ADSL2plus over ADSL Impairment, testprofile A2P_Fix_I_X,
CAL=36

TestProfile X	Loop Length (m, ETSI Loop #2)	A2P_Fix_I_X CAL=36,with X=600k, 2400k and 5952k							
		Upstream				Downstream			
		Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
		Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
5952k	50	640				5952			
5952k	750	640				5952			
2400k	50	352				2400			
2400k	750	352				2400			
2400k	2250	352				2400			
600k	50	128				600			
600k	1250	128				600			
600k	2500	128				600			

**Table A.3-10: Noise FD ADSL2plus over ADSL Impairment testprofile
A2P_Fix_I_2400k, CAL=52**

Loop Length	A2P_Fix_I_2400k CAL=52							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
50	352				2400			
1250	352				2400			
2750	352				2400			

A.3.2.2   Noise FD ADSL2plus over ADSL Impairment, fast profiles

28 individual tests – 26 tests SHALL be passed

**Table A.3-11: Noise FD ADSL2plus over ADSL Impairment testprofile
A2P_Fix_F_2400k, CAL=12**

Loop Length (m, ETSI loop #2)	A2P_Fix_F_2400k CAL=12							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
50	352				2400			
1250	352				2400			
2750	352				2400			

Table A.3-12: Noise FD ADSL2plus over ADSL Impairment, testprofile A2P_Fix_F_X, CAL=36

TestProfile X	Loop Length (m, ETSI Loop #2)	A2P_Fix_F_X CAL=36, with X= 600l,2400k and 5952k							
		Upstream				Downstream			
		Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
		Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
5952k	50	640				5952			
5952k	750	640				5952			
2400k	50	352				2400			
2400k	750	352				2400			
2400k	2250	352				2400			
600k	50	128				600			
600k	1250	128				600			
600k	2500	128				600			

Table A.3-13: Noise FD ADSL2plus over ADSL Impairment testprofile A2P_Fix_F_2400k, CAL=52

Loop Length	A2P_Fix_F_2400k CAL=52							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
50	352				2400			
1250	352				2400			
2750	352				2400			

A.4   Tests for systems supporting Virtual Noise (optional)

Virtual noise is an optional feature of G.992.3[1] and G.992.5[2]. This test is only applicable for systems (DSLAM-CPE combination) supporting VN. Systems claiming support of VN SHALL be required to perform this test.

A.4.1 Performance tests for ADSL2plus systems operating under Transmitter referred Virtual Noise

The purpose of this test is to examine the downstream performance based under two conditions:
    a) with activated transmitter referred virtual noise
    b) with actual noise injected to the line

A transmitter referred virtual noise profile SHALL be programmed in the DSLAM. The modem SHALL be trained with activated virtual noise and then the actual noise which PSD equals the virtual noise profile SHALL be injected to the line at transmitter side. Test setup SHALL support the actual noise injection over the entire transmission band.

When configuring the transmitter referred virtual Noise PSD using a G.997.1 interface, the frequency should be converted into the nearest subcarrier index, and the VN PSD power should be rounded to the nearest 0.5 dBm/Hz resolutions. The same correction SHALL also be applied to the actual noise.

The transmitter referred virtual noise at DSLAM side is defined in Table A.4-1.

Table A.4-1: Transmitter Referred Virtual Noise at DSLAM side

Freq / MHz	VN PSD / dBm/Hz
0.0	-140
0.137	-140
0.138	-95.0
1.104	-80.0
2.208	-80.0
2.209	-140

Table A.4-2 represents the TXREFVNds setting for the transmitter referred virtual noise defined in Table A.4-1.

Table A.4-2: TXREFVNds parameter setting

Breakpoint	Subcarrier index	VN PSD / dBm/Hz
1	32	-95
2	256	-80
3	511	-80

Due to a fact that the upstream is not protected by the virtual noise there is also noise applied in the upstream frequency band.

Table A.4-3: Initial US Noise injected at DSLAM side

Freq (kHz)	PSD (dBm/Hz)
25	-120
137	-110
138	-140
2.208	-140

Table A.4-4: Actual DS+US Noise injected at DSLAM side

Freq / kHz	PSD dBm/Hz
25	-120
137	-110
138	-95
1104	-80
2208	-80
2209	-140

Table A.4-5: Transmitter Referred Virtual Noise test - downstream

Test Configuration	(1) The modems SHALL be connected as shown in Section 7 and configured in the specific test profile A2P_RA_I_30000. (2) TXREFVNds SHALL be configured according to Table A4-2. (3) SNRMODEds SHALL be set to 2, which implies that the virtual noise is enabled. (4) Disable SRA function by setting RA-MODE to 2 (AT_INIT rate adaptation mode). (5) The Line simulator SHALL be set up for the first straight homogeneous loop PE04 specified in Table A.4-6 (6) Set the noise generator to –140dBm/Hz AWGN noise at CPE side and to the Initial noise defined in table A.4-3 at DSLAM side of the loop.
Method of Procedure	(1) Connect and configure DSLAM and CPE as per test configuration details (2) Force initialization and wait for modems to synchronize. (3) Wait 1 minute following synchronization. (4) Record downstream SNR margin SNR1 and net data rate DS1 (5) Inject at DSLAM side the actual noise with a PSD equal to Table A.4-4. (6) Wait 1 minute (7) Record downstream SNR margin SNR2 and net data rate DS2 (8) Deactivate the line. (9) Set SNRMODEds to 1 and reinitialize the line (10) Record downstream net data rate DS3 and the bits allocation tables BITpsds. Determine the number of loaded downstream carriers LC. (11) Set SNRMODEds to 2. (12) Set the noise generator to –140dBm/Hz AWGN noise at CPE side and to the Initial noise defined in table A.4-3 at DSLAM side of the loop. (13) Repeat steps {2} to {12} for the next looplengths specified in Table A.4-6
Expected Result	(1) The link SHALL NOT re-train after actual noise is turned on (2) DS1= DS2 (3) SNR2 >= SNR1 – 3dB (4) DS3 >= DS1 - [(LC *1*4e3) ceiled to 8kbit/s] NOTE: Factor 1 in ER(4) represents data rate deterioration of 3dB.

Table A.4-6: VN test, test profile A2P_RA_I_30000k

Loop Length, PE 0.4mm (m)	Interleaved profile A2P_RA_I_30000k								
	Downstream								
	Net data rate DS1	SNR Margin SNR1 (dB)	Net data rate DS2	SNR Margin SNR2 (dB)	Net data rate DS3	# loaded carriers LC	Net data rate lower limit	Net data rate upper limit	Pass/fail
500									
1000									
2000									
4000									

Annex B   Physical Layer Test Cases for systems using G.992.3/5 Annex B.

This Annex contains a set of tests and requirements specific for ADSL systems according to the recommendations:

- G.992.3[1] for ADSL2 over ISDN with Frequency Division Duplexing (FDD).
- G.992.5[2] for ADSL2plus over ISDN with Frequency Division Duplexing (FDD).

 Testplan details, especially performance tests, for ADSL over ISDN Systems using echo cancellation are actually not considered and are for further study.

The performance on short loops is based on the ADSL-like (G.992.1) power cutback mechanism.

Two performance classes based on the support of optional extended framing parameters for the use of high delay profile with INP = 2 are defined.

> Class A: The DSLAM – modem combination **does** support the optional extended framing parameters acc. G.992.3[1] and G.992.5[2]

> Class B: The DSLAM – modem combination **does not** support the optional extended framing parameters acc. G.992.3[1] and G.992.5[2]

The performance tests have to be performed once and after filling in the results table the DSLAM – modem combination is allocated to the one or the other performance class.

B.1   Annex B specific test setup information

In addition to the general part of this document the following configurations have to be considered.

B.1.1 Splitter model

All tests SHALL be done with splitters inserted in the line on both the CO and CPE side. The vendor of the EUT (DSLAM, MODEM) SHALL deliver together with the EUT a splitter that complies with the common recommendations ETSI TS101952-1[9] , Sub-Part 3: specification of ADSL/ISDN splitters and/or ETSI TS101952-1 [9], Sub-Part 4: ADSL/'ISDN or POTS' universal splitter. The splitter manufacturer and design (external, integrated or splitter line card) is left to the EUT vendor.

The functional model of the used splitters SHALL conform to the following figure:
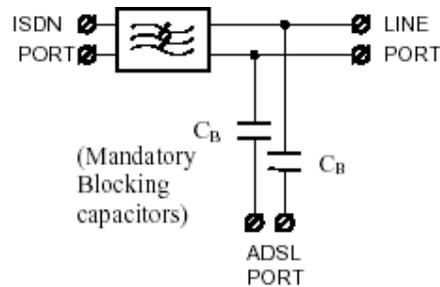
Figure B.1: structure of the ADSL/ISDN and ADSL/'ISDN or POTS' universal splitter

This structure of the splitter is a proposal for an external splitter. If the splitter functionality is integrated into the linecard, then the blocking capacitors are not mandatory.

B.1.2 Test loops / Loop characteristics

The tests of the physical layer are based on TS101388[8] for both ADSL2 and ADSL2plus. For the test setup figure 10 applies. The CPE and the DSLAM are connected via a loop simulator. The loop simulators SHALL simulate the loop characteristics specified in the above standards. The loop simulators SHALL be calibrated relative to the nominal attenuation as defined in the section 3.1.1.

B.1.3 Noise and noise injection

Noise SHALL be injected as specified in ETSI TS101388[8], with simultaneous noise injection at both ends of the loop. Possible deviations from this are stated in the test cases.
The noise injection SHALL be calibrated as defined in ETSI TS101388[8].
The simultaneous used generators SHALL be G1 (NEXT noise), G2 (FEXT noise), G4 (white noise) and G8 (Same Pair ISDN/line sharing noise).

For **white noise** set generator G4 at both ends of the total loop at –140 dBm/Hz.

For the **line sharing noise** generator G8 according to TS101388[8] is used.
If G8 is implemented in the above mentioned noise generator, through the noise injection circuit, the ISDN port of the splitter has to be terminated with the appropriate ISDN impedance.
If G8 is not implemented in the above mentioned noise generator, G8 has to be realized according to TS101388[8], Annex F. In this case the ISDN port of the splitter has to be used for injecting the line sharing noise.

B.1.3.1   Noise Generator settings G1, G2 and G4 for ADSL2, Annex B noise FB impairment

Set noise generator G4 to apply a white noise disturber at both ends of the loop at -140 dBm/Hz.
The noise model for G1 and G2 SHALL be ETSI FB:
At CO side:
  • G1 = X.LT.FB as defined in TS101388[8], section 5.3.4.1.4, table 14, with NEXT coupling function

- G2 = X.NT.FB as defined in TS101388[8], section 5.3.4.1.4, table 15, with FEXT coupling function

At CPE side:

- G1 = X.NT.FB as defined in TS101388[8], section 5.3.4.1.4, table 15, with NEXT coupling function
- G2 = X.LT.FB as defined in TS101388[8], section 5.3.4.1.4, table 14, with FEXT coupling function

All measurements with noise model FB SHALL be done with the noise model FB calculated for 2875m loop #1 (ETSI performance requirement for 768 kbps downstream and 128 kbps upstream, see TS101388[8], tables 38 and 39 for FDD ADSL over ISDN down- and upstream). To reduce test time only one noise model is used for all measurement points.

B.1.3.2   Noise Generator settings G1, G2 and G4 for ADSL2, Annex B noise FA or FD impairment

All measurements with noise model FA and FD SHALL be done with the noise model calculated for the corresponding length of the ETSI loop selected as indicated in the applicable testsection.
Set noise generator G4 to apply a white noise disturber at both ends of the loop at -140 dBm/Hz.
Set noise generator G1 and G2 for ETSI FA/FD noise:
At CO side:

- G1 = X.LT.FA/FD as defined in TS 101 388 [8], section. 5.3.4.1.3, table 15, with NEXT coupling function.
- G2 = X.NT.FA/FD as defined in TS 101 388 [8], section. 5.3.4.1.3, table 14, with FEXT coupling function.

At CPE side:

- G1 = X.NT.FA/FD as defined in TS 101 388 [8], section. 5.3.4.1.3, table 14, with NEXT coupling function.
- G2 = X.LT.FA/FD as defined in TS 101 388 [8], section. 5.3.4.1.3, table 15, with FEXT coupling function.

B.1.3.3   Noise Generator settings G1,G2 and G4 for ADSL2plus, Annex B noise FB impairment

Set noise generator G4 to apply a white noise disturber at both ends of the loop at -140 dBm/Hz.
The noise model for G1 and G2 SHALL be ADSL2plus Annex-B FB:
At CO side:

- G1 = X.LT.FB for ADSL2plus as defined in Annex D.3 table D.3-2, with NEXT coupling function
- G2 = X.NT.FB for ADSL2plus as defined in Annex D.3 table D.3-1, with FEXT coupling function

At CPE side:

- G1 = X.NT.FB for ADSL2plus as defined in Annex D.3 table D.3-1, with NEXT coupling function
- G2 = X.LT.FB for ADSL2plus as defined in Annex D.3 table D.3-2, with FEXT coupling function

All measurements with noise model FB SHALL be done with the noise model FB calculated for the corresponding length of ETSI loop #1.

B.1.3.4   Noise Generator settings G1, G2 and G4 for ADSL2plus, Annex B noise FA or FD impairment

Set noise generator G4 to apply a white noise disturber at both ends of the loop at -140 dBm/Hz.
All measurements with noise model FA/FD SHALL be done with the noise model FA/FD calculated for the corresponding length of the ETSI loop selected as indicated in the applicable testsection.

The noise model for G1 and G2 SHALL be ADSL2plus Annex-B FA or FD:
At CO side:
  - G1 = X.LT.FA/FD for ADSL2plus as defined in Annex D.3 table D.3-2, with NEXT coupling function
  - G2 = X.NT.FA/FD for ADSL2plus as defined in Annex D.3 table D.3-1, with FEXT coupling function
At CPE side:
  - G1 = X.NT.FA/FD for ADSL2plus as defined in Annex D.3 table D.3-1, with NEXT coupling function
  - G2 = X.LT.FA/FD for ADSL2plus as defined in Annex D.3 table D.3-2, with FEXT coupling function

B.1.4 Test procedure

Tests SHALL be performed according to the general procedure described in section 7.
In addition to achieving the required rate, both downstream and upstream noise margin values are to be considered in determining the result of an individual section.
It is acknowledged that achieving a desired noise margin is primarily the responsibility of the receiver. That is, the DSLAM is primarily responsible for achieving desired upstream noise margins, while the CPE (modem) is primarily responsible for achieving desired downstream noise margins.

Table B.1-1 outlines the Noise margin Pass/Fail criteria.

Table B.1-1: Noise margin chart

Reported Noise Margin (dB)	Requirement
< 5	On no test point
>= 5 and < 6	On at most 10% of the test points
>= 5.8	On at least 90% of the test points

All values SHALL be read out at the DSLAM.

Violation of any of the requirements in the Noise Margin Chart SHALL constitute a test section failure.

Overall pass/fail criteria for each adaptive rate test are then as follows:

- If any reported noise margin is less than 5 dB, then the CO/CPE pair fails the noise margin requirements of that section.
- If more than 10% of the reported noise margins are less than 5.8 dB in a section, then the CO/CPE pair fails the noise margin requirements of that section.
- If more than 10% of the data rates are less than the data rate requirements in a section, then the CO/CPE pair fails the data rate requirements of that section.
- If the CO/CPE pair passes both the data rate and noise margin requirements, it passes the section; otherwise, it fails the section.

Overall pass/fail criteria for each fixed rate test section are then as follows:

- If any reported noise margin is less than 5.8 dB, then the CO/CPE pair fails the noise margin requirements of that section.
- If any of the data rates are less than the data rate requirements in a section, then the CO/CPE pair fails the data rate requirements of that section.
- If the CO/CPE pair passes both the data rate and noise margin requirements, it passes the section; otherwise, it fails the section.

Table B.1-2 lists the number of test points per section corresponding to the overall pass/fail criteria (10% limit).

Table B.1-2: 10% limit for Annex B.2 test sections

Section Number	Number of test points in section	10% limit
B.2.4.1	36	4
B.2.4.2	28	3
B.2.5.1	34	n/a
B.2.5.2	30	n/a
B.2.5.3 a)	$0 \leq x \leq 10$	1
B.2.5.3 b)	$0 \leq x \leq 10$	1

Table B.1-3 lists the number of test points per section corresponding to the overall pass/fail criteria (10% limit) mentioned in section 0.

Table B.1-3: 10% limit for Annex B.3 test sections

Section Number	Number of test points in section	10% limit
B.3.4.1	36	4
B.3.4.2	42	6
B.3.5.1	44	n/a
B.3.5.2	38	n/a
B.3.5.3 a)	$0 \leq x \leq 10$	1
B.3.5.3 b)	$0 \leq x \leq 10$	1

B.3.7	6	1
B.3.8	5	1

B.2   Performance European Test set for ADSL2, Annex B

The specific testprofiles as defined in table 7.3 SHALL be used. The test case dependent parameters are defined as follows:

Table B.2-1: testcase dependant parameters for ADSL2, Annex-B

Parameter	Setting	Description
CARMASKds	1-59	mask on: 1 –59 mask off: 60-255 (used downstream subcarriers) ⇨ First-last subcarrier for ds: 60-255
CARMASKus	1 – 32 / 60-63	⇨ First-last subcarrier for us: 33-59

B.2.1 CPE Margin verification tests

For a detailed description of the margin verification test methodology/procedure, see section 7.5

The following tables B.2-2 up to B.2-8 show the loop and noise conditions for margin verification tests.

B.2.1.1   Noise ADSL2 FB impairments at 750m.

Settings as defined in section B.1.3.1, using testprofile B2_RA_F_16000.

Table B.2-2: Noise ADSL2 FB Impairment, testprofile B2_RA_F_16000k at 750 m

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 7544 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, fast path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
750	5				

B.2.1.2   Noise ADSL2 FB impairment at 2750m.

 Settings as defined in section B.1.3.1, using testprofile B2_RA_I_16000k.

Table B.2-3: Noise ADSL2 FB impairment, testprofile B2_RA_I_16000k at 2750 m.

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 1856 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
2750	40				

B.2.1.3   Random selected loop 1 (Optional test)

Select one test loop from: ETSI Loop #3-7 with either Noise Impairment FA or FD for ADSL2 as defined in section B.1.3.2, using testprofile B2_RA_I_16000k.

Table B.2-4: First Selected Test Loop, testprofile B2_RA_I_16000k

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
Loop Selected					

> Note: The table B.2-4 is an example table. The specific test loop selected and noise shape used should be indicated in the table. The connect rate and also test time calculated SHALL be indicated in the table B.2-4.

B.2.1.4   Random selected loop 2 (Optional test)

Select one test loop, different from the loop selected in section B.2.1.3, from: ETSI Loop #3-7, with either Noise Impairment FA or FD for ADSL2 as defined in section B.1.3.2, using testprofile B2_RA_I_16000k.

Table B.2-5: Second Selected Test Loop, testprofile B2_RA_I_16000k

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin - 1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
Loop Selected					

Note: The table B.2-5 is an example table. The specific test loop selected and noise shape used SHALL be indicated in the table. The connect rate and test time calculated SHALL also be indicated in the table B.2-5.

B.2.2 CO Margin Verification (Optional)

B.2.2.1 Noise ADSL2 FB impairments at 750m.

Noise FB settings as defined in section B.1.3.1, using testprofile B2_RA_F_16000k.

Table B.2-6: Upstream Margin Test with Noise ADSL2 FB Impairment, testprofile B2_RA_F_16000k at 750m.

Loop length (m) 0.4mm	Test time (minutes)	Anticipated US net data rate: >= 640 kbps Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, fast path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
750	40				

B.2.2.2   Noise ADSL2 FB impairments at 2750m

Noise FB settings as defined in section B.1.3.1, using testprofile B2_RA_I_16000k.

Table B.2-7: Upstream Margin Test with Noise ADSL2 FB Impairment, testprofile B2_RA_I_16000k, at 2750m.

Loop length (m) 0.4mm	Test time (minutes)	Anticipated US net data rate: >= 224kbps Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.75e-7 then PASS else FAIL	Pass / Fail
2750	150				

Note: Due to the low, achievable DS data rates under this loop and noise condition, the observation of 10 error events would require approximately 300 minutes (at BER ~ 1e-7). To accelerate testing, the desired number of observed error events is reduced to 5. To remain consistent with previous confidence levels of estimated BER, the range of allowed estimated BER is increased from 1.5-e7 to 1.75e-7.

B.2.2.3   Random selected loop 1

Select one test loop from: ETSI Loop #3-7 with either Noise Impairment FA or FD for ADSL2 as defined in section B.1.3.2, using testprofile B2_RA_I_16000k.

Table B.2-8: Downstream Margin Tests for First Selected ETSI Loop #3 – 7, testprofile B2_RA_I_16000k.

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
Loop Selected					

Note: the table B.2-8 is an example table. The specific test loop selected and noise shape used SHALL be indicated in the table. The connect rate and test time calculated SHALL also be indicated in the table B.2-8.

B.2.2.4   Random selected loop 2

Select one test loop, different from the loop selected in section B.2.2.3, from: ETSI Loop #3-7 with either Noise Impairment FA or FD for ADSL2 as defined in section B.1.3.2, using testprofile B2_RA_I_16000k.

Table B.2-9: Downstream Margin Tests for Second Selected ETSI Loop #3 – 7, testprofile B2_RA_I_16000k.

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
Loop Selected					

Note: the table B.2-9 is an example table. The specific test loop selected and noise shape used SHALL be indicated in the table. The connect rate and test time calculated SHALL also be indicated in the table B.2-9.

B.2.3 Verification of Downstream bi/gi Values

Table B.2-9 describes the testprocedure for the verification of downstream bi/gi values in ADSL2 operating mode.

Table B.2-10: Verification of downstream bi/gi values

Test Configuration	The CO and CPE are connected in turn through the following loops:
	   a) ETSI loop #1, 750 m with -140 dBm/Hz AWGN, testprofile B2_RA_F_16000k
	   b) ETSI loop #1, 2750 m with -140 dBm/Hz AWGN, testprofile B2_RA_I_16000k
	   c) ETSI loop #1, 750 m with noise FB as defined in section B.1.3.1, testprofile B2_RA_I_16000k
	   d) ETSI loop #1, 2750 m with noise FB as defined in section B.1.3.1, testprofile B2_RA_F_16000k

Method of Procedure	(1) Select test loop 1 from the set above. (2) Train the modem in the test profile defined for the selected loop. (3) From the DSLAM read the b_i and g_i values requested during initialisation (4) Repeat steps 1 to 3 for other test loops in the set.

Expected Results	The RMSGIds SHALL be calculated in linear scale with g_i values as contained in the BiGi table and then rounded to nearest 100th of a dB. The b_i and g_i values rounded to the nearest 100th of a dB in the bits-and-gains table SHALL comply with the following requirements (Sections 8.5.2 and 8.6.4 of G.992.3[1])
	(1) All b_i values SHALL be in the [0 to BIMAXds] (bits) range, where $8 \leq$ BIMAXds ≤ 15.
	(2) If $b_i > 0$, then g_i SHALL be in the [–14.54 to +2.50 + EXTGIds] (dB) range where $0 \leq$ EXTGIds $\leq$ MAXNOMPSDds – NOMPSDds.
	(3) RMSGIds $\leq$ EXTGIds + $1/16^{th}$ of a dB
	(4) If $b_i > 0$, then g_i SHALL be in the [RMSGIds – 2.60 to RMSGIds + 2.60] (dB) range.
	(5) If $b_i = 0$, then g_i SHALL be equal to 0 (linear) or in the [–14.54 to RMSGIds + 0.10] (dB) range.
	BIMAXds, EXTGIds, MAXNOMPSDds, NOMPSDds, RMSGIds are defined in G.992.3[1] Sections 8.5.1 and 8.5.2.

B.2.4 Loop Tests with Ports Set for Adaptive Rate

B.2.4.1   White Noise Impairment

Set noise generator G4 to apply white noise disturber at both ends of the total loop at –140 dBm/Hz.

18 individual tests – 16 tests SHALL be passed

Table B.2-11: White noise impairment, testprofile B2_RA_F_16000k

Loop Length [m, loop#1]	B2_RA_F_16000							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
0	1096				10000			
500	1096				10000			
1000	1096				10000			
1500	1096				10000			
2000	1048				8656			
2500	960				6560			
3000	744				4064			
3500	544				2200			
4000	344				720			

18 individual tests – 16 tests SHALL be passed

Table B.2-12: White noise impairment, testprofile B2_RA_I_16000k

Loop Length [m, loop#1]	B2_RA_I_16000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
0	888				7608			
500	888				7608			
1000	888				7608			
1500	888				7608			
2000	888				7608			
2500	888				6872			
3000	776				4584			
3500	584				2536			
4000	384				1000			

B.2.4.2   Noise FB impairment

Set noise generators G1, G2, G4 and G8 for model FB impairment as defined in section B.1.3.

Note: Short loop power cutback in ADSL2 can be determined on request by either side (DSLAM and CPE), depending on the receiver front-end capabilities. I.e. a short loop power cutback requested by CPE determines downstream aggregate transmit power, which mainly impacts downstream performance. Downstream performance targets defined in Table B.2-12 and B.2-13 take into account a maximum power cutback of 12 dB.

14 individual tests – 12 SHALL be passed

Table B.2-13: Noise FB impairment, testprofile B2_RA_F_16000k

Loop Length [m, loop#1]	B2_RA_F_16000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
250	1024				6470			
750	960				7551			
1250	800				7251			
1750	600				5963			
2250	392				3786			
2750	176				1532			
3000	64				400			

14 individual tests – 12 SHALL be passed

Table B.2-14: Noise FB impairment, testprofile B2_RA_I_16000k

Loop Length [m, loop#1]	B2_RA_I_16000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
250	888				6434			
750	888				7508			
1250	824				7334			
1750	640				6165			
2250	432				4121			
2750	224				1861			
3000	96				640			

B.2.5 Loop Tests with Ports Set For Fixed Rate

B.2.5.1   White Noise Impairment

Set noise generator G4 to apply white noise disturber at both ends of the total loop at –140 dBm/Hz.

a) Rate Profile: B2_Fix_F_864k and B2_Fix_I_864

12 individual tests – 12 SHALL be passed

Table B.2-15: White noise fixed rate profile 864k

loop length (m, loop#1)	B2_Fix_F_864k			B2_Fix_I_864k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
2000						
3000						
3900				Max. loop length requirement for fast mode, test not to perform		
4000	Max. loop length requirement for interleaved mode, test not to perform					

b) Rate Profile: B2_Fix_F_3456k and B2_Fix_I_3456k

12 individual tests – 12 SHALL be passed

Table B.2-16: White noise fixed rate profile 3456k

loop length (m, loop#1)	B2_Fix_F_3456k			B2_Fix_I_3456k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
2000						
2750						
3150				Max. loop length requirement for fast mode, test not to perform		
3200	Max. loop length requirement for interleaved mode, test not to perform					

c) Rate Profile: B2_Fix_F_7288k and B2_Fix_I_7288k

10 individual tests – 10 SHALL be passed

Table B.2-17: White noise fixed rate profile 7288k

loop length (m, loop#1)	B2_Fix_F_7288k			B2_Fix_I_7288k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
2000						
2300				Max. loop length requirement for low delay, test not to perform		
2350	Max. loop length requirement for high delay, test not to perform					

B.2.5.2   European noise FB Impairment

Set noise generators G1, G2, G4 and G8 for model FB impairment, same pair ISDN and white noise, as defined in section B.1.3.

a) Rate Profile: B2_Fix_F_864k and B2_Fix_I_864k

12 individual tests – 12 SHALL be passed

Table B.2-18: Noise FB impairment fixed rate profile 864k

loop length (m, loop#1)	B2_Fix_F_864k			B2_Fix_I_864k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
2000						
2500						
2750				Max. loop length requirement for fast mode, test not to perform		
2850	Max. loop length requirement for interleaved mode, test not to perform					

b) Rate Profile: B2_Fix_F_3456k and B2_Fix_I_3456k

10 individual tests – 10 SHALL be passed

Table B.2-19: Noise FB impairment fixed rate profile 3456k

loop length (m, loop#1)	B2_Fix_F_3456k			B2_Fix_I_3456k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
1750						
2100				Max. loop length requirement for fast mode, test not to perform		
2150	Max. loop length requirement for interleaved mode, test not to perform					

c) Rate Profile: B2_Fix_F_7288k and B2_Fix_I_7288k

8 individual tests – 8 SHALL be passed

Table B.2-20: Noise FB impairment fixed rate profile 7288k

loop length (m, loop#1)	B2_Fix_F_7288k			B2_Fix_I_7288k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
600						
750						
1000						
1150				Max. loop length requirement for fast mode, test not to perform		
1200	Max. loop length requirement for interleaved mode, test not to perform					

Note: because of the lower performance on short loops, the test starts at 500m.

B.2.5.3   Target Noise margin consideration

To ensure the consideration of the desired target noise margin for fixed rate operation during/after synchronization the noise margin for the maximum loop length for the below described scenario has to be recorded.

The defined requirement is a CPE connecting with the target noise margin. For this test the maximum loop length achieved is not a pass/fail consideration.

a) Target noise margin consideration upstream

Table B.2-21: Target noise margin consideration upstream

Test Configuration	(1) Rate parameters acc. B2_Fix_F_3456k. (2) Set noise generators for model FB impairment as defined in section B1.3.
Method of Procedure	(1) Start test at maximum length from test B.2.5.2 b) at which the modem was able to train successfully (2) Allow to train for 60 seconds to achieve showtime. (3) Record the upstream and downstream reported noise margin in the table below. (Read the margin one minute after show time is reached.) (4) If margin upstream > target noise margin + 1 dB, increase the loop length by: next loop length step = floor[(reported noise margin – target noise margin)]/0.6*50m (5) Repeat steps 2 – 3, if the modem was able to train increase the loop length 50 meters and follow steps 5, until the modem fails to connect. (6) After the first length for which the modem fails to connect attempt the next incremented loop length. (50 meters greater then the failing loop length of step 5.) If the CPE connects record the reported upstream and downstream margin.
Expected Result	If the modem reaches showtime for a certain loop length, then the related reported noise margin SHALL meet the pass/fail criteria for

the rate adaptive tests (10% limit) as stated in section B.1.4.

Table B.2-22: Target noise margin consideration upstream - Results table

B2_Fix_F_3456k				
loop length (m, loop#1)	Modem Trained (Y/N)?	Upstream Noise Margin Reported (dB)	Downstream Noise Margin, Reported (dB)	Pass/Fail
note 1				
..				
2250				
2300				
2350				
…				
…				

Note 1: max. length from test B.2.5.2 b), at which the modem was able to train successfully

b) Target noise margin consideration downstream

Table B.2-23: Target noise margin consideration downstream

Test Configuration	(1) Rate parameters acc. B2_Fix_F_3456k. (2) Set noise generators G4 to apply white noise impairment as defined in section B1.3.
Method of Procedure	(1) Start test at maximum length from test B.2.5.1 b) at which the modem was able to train successfully (2) Allow to train for 60 seconds to achieve showtime. (3) Record the upstream and downstream reported noise margin in the table below. (Read the margin one minute after show time is reached.) (4) If margin downstream > target noise margin + 1 dB, increase the loop length by: next loop length step = floor[(reported noise margin – target noise margin)/1.0]*50m (5) Repeat steps 2 – 3, if the modem was able to train increase the loop length 50 meters and follow steps 5, until the modem fails to connect. (6) After the first length for which the modem fails to connect attempt the next incremented loop length. (50 meters greater then the failing loop length of step 5.) If the CPE connects record the reported upstream and downstream margin.
Expected Result	If the modem reaches showtime for a certain loop length, then the related reported noise margin SHALL meet the pass/fail criteria as stated in section B.1.4.

Table B.2-24: Target noise margin consideration downstream - Results table

B2_Fix_F_3456k				
loop length (m, loop#1)	Modem Trained (Y/N)?	Upstream Noise Margin Reported (dB)	Downstream Noise Margin, Reported (dB)	Pass/Fail
note 2				
..				
3275				
3325				
3375				
…				
…				

Note 2: max. length from test B.2.5.1 b), at which the modem was able to train successfully

B.2.6 Performance in L2 mode

With this test it SHALL be proven that after a transition to L2 and back to L0, the performance (noise margin) is at least the same as in the initial L0 stage. For this test no change in loop/noise conditions are to be done during the test duration. This means the test should show that the power management transitions have no impact on the performance.

Table B.2-25: ADSL2 performance in L2 mode

Test Configuration	In addition to the configuration of section B.1 the following has to be defined:
	(1) Test configuration: Figure 4 to Figure 6, depending on customer interface of modem.
	(2) Configure the DSLAM with testprofile B2_RA_I_16000k (note 1).
	(3) PMMode: Low power state allowed (bit 0 = 0, bit 1 = 1).
	(4) PM-Parameters:
	    a. Minimum (Net) Data rate DS in Low Power state(L2Min): 128 kbps
	    b. L0-TIME: 60 sec.
	    c. L2-TIME: 15 sec.
	    d. L2-ATPR: 3 dB
	    e. L2-ATPRT:18 dB
	(5) Set loop simulator to: 2000 m with ETSI loop #1.
	(6) Set noise generators for model ADSL2 FB impairment as defined in section B1.3.1.

Method of Procedure	(1) Traffic generator/analyzer switched off or 120kbps DS traffic (2) Synchronize the line with the required parameters and note the actual downstream sync rate and noise margin (first L0 noise margin) value. (3) Wait for automatic transition to L2 with power trims. If automatic transition does not occur within 120 seconds, force L2 entry via the G997.1[4] PMFS MIB element. (4) After 5 minutes: read the actual downstream noise margin value (L2 noise margin) and DS Tx power (ACTATPds) (5) Switch on traffic generator with 90% of DS sync rate, to exit from L2 state to L0 state. (6) Wait 60 seconds and read the actual DS noise margin (second L0 noise margin) value.
Expected Result	(1) First L0 noise margin >= 5 dB. (2) L2 noise margin >= 5 dB. (3) Second L0 noise margin >= first L0 noise margin –1 dB. (4) No CRC error during the entire test.

Note 1: The B2_RA_I_16000k minimum net data rate in the L2 mode test SHALL be equal to L2_min.

B.3   Performance Test set for ADSL2plus, Annex B

The specific test profiles as defined in table 7.3 SHALL be used . The test case dependent parameters are defined as follows:

Table B.3-1: Testcase dependant parameters for ADSL2plus, Annex-B

Parameter	Setting	Description
CARMASKds	1-59	mask on: 1 –59 mask off: 60-511 (used downstream subcarriers) ⇨ First-last subcarrier for ds: 60-511
CARMASKus	1 – 32 / 60-63	⇨ First-last subcarrier for us: 33-59

B.3.1 CPE Margin verification tests

Section 7.5 gives a description and testprocedure for the margin verification tests in tables B.3-2 up to B.3-10

B.3.1.1 Noise FB ADSL2plus impairments at 250m.

Settings as defined in section B.1.3.3, using testprofile B2P_RA_F_30000k

Table B.3-2: Noise FB ADSL2plus impairment, testprofile B2P_RA_F_30000k, at 250m

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 13000 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-14, fast path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
250	5				

B.3.1.2 Noise FB ADSL2plus impairments at 1750m.

Settings as defined in section B.1.3.3, using testprofile B2P_RA_I_30000k

Table B.3-3: Noise FB ADSL2plus impairment, testprofile B2P_RA_I_30000k, at 1750m.

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 7640 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1. 5e-7 then PASS else FAIL	Pass / Fail
1750	10				

B.3.1.3   Noise FB ADSL2plus impairments at 750m.

Settings as defined in section B.1.3.3, using testprofile B2P_RA_F_30000k as defined in section B.3.8

Table B.3-4: Noise FB ADSL2plus impairment, testprofile B2P_RA_F_30000k, at 750m.

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 5536 kbps Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, fast path If: Estimated_BER < 1. 5e-7 then PASS else FAIL	**Pass / Fail**
750	5				

B.3.1.4   Random selected loop 1 (Optional test)

Select one test loop from: ETSI Loop #3-7 with either Noise Impairment FA or FD for ADSL2plus as defined in section B.1.3.4, using testprofile B2P_RA_I_30000k

Table B.3-5: Downstream Margin Tests for First Selected ETSI Loop #3 – 7, testprofile B2P_RA_I_30000k

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
Loop Selected					

Note: the table B.3-5 is an example table. The specific test loop selected and noise shape used SHALL be indicated in the table. The connect rate and also test time calculated SHALL be indicated in the table B.3-5.

B.3.1.5   Random selected loop 2 (Optional test)

Select one other test loop, different from the one selected in section B.3.1.4, from: ETSI Loop #3-7 with either Noise Impairment FA or FD for ADSL2plus as defined in section B.1.3.4, using testprofile B2P_RA_I_30000k (Optional test)

Table B.3-6: Downstream Margin Tests for Second Selected ETSI Loop #3 – 7, testprofile B2P_RA_I_30000k

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved DS net data rate (test start) Achieved DS net data rate (test end)	Measured DS CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
Loop Selected					

Note: the table B.3-6 is an example table. The specific test loop selected and noise shape used SHALL be indicated in the table. The connect rate and also test time calculated SHALL be indicated in the table B.3-6.

B.3.2 CO Margin Verification (Optional)

B.3.2.1   Noise FB ADSL2plus impairments at 250m.

Settings as defined in section B.1.3.3, using testprofile B2P_RA_F_30000k

Table B.3-7: Upstream Margin Test with Noise FB ADSL2plus Impairment, testprofile B2P_RA_F_30000k, at 250 meters

Loop length (m) 0.4mm	Test time (minutes)	Anticipated US net data rate: >= 1152 kbps Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, fast path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
250	25				

B.3.2.2   Noise FB ADSL2plus impairments at 1750m.

Settings as defined in section B.1.3.3, using testprofile B2P_RA_I_30000k

Table B.3-8: Upstream Margin Tests with Noise FB ADSL2plus Impairment at 1750 meters, testprofile B2P_RA_I_30000k

Loop length (m) 0.4mm	Test time (minutes)	Anticipated US net data rate: >= 640 kbps Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.75e-7 then PASS else FAIL	Pass / Fail
1750	55				

Note: Due to the low, achievable DS data rates under this loop and noise condition, the observation of 10 error events would require approximately 105 minutes (at BER ~ 1e-7). To accelerate testing, the desired number of observed error events is reduced to 5. To remain consistent with previous confidence levels of estimated BER, the range of allowed estimated BER is increased from 1.5-e7 to 1.75e-7.

B.3.2.3   Random selected loop 1.

Select one test loop from: ETSI Loop #3-7 with either Noise Impairment FA or FD for ADSL2plus as defined in section B.1.3.4, using testprofile B2P_RA_I_30000k

Table B.3-9: Upstream Margin Tests for First Selected ETSI Loop #3 – 7, testprofile B2P_RA_I_30000k

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
Loop Selected					

Note: the table B.3-9 is an example table. The specific test loop selected and noise shape used SHALL be indicated in the table. The connect rate and test time calculated SHALL also be indicated in the table B.3-9.

B.3.2.4   Random selected loop 2.

Select one other test loop, different from the one selected in section B.3.2.3, from: ETSI Loop #3-7 with either Noise Impairment FA or FD for ADSL2plus as defined in section B.1.3.4, using testprofile B2P_RA_I_30000k

Table B.3-10: Upstream Margin Tests for Second Selected ETSI Loop #3 – 7, testprofile B2P_RA_I_30000k

ETSI Loop Selected	Test time (minutes) Calculate based on connect rate.	Achieved US net data rate (test start) Achieved US net data rate (test end)	Measured US CRC count, after injected noise level has been raised by Min(initial_reported_margin -1, target_margin) dB	Estimated BER, based on equations in Table 8-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	**Pass / Fail**
Loop Selected					

> Note: the table for section B.3-10 is an example table. The specific test loop selected and noise shape used SHALL be indicated in the table. The connect rate and test time calculated SHALL also be indicated in the table B.3-10.

B.3.3 Verification of downstream bi/gi values

Table B.3-11 describes the testprocedure for the verification of downstream bi/gi values for ADSL2plus operating mode.

Table B.3-11: Verification of downstream bi/gi values

Test Configuration	The CO and CPE are connected in turn through the following loops: a) ETSI loop #1, 250 m, -140 dBm/Hz AWGN, testprofile B2P_RA_F_30000k b) ETSI loop #1, 1750 m, -140 dBm/Hz AWGN, testprofile B2P_RA_I_30000k c) ETSI loop #1, 250 m, noise FB as defined in section B.1.3.3, testprofile B2P_RA_I_30000k d) ETSI loop #1, 1750 m, noise FB as defined in section B.1.3.3, testprofile B2P_RA_F_30000k
Method of Procedure	(1) Select test loop 1 from the set above. (2) Train the modem in the test profile defined for the selected loop. (3) From the DSLAM read the b_i and g_i values requested during initialization (4) Repeat steps 1 to 3 for other test loops in the set.
Expected Result	The RMSGIds SHALL be calculated in linear scale with g_i values as contained in the BiGi table and then rounded to nearest 100th of a dB. The b_i and g_i values rounded to the nearest 100th of a dB in the bits-and-gains table SHALL comply with the following requirements (Sections 8.5.2 and 8.6.4 of G.992.3[1]) (1) All b_i values SHALL be in the [0 to BIMAXds] (bits) range, where $8 \leq$ BIMAXds ≤ 15. (2) If $b_i > 0$, then g_i SHALL be in the [–14.54 to +2.50 + EXTGIds] (dB) range where $0 \leq$ EXTGIds $\leq$ MAXNOMPSDds – NOMPSDds. (3) RMSGIds $\leq$ EXTGIds + $1/16^{th}$ of a dB (4) If $b_i > 0$, then g_i SHALL be in the [RMSGIds – 2.60 to RMSGIds + 2.60] (dB) range. (5) If $b_i = 0$, then g_i SHALL be equal to 0 (linear) or in the [–14.54 to RMSGIds + 0.10] (dB) range.

B.3.4 Loop Tests with Ports Set for Adaptive Rate

B.3.4.1   White Noise Impairment Only

Set noise generator G4 to apply white noise disturber at both ends of the total loop at –140 dBm/Hz.

18 individual tests – 16 tests SHALL be passed

Table B.3-12: White noise impairment, testprofile B2P_RA_F_30000k

Loop Length [m, loop#1]	B2P_RA_F_30000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
0	1096				24000			
500	1096				24000			
1000	1096				22712			
1500	1096				18112			
2000	1048				12496			
2500	960				7472			
3000	744				4000			
3500	544				1648			
4000	344				504			

18 individual tests – 16 tests SHALL be passed

Table B.3-13: White noise impairment, testprofile B2P_RA_I_30000k

Loop Length [m, loop#1]	B2P_RA_I_30000k								
	Upstream				Downstream				
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)				Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected		Measured	Pass/Fail	
					Class A	Class B			
0	888				19000	7640			
500	888				19000	7640			
1000	888				18488	7640			
1500	888				16280	7640			
2000	888				12328	7640			
2500	888				7640	7640			
3000	776				4400	4400			
3500	584				2000	2000			
4000	384				792	792			

B.3.4.2   Noise FB impairment

Set noise generators G1, G2, G4 and G8 for model FB impairment as defined in section B.1.3

14 individual tests – 12 SHALL be passed

Table B.3-14: Noise FB ADSL2plus impairment, testprofile B2P_RA_F_30000k

Loop Length [m, loop#1]	B2P_RA_F_30000							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
100	1096				13000			
250	1096				13000			
750	1000				13000			
1250	816				11208			
1750	600				7856			
2500	280				2760			
2750	184				1520			

14 individual tests – 12 SHALL be passed

Table B.3-15: Noise FB ADSL2plus impairment, testprofile B2P_RA_I_30000k

Loop Length [m, loop#1]	B2P_RA_I_30000								
	Upstream				Downstream				
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)				Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected		Measured	Pass/Fail	
					Class A	Class B			
100	888				13000	7640			
250	888				13000	7640			
750	888				13000	7640			
1250	832				12136	7640			
1750	640				9088	7640			
2500	328				3408	3408			
3000	128				1056	1056			

B.3.5 Loop Tests with Ports Set For Fixed Rate

B.3.5.1   White Noise Impairment.

Set noise generator G4 to apply white noise disturber at both ends of the total loop at –140 dBm/Hz.

a) Rate Profile: B2P_Fix_F_864k and B2P_Fix_I_864

12 individual tests – 12 SHALL be passed

Table B.3-16: White noise fixed rate profile 864k

loop length (m, loop#1)	B2P_Fix_F_864k			B2P_Fix_I_864k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
2000						
3000						
3700				Max. loop length requirement for fast mode, test not to perform		
3800	Max. loop length requirement for interleaved mode, test not to perform					

b) Rate Profile: BP2_Fix_F_3456k and B2P_Fix_I_3456k

12 individual tests – 12 SHALL be passed

Table B.3-17: White noise fixed rate profile 3456k

loop length (m, loop#1)	B2P_Fix_F_3456k			B2P_Fix_I_3456k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
2000						

2750						
3000				Max. loop length requirement for fast mode, test not to perform		
3100	Max. loop length requirement for interleaved mode, test not to perform					

c) Rate Profile: B2P_Fix_F_7288k and BP2_Fix_I_7288k

10 individual tests – 10 SHALL be passed

Table B.3-18: White noise fixed rate profile 7288k

loop length (m, loop#1)	B2P_Fix_F_7288k			B2P_Fix_I_7288k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
2000						
2400				Max. loop length requirement for low delay, test not to perform		
2500	Max. loop length requirement for high delay, test not to perform					

d) Rate Profile: B2P_Fix_F_10000k and BP2_Fix_I_10000k

10 individual tests – 10 SHALL be passed

Table B.3-19: White noise fixed rate profile 10000k

loop length (m, loop#1)	B2P_Fix_F_10000k			B2P_Fix_I_10000k (Class A only)		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
1750						
2200				Max. loop length requirement for low delay, test not to perform		
2300	Max. loop length requirement for high delay, test not to perform					

B.3.5.2   European noise FB Impairments

Set noise generators G1, G2, G4 and G8 for model FB impairment, same pair ISDN and white noise, as defined in section B.1.3.

   a) Rate Profile: B2P_Fix_F_864k and B2P_Fix_I_864k

12 individual tests – 12 SHALL be passed

Table B.3-20: Noise FB impairment fixed rate profile 864k

loop length (m, loop#1)	B2P_Fix_F_864k			B2P_Fix_I_864k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
1750						
2500						
2700				Max. loop length requirement for fast mode, test not to perform		
2800	Max. loop length requirement for interleaved mode, test not to perform					

   b) Rate Profile: B2P_Fix_F_3456k and BP2_Fix_I_3456k

10 individual tests – 10 SHALL be passed

Table B.3-21: Noise FB impairment fixed rate profile 3456k

loop length (m, loop#1)	B2P_Fix_F_3456k			B2P_Fix_I_3456k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
1750						
2050				Max. loop length requirement for fast mode, test not to perform		
2150	Max. loop length requirement for interleaved mode, test not to perform					

   c) Rate Profile: B2P_Fix_F_7288k and B2P_Fix_I_7288k

8 individual tests – 8 SHALL be passed

Table B.3-22: Noise FB impairment fixed rate profile 7288k

loop length (m, loop#1)	B2P_Fix_F_7288k			B2P_Fix_I_7288k		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
1000						
1200				Max. loop length requirement for fast mode, test not to perform		
1300	Max. loop length requirement for interleaved mode, test not to perform					

d) Rate Profile: B2P_Fix_F_10000k and BP2_Fix_I_10000k

8 individual tests – 8 SHALL be passed

Table B.3.23: Noise FB impairment fixed rate profile 10000k

loop length (m, loop#1)	B2P_Fix_F_10000k			B2P_Fix_I_10000k (Class A only)		
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)
0						
500						
750						
1150				Max. loop length requirement for low delay, test not to perform		
1250	Max. loop length requirement for high delay, test not to perform					

B.3.5.3   Target Noise margin consideration

For a detailed description of this test see section B.2.5.3.

a) Target noise margin consideration upstream

Table B.3-24: Target noise margin consideration upstream

Test Configuration	(1) Rate parameters acc. B2P_Fix_F_3456k. (2) Set noise generators for model FB impairment as defined in section B1.3.1.
Method of Procedure	(1) Start test at maximum length from test B.2.5.2 b) at which the modem was able to train successfully (2) Allow to train for 60 seconds to achieve showtime. (3) Record the upstream and downstream reported noise margin in the table below. (Read the margin one minute after show time is reached.) (4) If margin upstream > target noise margin + 1 dB, increase the loop length by: next loop length step = floor[(reported noise margin – target noise margin)]/0.6*50m (5) Repeat steps 2 – 3, if the modem was able to train increase the loop length 50 meters and follow steps 5, until the modem fails to connect. (6) After the first length for which the modem fails to connect attempt the next incremented loop length. (50 meters greater then the failing loop length of step 5.) If the CPE connects record the reported upstream and downstream margin.
Expected Result	If the modem reaches showtime for a certain loop length, then the related reported noise margin SHALL meet the pass/fail criteria as stated in section B.1.4.

Table B.3-25: Target noise margin consideration upstream - Results table

loop length (m, loop#1)	B2P_Fix_F_3456k			
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Pass / Fail
note 1				
..				
1950				
2000				
2050				
…				
…				

Note 1: max. length from test B.3.5.2 b), at which the modem was able to train successfully

b) Target noise margin consideration downstream

Table B.3-26: Target noise margin consideration downstream

Test Configuration	(1) Rate parameters acc. B2P_Fix_F_3456k. (2) Set noise generators G4 to apply white noise impairment as defined in section B1.3.
Method of Procedure	(1) Start test at maximum length from test B.2.5.1 b) at which the modem was able to train successfully (2) Allow to train for 60 seconds to achieve showtime. (3) Record the upstream and downstream reported noise margin in the table below. (Read the margin one minute after show time is reached.) (4) If margin downstream > target noise margin + 1 dB, increase the loop length by: next loop length step = floor[(reported noise margin – target noise margin)/1.0]*50m (5) Repeat steps 2 – 3, if the modem was able to train increase the loop length 50 meters and follow steps 5, until the modem fails to connect. (6) After the first length for which the modem fails to connect attempt the next incremented loop length. (50 meters greater then the failing loop length of step 5.) If the CPE connects record the reported upstream and downstream margin.
Expected Result	If the modem reaches showtime for a certain loop length, then the related reported noise margin SHALL meet the pass/fail criteria for the rate adaptive tests (10% limit) as stated in section B.1.4.

Table B.3-27: Target noise margin consideration downstream - Results table

loop length (m, loop#1)	B2P_Fix_F_3456k			
	Modem Trained (Y/N)?	Upstream Noise Margin, Reported (dB)	Downstream Noise Margin, Reported (dB)	Pass / Fail
note 2				
..				
2900				
2950				
3000				
…				
…				

Note 2: max. length from test B.3.5.1 b), at which the modem was able to train successfully

B.3.6 Performance in L2 mode

For a detailed description of this test see section B.2.6.

Table B.3-28: ADSL2plus performance in L2 mode

Test Configuration	For this test the following parameters have to be configured in addition to the defined parameters in B1.3:
	(1) Test configuration: see figures 4 to 6, depending on customer interface of modem.
	(2) Configure the line with testprofile B2P_RA_I_30000k (note 1)
	(3) PMMode: Low power state allowed (bit 0 = 0, bit 1 = 1)
	(4) PM-Parameters:
	    a. Minimum (Net) Data rate DS in Low Power state(L2Min): 128 kbps
	    b. L0-TIME: 60 sec.
	    c. L2-TIME: 15 sec.
	    d. L2-ATPR: 3 dB
	    e. L2-ATPRT:18 dB
	(5) Set loop simulator to: 1500m with ETSI loop #1.
	(6) Set noise generators for model ADSL2plus FB impairment as defined in section B1.3.2.

Method of Procedure	(1) Traffic generator/analyzer switched off or 120 kbps DS traffic (2) Synchronize the line with the required parameters and note the actual downstream sync rate and noise margin (first L0 noise margin) value. (3) Wait for automatic transition to L2 with power trims. If automatic transition does not occur within 120 seconds, force L2 entry via the G997.1[4] PMFS MIB element. (4) After 5 minutes read the actual downstream noise margin value (L2 noise margin) and DS Tx power (ACTATPds). (5) Switch on traffic generator with 90% of DS sync rate, to exit from L2 state to L0 state. (6) Wait 60 seconds and read the actual DS noise margin (second L0 noise margin) value.
Expected Result	(1) first L0 noise margin >= 5.0 dB. (2) L2 noise margin >= 5.0 dB. (3) Second L0 noise margin >= first L0 noise margin –1 dB. (4) No CRC error during the entire test.

Note 1: The B2P_RA_I_30000k minimum net data rate in the L2 mode test SHALL be equal to L2_min.

B.3.7 Performance with configured RFIBANDds

With this test the performance of an ADSL2 DSLAM – Modem combination with configured RFIBANDSds SHALL be proven. The following two RFI Bands SHALL be considered:
- RFI Band 1:   1.800 up to 2000 kHz / -80 dBm/Hz
- RFI Band 2:   2.173,5 up to 2.190,5 kHz / -80 dBm/Hz

Table B.3-29: ADSL2plus performance with configured RFIBANDds

Test Configuration	For this test the following parameters have to be configured in addition to the defined parameters in B1.2: (1) Testprofile: B2P_RA_F_30000k. (2) RFIBANDds and PSDMASKds parameters: • breakpoints representing RFI Band 1: subcarrier/level: t(2)= 417, PSD(2)= -80 dBm/Hz t(3)=464, PSD(3)= -80 dBm/Hz • breakpoints representing RFI Band 2: subcarrier/level: t(6)= 504, PSD(6)= -80 dBm/Hz t(7)= 508, PSD(7)= -80 dBm/Hz (3) Set noise generators for model ADSL2plus FB impairment as defined in section B1.3.2.
Method of Procedure	Steps per loop length: (1) Synchronize the line with the required parameters. (2) Note the actual downstream bitrate. (3) After 60 seconds note the reported DS noise margin.
Expected Result	(1) fast and stable synchronization. (2) DS Bitrate: see table B.3-30. (3) noise margin >= 5.0 dB.

Note: acc. G.992.5[2] and G.997.1[4] each RFI band [ti, ti+1] is also represented in the PSDMASKds with 4 breakpoints (t(i + 1), PSD(i + 1)) to (t(i + 4), PSD(i + 4)). The related breakpoints for PSDMASKds using the steepest allowed slope are:
• for RFI band 1: t(1) = 394 / -47 dBm/Hz, t(4) = 484 / -50 dBm/Hz
• for RFI band 2: t(5) = 484 / -50 dBm/Hz, t(8) = 511 / -75,5 dBm/Hz

6 individual tests – 5 SHALL be passed

Table B.3-30: performance requirements for Tests B.3.7

loop length [m, loop#1]	DS sync rate [kbps] expected	measured	Downstream Noise Margin, Reported (dB)	Pass / Fail
100	11000			
250	11000			
750	10904			
1250	9704			
2000	5904			
2750	904			

B.3.8 ADSL2plus European tests operating with DS-PSD mask above ADSL

With this test the performance of an ADSL2 DSLAM – Modem combination with DS-PSD mask above ADSL with additional activated RFI Bands acc. B.3.7 SHALL be proven.

Note : the handshake carrier set B43c SHALL be used to initiate startup.

Table B.3-31: ADSL2plus performance with DS-PSD mask above ADSL

Test Configuration	For this test the following parameters have to be configured in addition to the defined parameters in B1.2:
	(1) Testprofile: B2P_RA_F_30000k
	(2) RFIBANDds and PSDMASKds parameters:
	    ▪ breakpoints DS-PSD mask above ADSL:
	      t(1)= 233 (1004,8125 kHz), PSD1= -95 dBm/Hz
	      t(2)= 260 (1121.25 kHz), PSD2= -36.5 dBm/Hz
	      ⇨ t(2) as close as possible to tone 256
	    ▪ breakpoints representing RFI Band 1: subcarrier/level:
	      t(4)= 417, PSD(4)= -80 dBm/Hz
	      t(5)= 464, PSD(5)= -80 dBm/Hz
	    ▪ breakpoints representing RFI Band 2: subcarrier/level:
	      t(8)= 504, PSD(8)= -80 dBm/Hz,
	      t(9)= 508, PSD(9)= -80 dBm/Hz,
	(3) Set noise generators for model ADSL2plus FB impairment as defined in section B1.3.2.

Method of Procedure	Steps per loop length: (1) Synchronize the line with the required parameters. (2) Note the actual downstream bitrate. (3) After 60 seconds note the reported DS noise margin.
Expected Result	(1) Fast and stable synchronization (2) DS Bitrate: see table B.3-32 (3) Noise margin >= 5.0 dB

Note: acc. G.992.5[2] and G.997.1[4] each RFI band [ti, ti+1] is also represented in the PSDMASKds with 4 breakpoints (t(i + 1), PSD(i + 1)) to (t(i + 4), PSD(i + 4)).

The related breakpoints for PSDMASKds using the steepest allowed slope are:
- for RFI band 1: t(3) = 394 / -47 dBm/Hz, t(6) = 484 / -50 dBm/Hz
- for RFI band 2: t(7) = 484 / -50 dBm/Hz, t(10) = 511 / -75,5 dBm/Hz

5 individual tests – 4 SHALL be passed

Table B.3-32: performance requirements for Tests B.3.8

loop length [m, loop#1]	DS sync rate [kbps]		Downstream Noise Margin, Reported (dB)	Pass / Fail
	expected	measured		
100	5344			
250	5184			
750	4600			
1500	3520			
2250	1016			

B.4   Tests for systems supporting Virtual Noise (optional)

Virtual noise is an optional feature of G.992.3[1] and G.992.5[2]. This test is only applicable for systems (DSLAM-CPE combination) supporting VN. Systems claiming support of VN SHALL be required to perform this test.

B.4.1 Performance   tests   for   ADSL2plus   systems   operating   under Transmitter referred Virtual Noise (optional)

The purpose of this test is to examine the downstream performance under two conditions:
> a) with activated transmitter referred virtual noise
> b) with the actual noise injected to the line.

A transmitter referred virtual noise profile SHALL be programmed in the DSLAM. The modem SHALL be trained with activated virtual noise and then the actual noise which PSD equals the virtual noise profile SHALL be injected to the line at transmitter side. Test setup SHALL support the actual noise injection over the entire transmission band.

When configuring the transmitter referred virtual Noise PSD using a G.997.1 interface, the frequency should be converted into the nearest subcarrier index, and the VN PSD power should be rounded to the nearest 0.5 dBm/Hz resolutions. The same correction SHALL also be applied to the actual noise.

The transmitter referred virtual noise at DSLAM side is defined in Table B4-1.

Table B.4-1: Transmitter Referred Virtual Noise at DSLAM side

Freq / MHz	VN PSD / dBm/Hz
0.0	-140
0.275	-140
0.276	-95.0
1.104	-80.0
2.208	-80.0
2.209	-140

Table B.4-2 represents the TXREFVNds setting for the transmitter referred virtual noise defined in Table B.4-1.

Table B.4-2: TXREFVNds parameter setting

Breakpoint	Subcarrier index	VN PSD / dBm/Hz
1	64	-95
2	256	-80
3	511	-80

Due to a fact that the upstream is not protected by the virtual noise there is also noise applied in the upstream frequency band.

Table B.4-3: Initial US Noise injected at DSLAM side

Freq (kHz)	PSD (dBm/Hz)
138	-120
275	-110
276	-140
2.208	-140

Table B.4-4: Actual DS+US Noise injected at DSLAM side

Freq (kHz)	PSD (dBm/Hz)
138	-120
275	-110
276	-95.0
1104	-80
2208	-80
2209	-140

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Table B.4-5: Transmitter Referred Virtual Noise test - downstream

Test Configuration	(1) The modems SHALL be connected as shown in Section 7 and configured in the specific test profile B2P_RA_I_30000. (2) TXREFVNds SHALL be configured according to Table B.4-2. (3) SNRMODEds SHALL be set to 2, which implies that the virtual noise is enabled (4) Disable SRA function by setting RA-MODE to 2 (AT_INIT rate adaptation mode). (5) Line simulator SHALL be set up for the first straight homogeneous loop PE04 specified in Table B.4-6 (6) Set the noise generator to –140dBm/Hz AWGN noise at CPE side and to the Initial noise defined in table B.4-3 at DSLAM side of the loop.
Method of Procedure	(1) Connect and configure the DSLAM and CPE as per test configuration details. (2) Force initialization and wait for modems to synchronize. (3) Wait 1 minute following synchronization. (4) Record downstream SNR margin SNR1 and net data rate DS1. (5) Configure and inject at the DSLAM side the actual noise with a PSD equal to Table B.4-4. (6) Wait 1 minute. (7) Record downstream SNR margin SNR2 and net data rate DS2. (8) Deactivate the line. (9) Set SNRMODEds to 1 and reinitialize the line. (10) Record downstream net data rate DS3 and the bits allocation table. Determine number of loaded downstream carriers LC. (11) Set SNRMODEds to 2. (12) Set the noise generator to –140dBm/Hz AWGN noise at CPE side and to the Initial noise defined in table B.4-3 at DSLAM side of the loop (13) Repeat step 2 to 12 for the next loop lengths specified in Table B.4-6.
Expected Result	(1) The link SHALL not re-train after the actual noise is turned on (2) DS1= DS2 (3) SNR2 >= SNR1 – 3dB (4) DS3 >= DS1 - [(LC *1*4e3) ceiled to 8kbit/s] NOTE: Factor 1 in ER(4) represents a data rate deterioration of 3dB.

Table B.4-6: VN test, test profile B2P_RA_I_30000k

Loop Length, PE 0.4mm (m)	Interleaved profile B2P_RA_I_30000k								
	Downstream								
	Net data rate DS1	SNR Margin SNR1 (dB)	Net data rate DS2	SNR Margin SNR2 (dB)	Net data rate DS3	# loaded carriers LC	Net data rate lower limit	Net data rate upper limit	Pass/fail
500									
1000									
2000									
4000									

B.5   Performance of ADSL2plus Annex B with DPBO enabled

With this test the performance of an ADSL2plus DSLAM – Modem combination with activated Downstream Power Back-Off (DPBO) SHALL be proven.

B.5.1 Noise generator setting G1, G2 and G4 for ADSL2plus Annex B with DPBO enabled

The settings for noise generators G1, G2 and G4 SHALL be as follows. Noise generators G1 (NEXT noise) and G2 (FEXT noise) are activated on one side at a time. Set noise generator G4 to apply white noise disturber on one side at a time (same side as for G1 and G2) at -140 dBm/Hz.

The crosstalk coupling functions NEXT and FEXT SHALL be calculated using the transfer function equations from ETSI TS 101 388 [8].

All measurements SHALL be done with the generic noise model n_XYZ. It consists of two components:
- Noise component 1 (N1) is associated with the mix of alien noise disturbers defined in the medium density European VDSL2 noise models MD_CAB27 and MD_CAB72 as specified by ETSI TM6 and reported in Annex E of this document;
- Noise component 2 (N2) is associated with 15 VDSL2 homogeneous disturbers having the following characteristics:
  - for testing with B2P_CAB27 band-profile, the single VDSL2 disturber SHALL have a BB17a_CAB27 profile as described below;
  - for testing with B2P_CAB72 band-profile, the single VDSL2 disturber SHALL have a BB30a_CAB72 profile as described below.

The abbreviations BB17a_CAB27 and BB30a_CAB72 define the single VDSL2 disturber profile in more details. First letter designates the G.993.2 Annex the disturber refers to, followed by a letter that indicates the underlying narrowband service ISDN (B). The alphanumeric symbols describe the VDSL2 profile as in Table 7-1/G.993.2 [22].

Table B.5-1: Definition of VDSL2 disturber profile

VDSL2 Disturber profile	G.993.2 Annex	Underlying Narrowband service	G.993.2 VDSL2 profile	Limit PSD mask	MAXNO MATPds
BB17a_CAB27	B	B (ISDN)	17a	998ADE17-M2x-B	14.5 dBm
BB30a_CAB72	B	B (ISDN)	30a	998ADE30-M2x-NUS0-M	14.5 dBm

Parameter settings for the VDSL2 disturber profiles that SHALL be applied for the computation of the noise component N2 are defined in Table B.1-2.

Table B.5-2: Parameter settings for VDSL2 disturber profiles

Parameter	VDSL2 disturber BB17a_CAB27	VDSL2 disturber BB30a_CAB72	Description
DPBO parameters	same as DPBO profile for B2P_CAB27, Table 8-4	same as DPBO profile for B2P_CAB72, Table 8-4	
UPBOA US0	40.00	40.00	A and B values US band 0
UPBOB US0	0	0	(these values imply no UPBO)
UPBOA US1	47.30	47.30	A value US band 1
UPBOB US1	21.14	21.14	B value US band 1
UPBOA US2	54.00	54.00	A value US band 2
UPBOB US2	16.29	16.29	B value US band 2
UPBOA US3	NA	40.00	A value US band 3
UPBOB US3	NA	0	B value US band 3
UPBOKL	Table B.1-3	Table B.1-3	The electrical length klo (UPBOKL) is defined per test point

Table B.5-3: The UPBOKL values

VDSL2 disturber BB17a_CAB27	
Loop length (m, PE0.4mm)	UPBOKL (dB)
150	3.7
450	11.1
1050	26.0
1500	37.1
VDSL2 disturber BB30a_CAB72	
Loop length (m, PE0.4mm)	UPBOKL (dB)
150	3.7
300	7.4
450	11.1

The generic noise model n_XYZ is defined in Table B.1-4:

Table B.5-4: Generic noise model

Associated band-profile	Noise model	Noise component 1 (N1)	Noise component 2 (N2)
B2P_CAB27	n_B2P_CAB27	Mix of alien disturbers in the ETSI MD_CAB_27 VDSL2 noise model	15 VDSL2 BB17a_CAB27 disturbers
B2P_CAB72	n_B2P_CAB72	Mix of alien disturbers in the ETSI MD_CAB_72 VDSL2 noise model	15 VDSL2 BB30a_CAB72 disturbers

B.5.2 Definition of noise components for noise model n_XYZ

Be $P_{N1-XYZ,SS}$ and $P_{N2-XYZ,SS}$ the PSD of the noise components N1 and N2 for the generic n_XYZ noise at the SS side (SS=LT, NT) in W/Hz. Be XN1.LT.n_XYZ and XN1.NT.n_XYZ the frequency profiles of the noise component N1 defined in section E.1 and E.2. Frequency profiles of the noise component N2, XN2.LT.n_XYZ and XN2.NT.n_XYZ, are specified in Table B.5-5 and describe the crosstalk portion of 15 VDSL2 disturbers co-located at the LT and NT end of the loop. The value 7.06 dB refers to the power generated by the sum of 15 VDSL2 disturbers, which is added to the single VDLS2 disturber PSD $P_{SingleSelf-XYZ,SS}$ for the generic n_XYZ noise.

Table B.5-5: Frequency profile of the noise component N2

Noise component 2 (N2)	Definition
XN2.LT.n_XYZ	$P_{N2-XYZ,LT} = P_{Single-XYZ,LT} + 7.06$ dB
XN2.NT.n_XYZ	$P_{N2-XYZ,NT} = P_{Single-XYZ,NT} + 7.06$ dB

The PSD of the noise generators G1 and G2 for the generic n_XYZ noise is a weighted sum of the noise component N1 and N2, as specified in ETSI TS 101 270-1 [20], section 9.3.3.

At CO side:
- G1 = (XN1.LT.n_XYZ ∗ XN2.LT.n_XYZ), with NEXT coupling function
- G2 = (XN1.NT.n_XYZ ∗ XN2.NT.n_XYZ), with FEXT coupling function

At CPE side:
- G1 = (XN1.NT.n_XYZ ∗ XN2.NT.n_XYZ), with NEXT coupling function
- G2 = (XN1.LT.n_XYZ ∗ XN2.LT.n_XYZ), with FEXT coupling function

Symbol "∗" refers to the FSAN crosstalk sum $P_{XYZ,SS}$ of two PSDs in W/Hz, $P_{N1-XYZ,SS}$ and $P_{N2-XYZ,SS}$ as shown in Equation 10:

$$PXYZ,SS = \left[P_{N1-XYZ,SS}^{1/0.6} + P_{N2-XYZ,SS}^{1/0.6} \right]^{0.6}$$

Equation 10

B.5.3 Method for computing the single VDSL2 disturber PSD

The following clause specifies the method of computation that applies for the single VDSL2 disturber PSD $P_{Single-XYZ,SS}$. The basic PSD template corresponds to the associated VDSL2 disturber profile as per ITU-T G.993.2/Amd.1, sections B.2.4 and B.2.5 and is defined in accordance with the ITU-T G.993.2/Amd.1, section B.4. This is considered constant regardless of the loop length corresponding to the specific test point. $P_{Single-XYZ,SS}$ is always defined for the complete frequency spectrum as given by the VDSL2 disturber profile configuration. No power reallocation to lower frequencies is taken into account as the loop length increases from one test point to the next.

The following steps SHALL be applied:

- identify the basic PSD template that corresponds to the associated VDSL2 disturber profile

- apply to the above basic PSD template the DPBO and UPBO shaping of the associated VDSL2 disturber profile to calculate a shaped PSD template

- apply a flattening operation that consists in lowering all the highest levels of the above shaped PSD template down such that the power in all bands under the resulting template is less or equal, within a 0.1 dBm difference, to the MAXNOMATP of the associated VDSL2 disturber profile (as per Table 7-1/G.993.2), both for upstream and

downstream. The calculated <u>flattened PSD template</u> corresponds to the $P_{SingleSelf\text{-}XYZ,SS}$.

B.5.4 Performance tests for ADSL2plus Annex B with DPBO enabled

For this whole section the systems under test SHALL be configured as defined in the following table.

Table B.5-6: DPBO Performance test configuration

Test configuration	Test profile B2P_CAB27_RA_F_30000k and B2P_CAB72_RA_F_30000k, as defined in section 8 Noise n_B2P_CAB27 and n_B2P_CAB72 settings, as defined in section B.1.3.5. Handshake carrier set B43

a) Test profile B2P_CAB27_RA_F_30000k

8 individual tests – 7 SHALL be passed

Table B.5-7: performance requirements for B2P_CAB27_RA_F_30000k

loop length [m, PE0.4]	US sync rate [kbps]		Upstream Noise Margin Reported [dB]	Pass / Fail	DS sync rate [kbps]		Downstream Noise Margin Reported [dB]	Pass / Fail
	expected	measured			expected	measured		
150	1096				12740			
450	1096				11000			
1050	1096				7568			
1500	1096				5064			

b) Test profile B2P_CAB27_RA_I_30000k

8 individual tests – 7 SHALL be passed

Table B.5-8: performance requirements for B2P_CAB27_RA_I_30000k

loop length [m, PE0.4]	US sync rate [kbps]		Upstream Noise Margin Reported [dB]	Pass / Fail	DS sync rate [kbps]		Downstream Noise Margin Reported [dB]	Pass / Fail
	expected	measured			expected	measured		

150	804				11984			
450	804				10248			
1050	804				7260			
1500	804				4812			

c) Test profile B2P_CAB72_RA_F_30000k

6 individual tests – 5 SHALL be passed

Table B.5-9: performance requirements for B2P_CAB72_RA_F_30000k

loop length [m, PE0.4]	US sync rate [kbps]		Upstream Noise Margin Reported [dB]	Pass / Fail	DS sync rate [kbps]		Downstream Noise Margin Reported [dB]	Pass / Fail
	expected	measured			expected	measured		
150	1096				15584			
300	1096				14496			
450	1096				13584			

d) Test profile B2P_CAB72_RA_I_30000k

6 individual tests – 5 SHALL be passed

Table B.5-10: performance requirements for B2P_CAB72_RA_I_30000k

loop length [m, PE0.4]	US sync rate [kbps]		Upstream Noise Margin Reported [dB]	Pass / Fail	DS sync rate [kbps]		Downstream Noise Margin Reported [dB]	Pass / Fail
	expected	measured			expected	measured		
150	804				14380			
300	804				13488			
450	804				12680			

Annex C   Physical Layer Test Cases for systems using G.992.3/5 annex C

For further study.

Annex D   ADSL2plus Equivalent disturber frequency domain profiles of generators G1 and G2 for the European test sets.

Linear interpolation of the PSD in dBm/Hz against log(f) SHALL be used to calculate the values between breakpoints.

D.1   Equivalent disturber frequency domain profiles for Annex A.2 test set

Table D.1-1: NT-profiles for Annex A

X.NT.FA		X.NT.FB		X.NT.FD	
[kHz]	[dBm/Hz]	[kHz]	[dBm/Hz]	[kHz]	[dBm/Hz]
1	-20	1	-25.8	1	-90.9
15	-20	15	-25.6	3.99	-90.9
24	-20.9	24	-26.5	4	-85.9
30	-21	30	-26.8	25.875	-27.9
45	-23	61	-30.5	138	-27.9
60	-24.7	138	-30.8	229.6	-82.8
138	-24.9	149	-33	686	-89.9
151	-28	200	-33.5	1411	-89.9
207	-28.7	308	-35.2	1630	-99.9
300	-30.3	375	-38.5	5275	-101.9
358	-32.8	456	-46.9	12000	-101.9
407	-36.7	605	-68.4	30000	-101.9
500	-48.6	755	-68.4		
594	-62.3	980	-77.3		
755	-62.3	1128	-80.8		
1059	-73.7	1402	-83.7		
1221	-75.5	1750	-90.8		
1400	-77.9	2208	-97.6		
1750	-85	2800	-101.4		
2212	-92	5274	-102.2		
2800	-96	30000	-102.2		
5274	-97.1				
30000	-97.1				

Table D.1-2: LT-profiles for Annex A

X.LT.FA			X.LT.FB			X.LT.FD	
[kHz]	[dBm/Hz]		[kHz]	[dBm/Hz]		[kHz]	[dBm/Hz]
1	-20.1		1	-25.7		1	-90.9
15	-20		15	-25.6		3.99	-90.9
30	-21.6		30	-27.1		4	-85.9
45	-24.1		45	-29.6		80	-65.9
60	-26.9		65	-32.6		137.99	-37.6
68	-27.6		137.99	-32.8		138	-29.9
137.99	-27.9		138	-31.7		1104	-29.9
138	-26.1		272	-32.6		1622	-39.9
300	-27		414	-34.2		2208	-41.2
470	-27.8		1103	-34.2		2500	-52.8
1106	-27.8		1622	-44.2		3001.5	-73.4
1622	-37.8		2208	-45.5		3175	-89.9
2208	-39.1		2500	-57.1		3750	-89.9
2500	-50.7		3001.5	-77.7		4545	-99.9
3001.5	-71.3		3175	-94.1		7225	-101.9
3175	-87.7		3750	-94.1		12000	-101.9
3750	-87.7		4000	-97.2		30000	-101.9
4000	-91		4300	-100.2			
4300	-94.3		4545	-101.6			
4545	-96.2		7225	-102.2			
7225	-97.1		30000	-102.2			
30000	-97.1						

Table D.1-3: 19 ADSL2plus downstream disturber noise models

FREQ [KHZ]	Template ADSL2+ PSD [dBm/Hz]	X.LT.FD19 [dBm/Hz]
0	-101	-93.3
4	-101	-93.3
4	-96	-88.3
80	-76	-68.3
138	-47.7	-40
138	-40	-32.3
1104	-40	-32.3
1622	-50	-42.3
2208	-51.3	-43.6
2500	-62.9	-55.2
3001.5	-83.5	-75.8
3175	-100	-92.3
3750	-100	-92.3
4545	-110	-102.3
7225	-112	-104.3
12000	-112	-104.3

Table D.1-4: 19 ADSL2plus upstream disturber noise model

Freq [kHz]	Template ADSL2plus PSD [dBm/Hz]	X.NT.FD19 [dBm/Hz]
0	-101	-93.3
4	-101	-93.3
4	-96	-88.3
25.875	-38	-30.3
138	-38	-30.3
229.6	-92.9	-85.2
686	-100	-92.3
1411	-100	-92.3
1630	-110	-102.3
5275	-112	-104.3
12000	-112	-104.3

D.2 Equivalent disturber frequency domain profiles for Annex A.3 test set

Table D.2-1: 19 ADSL2plus over ADSL downstream PSD and crosstalk noise model for CAL = 12

	CAL=12	
Freq [kHz]	PSD [dBm/Hz]	X.LT.C12 [dBm/Hz]
50	-90.5	-82.8
80	-83.8	-76.1
138	-41.4	-33.7
168	-53.0	-45.3
372	-53.0	-45.3
677	-56.7	-49.0
1108	-61.3	-53.6
1622	-76.1	-68.4
2208	-82.5	-74.8
3200	-110.0	-102.3
15000	-110.0	-102.3

Table D.2-2: 19 ADSL2plus over ADSL downstream PSD and crosstalk noise model for CAL = 36

	CAL=36	
Freq [kHz]	PSD [dBm/Hz]	X.LT.C36 [dBm/Hz]
50	-90.5	-82.8
80	-83.8	-76.1
138	-41.4	-33.7
200	-63.7	-56.0
300	-72.5	-64.8
301	-76.0	-68.3
500	-83.8	-76.1
782	-93.5	-85.8
1011	-93.5	-85.8
1131	-83.5	-75.8
1132	-53.0	-45.3
2208	-53.0	-45.3
4600	-110.0	-102.3
15000	-110.0	-102.3

**Table D.2-3: 19 ADSL2plus over ADSL downstream PSD and crosstalk noise model for
CAL = 52**

	CAL=52	
Freq [kHz]	PSD [dBm/Hz]	X.LT.C52 [dBm/Hz]
50	-90.5	-82.8
80	-83.8	-76.1
138	-41.4	-33.7
200	-63.7	-56.0
300	-72.5	-64.8
301	-82.5	-74.8
452	-91.3	-83.6
551	-83.5	-75.8
552	-53.0	-45.3
2208	-53.0	-45.3
4600	-110.0	-102.3
15000	-110.0	-102.3

D.3   Equivalent disturber frequency domain profiles for Annex B.3 test set

Table D.3-1: NT-profiles for Annex B

X.NT.FA		X.NT.FB		X.NT.FD	
[kHz]	[dBm/Hz]	[kHz]	[dBm/Hz]	[kHz]	[dBm/Hz]
1	-20.1	1	-25.8	1	-79.9
15	-20	15	-25.6	50	-79.9
30	-21.5	30	-27.2	80	-75.2
45	-24.1	45	-29.6	120	-27.9
69	-27.6	70	-32.6	276	-27.9
108	-27.6	108	-32.7	491	-87.7
119	-24.8	119	-30.7	686	-89.9
276	-25.3	276	-31.4	1411	-89.9
310	-30.6	310	-35.5	1630	-99.9
400	-36.2	400	-41.1	5275	-101.9
595	-62.4	605	-68.4	12000	-101.9
755	-62.4	755	-68.4	30000	-101.9
1082	-74.2	1082	-80.2		
1183	-76.3	1186	-82.2		
1400	-77.9	1400	-83.7		
1750	-85	1750	-90.8		
2212	-92	2208	-97.6		
2800	-96	2800	-101.4		
5274	-97.1	5274	-102.2		
30000	-97.1	30000	-102.2		

Table D.3-2: LT-profiles for Annex B

X.LT.FA			X.LT.FB			X.LT.FD	
[kHz]	[dBm/Hz]		[kHz]	[dBm/Hz]		[kHz]	[dBm/Hz]
1	-20.1		1	-25.7		1	-79.9
15	-20		15	-25.6		93.1	-79.9
30	-21.5		30	-27.1		209	-55.4
44	-24.1		45	-29.6		253.99	-41.9
60	-26.9		59	-32		254	-29.9
68	-27.6		66	-32.5		1104	-29.9
99	-27.6		99	-32.6		1622	-39.9
200	-28.7		200	-33.6		2208	-41.2
254	-29.5		253	-34.3		2500	-52.8
255	-26.7		254	-32.5		3000	-73.4
414	-27.8		414	-34.2		3175	-89.9
1104	-27.8		1103	-34.2		3750	-89.9
1622	-37.8		1622	-44.2		4545	-99.9
2208	-39.1		2208	-45.5		7225	-101.9
2500	-50.7		2500	-57.1		12000	-101.9
3000	-71.3		3000	-77.7		30000	-101.9
3174	-87.8		3175	-94.1			
3750	-87.8		3750	-94.1			
4550	-96.2		4220	-99.5			
7200	-97.1		4550	-101.6			
30000	-97.1		7200	-102.2			
			30000	-102.2			

Annex E   Equivalent noise disturber frequency profiles for European test set for DPBO enabled

Linear interpolation of the PSD in dBm/Hz against log(f) SHALL be used to calculate the values between breakpoints.

E.1 PSD profiles of the noise component N1 for ETSI MD_CAB27 noise scenario

Table E.1-1: LT and NT component for ETSI MD_CAB27 noise scenario

LT component		NT component	
[Hz]	[dBm/Hz]	[Hz]	[dBm/Hz]
0.01	-30.2	0.01	-30.2
6900	-30.3	7000	-30.2
15000	-30.5	15000	-30.5
29000	-32	22000	-31
45000	-35.5	24000	-31
74000	-47.4	25000	-30.9
86000	-48	28000	-30.9
102000	-47.5	55000	-33.3
137000	-49.8	69000	-33.6
138000	-48.2	112000	-33.7
139000	-48	119000	-32.9
140000	-47.2	129000	-33
254000	-50.3	136000	-32.8
255000	-49.3	139000	-33.3
272000	-49.7	140000	-33.3
273000	-49	148000	-33.9
560000	-54.7	168000	-34.1
1104000	-63	274000	-34.3
1250000	-68.9	283000	-38.1
1622000	-81.2	301000	-42.4
2208000	-88.8	362000	-48.8
2696000	-113.1	512000	-71
2830000	-117.2	644000	-93.3
3040000	-118.2	676000	-93.3
30000000	-118.2	759000	-94
		918000	-94.5
		1030000	-94.6
		1411000	-94.6
		1630000	-104.6
		5274000	-106.5

30000000	-106.5

E.2   PSD profiles of the noise component N1 for ETSI MD_CAB72 noise scenario

Table E.2-1: LT and NT component for ETSI MD_CAB72 noise scenario

LT component		NT component	
[Hz]	[dBm/Hz]	[Hz]	[dBm/Hz]
0.01	-30.2	0.01	-30.2
6500	-30.3	9100	-30.2
15000	-30.7	16000	-30.5
30000	-32.4	24000	-31
55000	-39.4	26000	-31
71000	-50.4	28000	-30.8
79000	-65	55000	-33.1
81000	-65	70000	-33.4
89000	-54.6	129000	-33.8
102000	-50.1	136000	-33.4
110000	-50.1	138000	-34.3
133000	-55.1	140000	-33.7
157000	-68.2	142000	-33.9
163000	-68.7	175000	-34.3
177000	-64.8	216000	-34.4
187000	-63.3	274000	-34.4
193000	-63.3	291000	-51.4
208000	-65.3	292000	-51.4
234000	-73	321000	-56.4
247000	-73.6	322000	-56.4
272000	-71.7	338000	-79.1
273000	-71.1	352000	-79.1
336000	-76.6	516000	-88.4
349000	-76.5	676000	-93.3
682000	-92.8	838000	-94.4
915000	-101.8	1112000	-94.6
1157000	-109.4	1411000	-94.6
1570000	-118.2	1630000	-104.5
30000000	-118.2	5274000	-106.5
		30000000	-106.5

Annex-J   Physical Layer Test Cases for systems using G.992. 5 Annex J.

This annex contains tests specifically for ADSL2plus systems configured for G.992. 5 Annex-J.

J.1   Test Set-Up / Configuration

General settings and test procedures from section 7 apply.

Figure J.1 shows the test setup valid for Annex J testing.
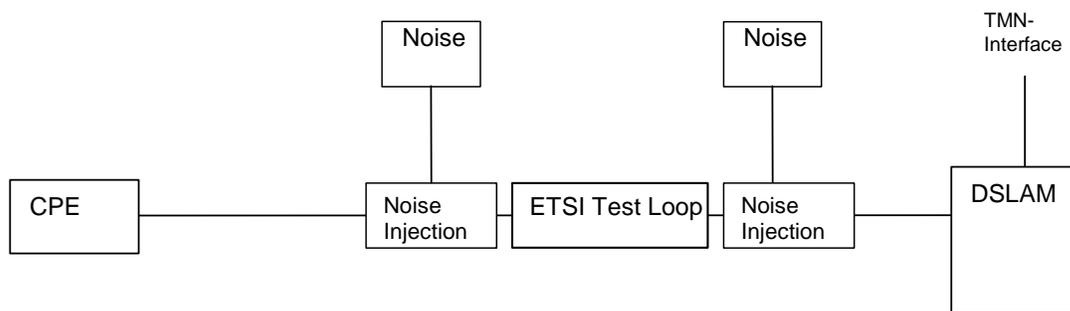
Figure J.1: Test set-up for European Annex J tests without splitters

Table J.1-1: Specific Annex-J Testprofiles

Specific Testprofile	General test profile DS	General test profile US	ATSE	RA-Mode	DS net datarate (kbit/s) (max-min)	US net datarate (kbit/s) (max-min)
J2P60_RA_F_30000k	F-1/0	F-1/0	G.992.5 An.J (ADLU-60)	AT_INIT	30000-32	4032-32

J.2   Noise Generator settings ADSL2plus,Annex J noise FB

Set noise generator G4 to apply a white noise disturber at both ends of the loop at -140 dBm/Hz.

The noise model for G1 and G2 SHALL be ADSL2plus Annex-J FB:
At CO side:
- G1 = X.LT.FB for ADSL2plus Annex J as defined in table J.2, with NEXT coupling function
- G2 = X.NT.FB for ADSL2plus Annex J as defined in table J.2, with FEXT coupling function
At CPE side:

- G1 = X.NT.FB for ADSL2plus Annex J as defined in table J.2, with NEXT coupling function
- G2 = X.LT.FB for ADSL2plus Annex J as defined in table J.2, with FEXT coupling function

Table J.2-1: Equivalent disturber frequency domain profiles for Annex J test set

X.NT.FB		X.LT.FB	
[kHz]	**[dBm/Hz]**	**[kHz]**	**[dBm/Hz]**
1	-25.8	1	-25.7
2	-25.8	15	-25.6
3	-25.7	30	-27.1
15	-25.6	45	-29.6
30	-27	59	-32
45	-29.3	66	-32.5
60	-31.3	99	-32.6
65	-31.7	200	-33.6
99	-31.8	253	-34.3
276	-33.2	254	-32.5
355	-37.5	414	-34.2
380	-39.3	1103	-34.2
500	-53.5	1622	-44.2
605	-68.4	2208	-45.5
755	-68.4	2500	-57
980	-77.3	3000	-77.7
1130	-81.2	3175	-94.1
1400	-83.7	3750	-94.1
1750	-90.8	4220	-99.5
2000	-94.9	4550	-101.6
2350	-99.1	7200	-102.2
2700	-101.1	30000	-102.2
5200	-102.2		
30000	-102.2		

All measurements with noise model FB SHALL be done with the noise model FB calculated for the corresponding length of ETSI loop #1.

J.3   CPE Margin verification tests

As the DS bands are the same for ADSL2plus Annex-B and Annex-J, the following applies:

- For CPE supporting both Annex-B and Annex-J, the DS Margin verification tests SHALL be performed according to section B.3.1 for Annex-B operating mode only.

- For CPE supporting only Annex-J, the DS Margin verification tests SHALL be performed according to section B.3.1 but using Annex-J operating mode and profile J2P60_RA_F_30000k.

J.4   Verification of downstream bi/gi values

As the DS bands are the same for ADSL2plus Annex-B and Annex-J, the following applies:

- For CPE supporting both Annex-B and Annex-J, the verification of DS bi/gi values SHALL be performed according to section B.3.3 for Annex-B operating mode only.

- For CPE supporting only Annex-J, the verification of DS bi/gi values SHALL be performed according to section B.3.3 but using Annex-J operating mode and profile J2P60_RA_F_30000k.

J.5   Loop Tests with Ports Set for Adaptive Rate

J.5.1 White Noise Impairment Only

Set noise generator G4 to apply white noise disturber at both ends of the total loop at -140 dBm/Hz.

18 individual tests – 16 tests SHALL be passed

Table J.3-1: White noise impairment, testprofile J2P60_RA_F_30000k

Loop Length [m, loop#1]	J2P60_RA_F_30000k							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
0	2788				24000			
500	2788				24000			
1000	2784				22712			
1500	2784				18112			
2000	2736				12496			
2500	2436				7472			
3000	2060				4000			
3500	1584				1648			
4000	1184				504			

J.5.2 Noise FB impairment

Set noise generators G1, G2 and G4 for model Annex J FB impairment as defined in section J.2.

14 individual tests – 12 SHALL be passed

Table J.3-2: Noise FB ADSL2plus impairment, testprofile J2P60_RA_F_30000k

Loop Length [m, loop#1]	J2P60_RA_F_30000							
	Upstream				Downstream			
	Sync Rate (kbps)			Noise Margin, Reported (dB)	Sync Rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
100	2624				13000			
250	2524				13000			
750	2176				13000			
1250	1824				11208			
1750	1424				7856			
2500	876				2760			
2750	680				1520			

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Annex-R   G.998.4[21] Retransmission for G.992.5

Three groups of tests are defined for each profile, to set requirements for ADSL2/2plus in combination with G.INP[21]. These are:

- REIN immunity

- PEIN immunity

- Immunity to combined REIN and PEIN noise ingress

The acronym PEIN refers to impulse noise events loosely defined as having duration up to the upper limit of error correctability for the method under test. The acronym SHINE refers to pulses that are generally longer and of higher level and may lead to un-correctable error bursts.
 PEIN may be interpreted as a subset of SHINE as related to G.998.4 control parameters.

Table R-1: Basic test setup parameters

Test Parameter	Value
Test Loop	PE04 [8] loop, length: 1050 m, 1650 m, 2400 m, 3000 m, 3750 m
Crosstalk Noise model	1 self FEXT+NEXT interferer + -140dBm/Hz AWGN
REIN repetition rate	100Hz
REIN pulse amplitude	Nominal 0dB relative to the TR-100 REIN noise impairment
REIN duration (REIN_T)	{0 | 100µs}
PEIN test pattern	As defined in Table R-9
PEIN duration (PEIN_T)	{0 | 4.3 ms | 9.7 ms}
PEIN repetition rate	1 per second
Initialization	Rate adaptive start-up without PEIN and without REIN
Outlet shaping	Off
Ethernet frame size for Down- and Upstream (FS)	300 bytes
Ethernet frames per second DS (FpSds) (testgroup 0)	FLOOR(NDRds*1000*0.95/(8*53*CEIL((FS+18)/48)))
Ethernet frames per second upstream (FpSus)	53

Table R-2: RTX Common Line Settings

Parameter	Setting	Description
TARSNRM	6 dB	
MINSNRM	0 dB	
MAXSNRM	15 dB	
RTX_MODE	2	RTX_FORCED
IAT_REIN_RTX	0	REIN at 100Hz

Note: Other Common Line Settings parameters are defined in Table 8-1.

Table R-3: RTX General Line Settings

General line setting	Parameter	Setting	Description
"R-10/2/0" Use for REIN only	INPMIN_REIN_RTX	2	RTX equivalent to INPMIN=2
	INPMIN_SHINE_RTX	0	No protection against SHINE
	SHINERATIO_RTX	0	No protection against SHINE
	LEFTR_THRESH	0.80	Low rate defect threshold
	DELAYMAX_RTX	10	ms
	DELAYMIN_RTX	0	Outlet shaper off
"R-15/0/41" Use for PEIN only	INPMIN_REIN_RTX	0	No guaranteed protection against REIN
	INPMIN_SHINE_RTX	41	DMT symbols protection against PEIN/SHINE
	SHINERATIO_RTX	2	Worst case PEIN retransmission overhead (percent %) .
	LEFTR_THRESH	0.98	Low rate defect threshold
	DELAYMAX_RTX	15	ms
	DELAYMIN_RTX	0	Outlet shaper off
"R-17/2/41" Use for REIN+PEIN	INPMIN_REIN_RTX	2	DMT symbol protection against REIN
	INPMIN_SHINE_RTX	41	DMT symbols protection against SHINE
	SHINERATIO_RTX	2	Worst case PEIN retransmission overhead(percent %)
	LEFTR_THRESH	0.78	Low rate defect threshold
	DELAYMAX_RTX	17	ms
	DELAYMIN_RTX	0	Outlet shaper off

Table R-4: RTX Specific Test profiles

RTX Specific Test profile	RTX DS General line settings	RTX US General line setting	ATSE	RA-Mode	DS Expected throughput, net data rate (kbit/s) (max-min)	US net data rate(kbit/s) (max-min)
A2P_RA_F_30000k*	F-1/0	I-8/2	G.992.5 An.A	AT_INIT	MAXNDR = 30000 MINNDR = 32	MAXNDR = 2016 MINNDR = 160
A2P_RA_R10/2/0_30000k	R-10/2/0	I-8/2	G.992.5 An.A	AT_INIT	MAXETR_RTX = 30000 MAXNDR_RTX = 30000 MINETR_RTX = 424	MAXNDR = 2016 MINNDR = 160
A2P_RA_R15/0/41_30000k	R-15/0/41	I-8/2	G.992.5 An.A	AT_INIT	MAXETR_RTX = 30000 MAXNDR_RTX = 30000 MINETR_RTX = 424	MAXNDR = 2016 MINNDR = 160
A2P_RA_R17/2/41_30000k	R-17/2/41	I-8/2	G.992.5 An.A	AT_INIT	MAXETR_RTX = 30000 MAXNDR_RTX = 30000 MINETR_RTX = 424	MAXNDR = 2016 MINNDR = 160

Repeat procedure for each loop length and test group as described in Table R-5. Note that this table contains mandatory (M) and optional (O) tests.

Table R-5: Test matrix showing mandatory and optional tests

Test Loop PE04 (m)	Test Group			
	0	1	2	3
1050	O	O	O	O
1650	M	M	M	M
2400	M	M	M	M
3000	M	M	M	M
3750	O	O	O	O

Table R-6: Summary of parameters for each Test Group

Test profile and Impulse Noise Configuration	Test Group			
	0	1	2	3
A2P_RA_F_30000k*	Y			
A2P_RA_R10/2/0_30000k		Y		
A2P_RA_R15/0/41_30000k			Y	
A2P_RA_R17/2/41_30000k				Y
REIN_T ((µs)	0	100	0	100
PEIN_T(ms)	0	0	9.7	4.3

Table R-7 describes the test procedure for the Retransmission test.

Table R-7: RTX test specification

Test Configuration	(1) The ADSL2plus test profiles SHALL be configured according to Table R-6 (2) Line simulator SHALL be set up for the straight homogeneous loop of PE04. Its length SHALL be as defined in Table R-5 (3) The crosstalk noise SHALL be injected at CO and CPE (4) REIN & PEIN SHALL be injected at the CPE (5) All MINEFTR values for each test group SHALL be read within the same monitoring period
Method of Procedure	(1) Configure the ATU-C with the test profile for testgroup 0 as defined in table R-6. (2) Enable crosstalk & disable REIN and PEIN. (3) Set the first loop for testgroup 0 as specified in table R-5. (4) Allow modem to train and wait 1 minute (5) Record the Net data rate downstream NDRds (6) Enable Ethernet traffic generation with a frame rate FpSds in the Downstream direction and FpSus in the Upstream direction as defined in Table R-1 (7) Allow traffic to run for 2 minutes (8) Record the highest downstream packet delay as PDfds (9) Repeat steps 2 to 8 for the next looplenght from Table R-5 (10) Configure the DSLAM with the test profile for testgroup 1 as defined in Table R-2 and R-6. Configure the REIN and PEIN parameters for testgroup 1 as defined in table R-6 (11) Set the first loop for testgroup 1 as specified in Table R-5 (12) Enable crosstalk for this looplength and disable REIN and PEIN. (13) Allow modem to train (14) Allow 1 minute after training for link to stabilize (15) Enable Ethernet traffic generation with a frame rate FpSds in the downstream direction as defined in Table R-8 and FpSus in the upstream direction as defined in Table R-1 (16) Record the downstream ES, SES, and CV counters. (17) Allow traffic to run for 2 minutes (18) Record the downstream ES, SES and CV counters. Record the number of dropped packets and highest packet delay. (19) Enable REIN and/or PEIN and repeat steps 16 to 18 (20) Record MINEFTR and ETR (21) Record the difference between the E2E packet delay without and with

	impulse noise impairment as Delay_diff (22) Repeat steps 12 to 21 for the next looplengths from Table R-5 (23) Repeat steps 10 to 22 for the next test groups from Table R-5

Expected Result	For testgroup 1 to 3 and each looplength:
	(1) MINEFTR >= ETR – ETR*0.02
	(2) Packet Delay without impulse noise – PDfds <= 3.5ms
	(3) If the result is > 3.5ms then the Packet Delay measurement without impulse noise SHALL be repeated once.
	(4) Delay_diff <= DELAYMAX_RTX
	(5) Within the 2 minutes traffic test periods there SHALL be
	    • no dropped packets
	    • no increase in downstream CV, ES and SES counters
	If the CV count increased by 1, the test for this looplength SHALL be repeated once.

Table R-8: Minimum required Ethernet Throughput Frames per second downstream (FpSds)

Test Loop PE04 (m)	Test Group		
	1	2	3
1050	5615	5948	5593
1650	4847	5098	4793
2400	3297	3519	3338
3000	2283	2476	2324
3750	1288	1349	1253

Table R-9: PEIN Test Pattern Definition

PEIN test pattern fixed pulse length PEIN_T Part 1		PEIN test pattern fixed pulse length PEIN_T Part 2		PEIN test pattern fixed pulse length PEIN_T Part 3		PEIN test pattern fixed pulse length PEIN_T Part 4	
PSD (dB/Hz)	Pulse Duration	PSD (dB/Hz)	Pulse Duration	PSD (dB/Hz)	Pulse Duration	PSD (dB/Hz)	Pulse Duration
-114	T	-114	T	-108	T	-110	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-102	T	-94	T	-114	T	-98	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-108	T	-112	T	-98	T	-112	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-106	T	-104	T	-90	T	-112	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-108	T	-106	T	-112	T	-90	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-106	T	-112	T	-94	T	-110	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-112	T	-112	T	-108	T	-98	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T

-90	T	-92	T	-106	T	-88	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-110	T	-108	T	-106	T	-110	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-102	T	-114	T	-106	T	-112	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-98	T	-114	T	-92	T	-114	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-104	T	-108	T	-110	T	-114	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-100	T	-98	T	-100	T	-104	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-114	T	-114	T	-114	T	-96	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-104	T	-100	T	-114	T	-108	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-100	T	-102	T	-114	T	-112	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-112	T	-96	T	-114	T	-110	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-94	T	-104	T	-108	T	-106	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-98	T	-96	T	-106	T	-110	T
-140	1-T	-140	1-T	-140	1-T	-140	1-T
-112	T	-108	T	-102	T	Restart from the beginning	
-140	1-T	-140	1-T	-140	1-T		

Appendix I : Effect of Statistical Variability in CPE Manufacturing (*Informative*)

This section gives information on the effect of statistical variability in CPE manufacturing variation on the statistics involved with the methodology, how the "expected" datarate requirements were determined for section A.1 "North American Test Set".

Methodology
This section describes the essentials of the methodology, how the "expected" datarate requirements were determined for section A.1 "North American Test Set". Only the essentials needed for understanding the statistics in the next section are given. Full details of the testmethodology can be found in TR-067[19] Annex Y "Test Event Methodology".

A number of CPE's have been submitted by CPE vendors to an test event, open to service providers and vendors. It is assumed that these modems represent randomly selected samples from a production lot.
Based on the methodology in Annex Y, a selection of 2 candidate modem-types was established, which correspond with the best 2 modem-types that are fully standard compliant. Preliminary datarates where measured, and that modem-type was selected with the lowest datarate. This was done for each test point, and for upstream and downstream direction independently.

In a further refinement process, 4 units of the selected modem-type were measured and datarates recorded. The final datarate requirements have been established, by taking picking the rates of 4 units, and determining picking the lowest of these 4 rates.

Statistical Analysis

In this section, the analysis is given of the statistics of the rate-requirement (Rr) which is determined by taking the lowest rates out of N rates (Ri: I=1…N) obtained from different units. It can be assumed that the manufacturing variance on equipment corresponds with a gaussian distribution of the rates R.

The probability density function (PDF) of the rate-requirement is given by Equation 11:

$$Prob(Rr) = Prob(R1=Rr) * Prob(R1 < All\ other\ Ri) +$$
$$Prob(R2=Rr) * Prob(R2 < All\ other\ Ri) +$$
$$…$$
$$Prob(RN=Rr) * Prob(RN < All\ other\ Ri)$$

Equation 11

Therefore:
$$PDF(Rr) = N * PDF\_gaussian(Rr) * (CDF\_gaussian(Rr))^{(N-1)}$$

Equation 12

This is illustrated in Figure 1. In this figure the distributions are plotted in function of the "normalised R":
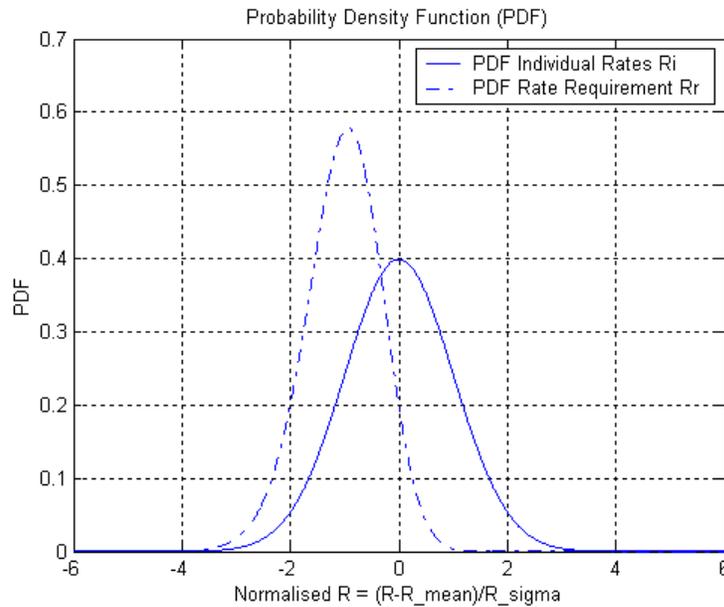
$$Normalised\_R = (R-R\_mean)/R\_sigma$$

With

$$R\_mean = mean\ value\ of\ rates\ R\text{-}\ distribution$$
$$R\_sigma = variance\ of\ rates\ R\text{-}distribution.$$

The solid curve gives the gaussian PDF of the individual rates Ri. The dashed curve gives the PDF of the rate-requirement Rr for N=4 as in [Annex Y].

Figure I.1 PDF of the individual rates Ri, and the Rate-requirement Rr.

The overlapping part in Figure 1 correspond with modem-units for which Ri < Rr, i.e. the part of the production lot which could show a fail on the performance tests, although the modem-type is compliant to this TR.

The probability that this occurs can be calculated as :

$$Failprobability = \int_{-\infty}^{+\infty} prob(Rr) * prob(Ri < Rr) * dRr$$

Equation 13

This probability has been evaluated, with results showing that the large majority, (but not all) of randomly-selected units will pass the rate requirements.

Appendix II : Computing the Maximum Number of Frames Per Second *(Informative)*

RFC 2684 section 5.2 specifies the AAL5 CPCS-PDU payload using LLC-SNAP encapsulation for bridged protocols. In the AAL5 CPCS-PDU payload, a 3-octet LLC and a 5 octet (3-octet OUI and 2-octet PID) SNAP field will be present, giving a total of 8 octets. In addition, the original 4-octet LAN Frame Check Sequence (FCS) of the LAN frame may or may not be preserved within the bridged PDU.

The necessary number of padding octets needs to be added after the PID field in order to align the Ethernet/802.3 LLC Data field of the bridged PDU to begin at a **four octet boundary**. Here the RFC specifies two cases:

- A bridge that uses the Bridged Ethernet/802.3 encapsulation format **with** the preserved LAN FCS MUST include 2 octets of padding. The resulting overhead of the LLC-SNAP header and padding will then be 10 octets
- A bridge that uses the Bridged Ethernet/802.3 encapsulation format **without** the preserved LAN FCS MAY either include padding, or omit it. In case padding is omitted, the overhead will be 8 octets. In case padding is added the overhead will be 10 octets

It should be noted that when the padding is omitted, the Ethernet/802.3 LLC Data field will not begin at a four octet boundary. It is then the responsibility of the bridging receiver to add the 2 octets of padding before forwarding the bridged frame.

In the formulas below the LAN FCS (4 octets) is considered to be useful data i.e. part of the "frame size" as used in the calculations below.

In addition to the LLC-SNAP header files described above, ATM AAL5 adds an additional 9-octet trailer to each bridged frame. These 8 octets also need to be considered in the calculations below.

The following formulas are used to compute the Maximum number of Frames per Second (MAX FPS), section 8.1, given a data rate at the ATM layer, and a frame size.

In case the FCS is not preserved within the RFC-2684 encapsulation and the 2 bytes of PAD are not present after the SNAP header, the number of cells required, for each frame, is is calculated according to Equation 14:

$$\text{ATM cells per frame} = ceil\left(\frac{\text{frame size} + 16}{48}\right)$$

Equation 14

In case the FCS is preserved within the RFC-2684 encapsulation or the FCS is not preserved within the RFC-2684 encapsulation and the 2 bytes of PAD are present after the SNAP header, the number of cells required, for each frame, are calculated according to Equation 15:

$$\text{ATM cells per frame} = ceil\left(\frac{\text{frame size} + 18}{48}\right)$$

<div align="center">Equation 15</div>

In the above, the frame size is in bytes, and the *ceil* function rounds up to the next integer value.

Each ATM cell is composed of 53 bytes, so that

$$\text{ATM layer bits per frame} = 53 \times 8 \times \text{ATM cells per frame}$$

<div align="center">Equation 16</div>

Finally, since the data rate is that rate available to the ATM layer, the Maximum number of Frames per Second (Max FPS) is:

$$\text{Max FPS} = floor\left(\frac{\text{data rate}}{\text{ATM layer bits per frame}}\right)$$

<div align="center">Equation 17</div>

In the above, the data rate is in bits per second, and the *floor* function rounds down to the next integer value.

<div align="center">

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