

TR-100

ADSL2/ADSL2plus Performance Test Plan

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Table of Contents

1.	SUMMARY	7
1.1	Interoperability	7
1.2	Conventions	7
1.3	Scope	8
2.	REFERENCES	9
3.	TEST TOOLS REQUIREMENTS AND COMPENSATION	11
3.1	Accuracy of Loop simulators and noise sources	11
3.1.1	Loop Simulators	11
3.1.2	Noise Sources	17
3.1.3	Cabling	18
4.	COMMON TEST INFORMATION	20
4.1	Net data rates for DSLAMs	20
4.2	Compatibility Matrix/Definitions	20
4.3	Recording Temperature and Humidity	20
4.4	Sync State Definition	20
5.	EQUIPMENT FEATURES	21
5.1	DSLAM	21
5.2	CPE	21
6.	TEST CONFIGURATIONS	24
7.	PHYSICAL LAYER TEST CASES	27
7.1	Bitswap performance test	31
7.2	DSL Noise Spikes/Surges Tests	33
7.2.1	Isolated noise burst test	33
7.2.2	Repetitive High level Impulse Noise (REIN) test	34
7.2.3	Common mode noise susceptibility test	36
7.3	Stress Test	36
7.4	Verification of CRC error reporting by ATU-R (Basic CRC Functionality Test)	37
7.5	Margin verification test procedure	38
8.	HIGHER LAYER TEST CASES	41
8.1	RFC2684 [11] Layer 3 Ethernet or USB Interface bridged mode	41
8.1.1	Packet Throughput Test	41
8.2	RFC2516 [12] PPPoE Throughput Test	44
8.3	RFC2364 [13] PPPoA End-to-End Connectivity Test	45
8.4	RFC2684 [11] IP Bridged End-to-End Connectivity Test	46
8.5	Power Cycle Test	47
	ANNEX A PHYSICAL LAYER TEST CASES FOR SYSTEMS USING G.992.3[1] AND G.992.5[2] ANNEX A.	48
A.1	North American Test set	48

A.1.1	CPE Margin verification tests	50
A.1.2	Operation in the Presence of Impulse Noise Events	53
A.1.3	Verification of downstream bi/gi values	53
A.1.4	Loop tests with ports set for adaptive rate, automode operation	55
A.1.5	Loop tests with ports set for adaptive rate, single operating mode	64
A.1.6	Loop Tests with Ports Set For Fixed Rate	69
A.1.7	ADSL2plus Coexistence with Phoneline Networking	69
A.1.8	REIN noise impairment	71
A.2	European Test set	72
A.2.1	Noise and noise injection	72
A.2.2	CPE Margin verification tests	73
A.2.3	CO Margin Verification (Optional)	78
A.2.4	Verification of downstream bi/gi values	81
A.2.5	Loop Tests with Ports Set for Adaptive Rate	82
A.2.6	Loop Tests with Ports Set for Fixed Rate	89
A.2.7	Loop Tests with Ports Set for ADSL2 Annex L operating mode	96
A.2.8	REIN noise impairment	98
A.3	ADSL2plus European tests operating with DS-PSD mask above ADSL	100
A.3.1	Noise ADSL2plus over ADSL FD (rate adaptive)	101
A.3.2	Noise ADSL2plus over ADSL FD (fixed rate)	104
ANNEX B PHYSICAL LAYER TEST CASES FOR SYSTEMS USING		
G.992.3/5 ANNEX B. 108		
B.1	Annex B specific test setup information	108
B.1.1	Splitter model	108
B.1.2	Test loops / Loop characteristics	109
B.1.3	Noise and noise injection	109
B.1.4	Test procedure	111
B.2	Performance European Test set for ADSL2, Annex B	113
B.2.1	CPE Margin verification tests	114
B.2.2	CO Margin Verification (Optional)	116
B.2.3	Verification of Downstream bi/gi Values	119
B.2.4	Loop Tests with Ports Set for Adaptive Rate	119
B.2.5	Loop Tests with Ports Set For Fixed Rate	122
B.2.6	Performance in L2 mode	129
B.3	Performance Test set for ADSL2plus, Annex B	130
B.3.1	CPE Margin verification tests	130
B.3.2	CO Margin Verification (Optional)	133
B.3.3	Verification of downstream bi/gi values	135
B.3.4	Loop Tests with Ports Set for Adaptive Rate	136
B.3.5	Loop Tests with Ports Set For Fixed Rate	139
B.3.6	Performance in L2 mode	148
B.3.7	Performance with configured RFIBANDds	149
B.3.8	ADSL2plus European tests operating with DS-PSD mask above ADSL	151
ANNEX C PHYSICAL LAYER TEST CASES FOR SYSTEMS USING		
G.992.3/5 ANNEX C 153		

ANNEX D ADSL2PLUS EQUIVALENT DISTURBER FREQUENCY DOMAIN PROFILES OF GENERATORS G1 AND G2 FOR THE EUROPEAN TEST SETS.	154
D.1 Equivalent disturber frequency domain profiles for Annex A.2 test set	154
D.2 Equivalent disturber frequency domain profiles for Annex A.3 test set	157
D.3 Equivalent disturber frequency domain profiles for Annex B.3 test set	158
APPENDIX I : EFFECT OF STATISTICAL VARIABILITY IN CPE MANUFACTURING (<i>INFORMATIVE</i>)	160
APPENDIX II : COMPUTING THE MAXIMUM NUMBER OF FRAMES PER SECOND (<i>INFORMATIVE</i>)	162

List of Figures

Figure 1/TR-100 : A_{max} vs. frequency for ADSL2plus annex-A.....	13
Figure 2/TR-100 : A_{max} vs. frequency for ADSL2plus annex-B	13
Figure 3/TR-100: Test setup for loop tests for ADSL2/ADSL2plus external modems ...	24
Figure 4/TR-100: Test setup for throughput tests for ADSL2/ADSL2plus external modems with Ethernet interfaces	24
Figure 5/TR-100: Test set-up for USB modems.....	25
Figure 6/TR-100: Test set-up for internal modems	25
Figure 7/TR-100: Test set-up for European Annex B tests with splitters.....	26
Figure 8/TR-100: Test setup for PPPoE testing with Ethernet modems	44
Figure 9/TR-100: Test setup for PPPoE testing with USB modems	44
Figure 10/TR-100: Test setup for PPPoA testing with Ethernet modems	46
Figure 11/TR-100: Test setup for PPPoA testing with USB modems.....	46
Figure 12/TR-100 Straight Loop Configuration	49
Figure 13/TR-100 Bridged Tap Loop Configuration	49
Figure 14/TR-100: G.pnt test setup	71

1. Summary

This document describes performance and interoperability test cases required for ADSL2/ADSL2plus systems consisting of DSLAMs and CPE modems.

1.1 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 (ATU-R and/or ATU-C) 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 ATU-R/ATU-C 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 ATU-C. The terms "CPE", "CPE modem" and "modem" are understood to refer to the functionality of the ATU-R, unless stated otherwise. ATU-C 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.

1.2 Conventions

This document uses several words to signify the specification requirements. This section defines these words as they shall be interpreted. The key words "must", "must not", "required", "shall", "shall not", "should", "should not", "recommended", "may", and "optional" in this document are to be interpreted as described below.

- **Must**: This word, or the terms "required" or "shall", mean that the definition is an absolute requirement of the specification.
- **Must Not**: This phrase, or the phrase "shall not", means that the definition is an absolute prohibition of the specification.
- **Should**: This word, or the adjective "recommended", means that there may exist valid reasons in particular circumstances to ignore a particular item, but the full

implications must be understood and carefully weighed before choosing a different course.

- *Should Not*: This phrase, or the phrase "not recommended" means that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
- *May*: This word, or the adjective "optional", means that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation that does not include a particular option must be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same vein, an implementation that does include a particular option must be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides).

1.3 Scope

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 ATU-C equipment, capable of providing the maximum allowable power. ATU-C equipment unable to provide this transmit power is considered to be out of the scope of this interoperability testplan. The performance points may differ from the performance requirements of G.992.3[1], G.992.5[2] and TS101388[8]. It does not replace operators' pre-deployment testing.

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 is developing a specification for functional testing of ADSL2/2plus modems. 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.

2. References

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

- [1] ITU-T Recommendation G.992.3 (01/2005), Asymmetric digital subscriber line transceivers 2 (ADSL2), including amendment 1 (09/2005) and amendment 2 (03/2006).
- [2] ITU-T Recommendation G.992.5 (01/2005), Asymmetric digital subscriber line (ADSL) transceivers – extended bandwidth (ADSL2plus), including amendment 1 (07/2005) and amendment 2 (06/2006).
- [3] ITU-T Recommendation G.996.1 (02/2001), Test procedures for digital subscriber line (DSL) transceivers.
- [4] ITU-T G.997.1 (06/2006), Physical Layer Management for Digital Subscriber Line (DSL) Transceivers.
- [5] ANSI T1.413 (1998), Network to Customer Installation Interfaces - Asymmetric Digital Subscriber Line (ADSL) Metallic Interface.
- [6] ANSI T1.417 issue 2 (09/2003), Spectrum Management for Loop Transmission System
- [7] ITU-T Recommendation G.117 (1996), Transmission aspects of unbalance about earth.
- [8] ETSI TS101388 V1.3.1 (2002-05), ADSL – European Specific Requirements.
- [9] ETSI TS101952-1 V1.1.1 (04/2002) - Specification of ADSL splitters for European deployment.
- [10] IEEE 802.3u, Fast Ethernet.
- [11] RFC2684, Multiprotocol Encapsulation over ATM Adaptation Layer 5 (AAL5).
- [12] RFC 2516, Method for Transmitting PPP over Ethernet. (PPPoE).
- [13] RFC 2364, PPP over AAL5 (PPPoA).
- [14] ITU-T Recommendations G.9954 (02/2005) 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] RFC 1242, Benchmarking terminology for network interconnection devices.
- [18] RFC 2544, Benchmarking terminology for network interconnection devices (Test methodology).
- [19] TR-067 Issue2, Broadband Forum Technical Report “ADSL Interoperability Test Plan”

3. Test Tools Requirements and Compensation

- 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 must 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.

3.1 Accuracy of Loop simulators and noise sources

3.1.1 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 $[f_1, f_2]$, given by table 3-1 and 3-2 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 3-1/TR-100: Compensation boundaries for ADSL2

	Annex A/L	Annex B
f1	20kHz	120kHz
f2	1104kHz	1104kHz
f _{delta}	10kHz	10kHz
A _{max}	95dB	95dB

Table 3-2/TR-100: Compensation boundaries for ADSL2plus

	Annex A	Annex B
f1	20kHz	120kHz
f2	2208kHz	2208kHz
f _{delta}	10kHz	10kHz
A _{max}	note1	note2

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

Note2: the A_{max} for ADSL2plus annex-B shall be the inverse function of the ADSL2plus annex-B PSD mask, as specified in table 3-4

Table 3-3/TR-100: Definition of A_{max} for ADSL2plus Annex A

Frequency	Level dB
25 kHz	95 dB
1104 kHz	95 dB
1622 kHz	85 dB
2208 kHz	83.7 dB

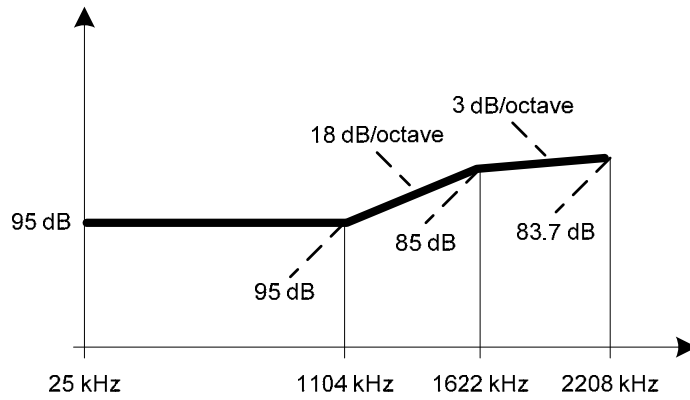


Figure 1/TR-100 : Amax vs. frequency for ADSL2plus annex-A

Table 3-4/TR-100: Definition of A_{max} for ADSL2plus Annex B

Frequency	Level dB
120 kHz	95 dB
1104 kHz	95 dB
1622 kHz	85 dB
2208 kHz	83.7 dB

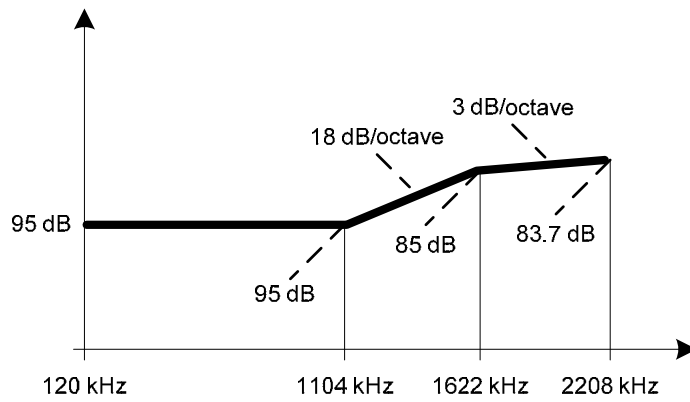


Figure 2/TR-100 : A_{max} vs. frequency for ADSL2plus annex-B

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

Formula 1/TR-100

$$\text{MAE}_{\text{loop X}} = \frac{1}{N_i} \sum_{i \in \{A_{Ti} \leq A_{Max_i}\}} |A_{R_i} - A_{T_i}| + \frac{1}{N_j} \sum_{j \in \left\{ \begin{array}{l} A_{T_j} > A_{Max_j} \\ A_{R_j} - A_{Max_j} < -0.5 \end{array} \right\}} |A_{R_j} - A_{Max_j}|$$

Formula 2/TR-100

$$\text{ME}_{\text{loop X}} = \frac{1}{N_i} \sum_{i \in \{A_{Ti} \leq A_{Max_i}\}} (A_{R_i} - A_{T_i}) + \frac{1}{N_j} \sum_{j \in \left\{ \begin{array}{l} A_{T_j} > A_{Max_j} \\ A_{R_j} - A_{Max_j} < -0.5 \end{array} \right\}} |A_{R_j} - A_{Max_j}|$$

[positive error = too much attenuation]

A_{R_i} = Attenuation sample, in dB, of the measured loop X

A_{T_i} = 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 $A_T \leq A_{\text{Max}}$ dB.

N_i 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 ohms, for European noises, this shall be according TS101388[8], section 5.1.

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

Formula 3/TR-100

$$\begin{aligned} \Delta p_i &= 10 \cdot \log_{10}(p_{out}^{sim}) - 10 \cdot \log_{10}(p_{out}^{loop}) \\ &= 10 \cdot \log_{10}\left(\left|\frac{Z_{in,sim}^R(f_i) \cdot Z_L(f_i)}{Z_{in,sim}^R(f_i) + Z_L(f_i)}\right|^2\right) - 10 \cdot \log_{10}\left(\left|\frac{Z_{in,loop}^R(f_i) \cdot Z_L(f_i)}{Z_{in,loop}^R(f_i) + Z_L(f_i)}\right|^2\right) \text{ dB} \end{aligned}$$

where

f_i are the frequency bins.

The mean absolute error is defined in Formula 4.

Formula 4/TR-100

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

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 B6 "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".

Mean Average Percentage Error for Phase delay shall be defined as in formula 5.

Formula 5/TR-100

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

where

Phase Delay(f) = unwrapped(phase(f))/ (2*pi*f)

f is the frequency

PD_{cable} is the Phase delay for a theoretical loop, and

PD_{sim} is the measured Phase delay for the simulator,

N is the number of frequencies used in the averaging.

Mean Average Percentage Error for Group Delay shall be defined as in formula 6.

Formula 6/TR-100

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

where

GD_{cable} is the Group delay for a theoretical loop

GD_{sim} is the measured Group delay for the simulator,

N is the number of frequencies used in the averaging.

Points where $|GD_{\text{cable}}|$ 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 be made over a frequency range of \pm 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 formula 7.

Formula 7/TR-100

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

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 point.

3.1.2 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 ($\pm 1\%$) 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.

For the noise source used in testing, the simulated noise level shall be measured over the frequency band $[f1, f2]$, given by table 3-5 for the different annexes. 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.

Table 3-5/TR-100: Compensation frequency boundaries

	Annex A	Annex B
f1	20 kHz	120 kHz
f2	1104 kHz	1104 kHz

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

Formula 8/TR-100

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

Formula 9/TR-100

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

[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 $P_{Ti} \geq -140$ dBm/Hz.

M is the number of elements in the above set.

3.1.2.1 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.

3.1.3 Cabling

Cabling, switches and other equipment are needed to connect the DSLAM, the loop simulator, the noise generator and the ATU-R. Care must 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.

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 ATU-R and ATU-C 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).

4. Common Test Information

4.1 Net data rates for DSLAMs

Throughout this document, the variable “net data rate” is used. This parameter is defined in section 3.28 of G.992.3[1]. The “sync rate” is the net data rate achieved in showtime.

4.2 Compatibility Matrix/Definitions

A modem must 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 must achieve the minimum required performance in each test against each DSLAM.

4.3 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 4-1. 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 4-1/TR-100: Temperature and Humidity

<i>Parameter</i>	<i>High</i>	<i>Low</i>
Temperature		
Humidity		

4.4 Sync State Definition

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

5. Equipment Features

The listed tables 5-1 and 5-2 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.

5.1 DSLAM

Table 5-1/TR-100: 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	

5.2 CPE

Table 5-2/TR-100: CPE Features Tables (Informative)

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

Test Item	Results
Other supported protocols	
Splitter Characteristics	
Vendor information	
Type (POTS, 2B1QISDN, 4B3T ISDN,...)	
HW version	

6. Test Configurations

Note: for Figures 3 through 7: high-impedance couplings may be integrated in noise sources, and high impedance is defined as in G.996.1[3] Figure 3.

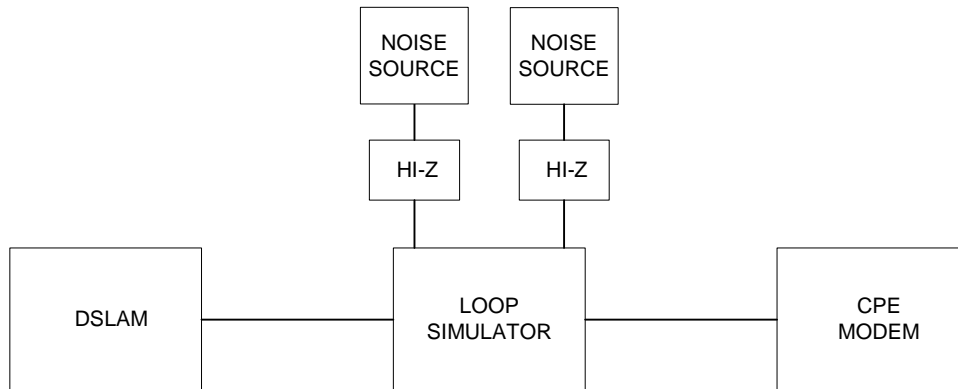


Figure 3/TR-100: Test setup for loop tests for ADSL2/ADSL2plus external modems

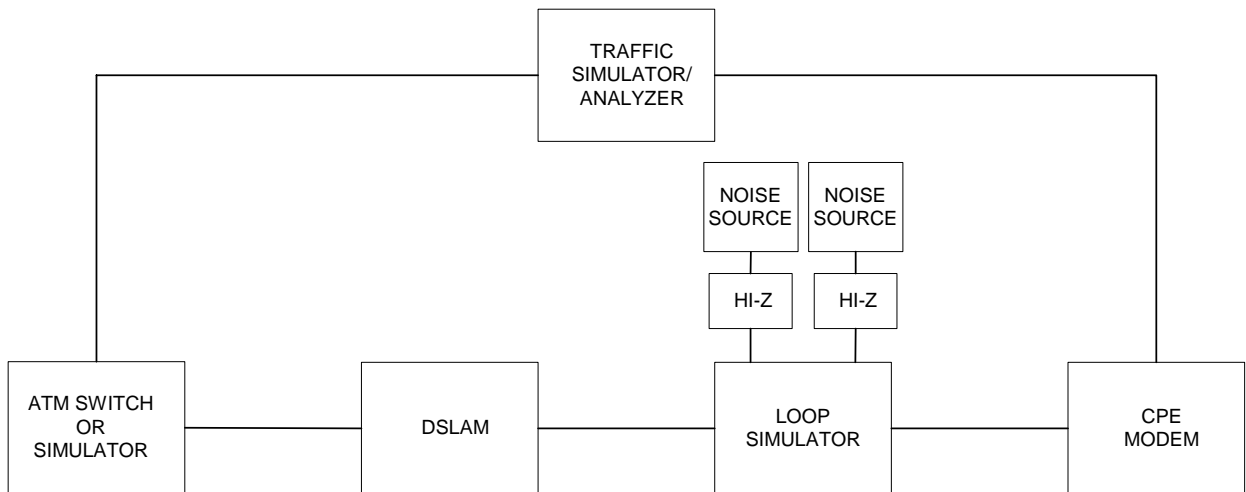


Figure 4/TR-100: Test setup for throughput tests for ADSL2/ADSL2plus external modems with Ethernet interfaces

Note for Figure 4:

- 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.

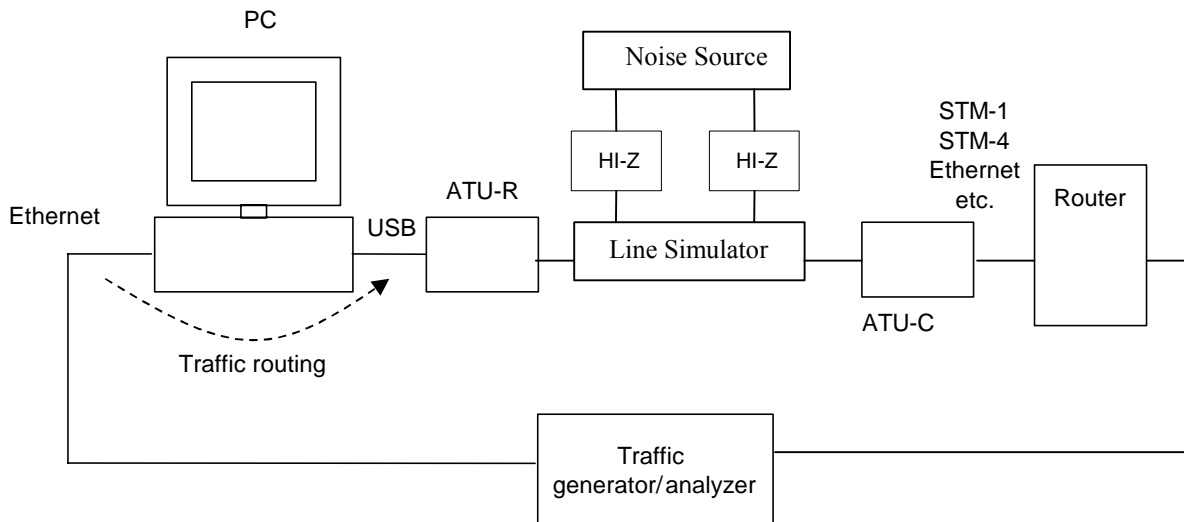


Figure 5/TR-100: Test set-up for USB modems

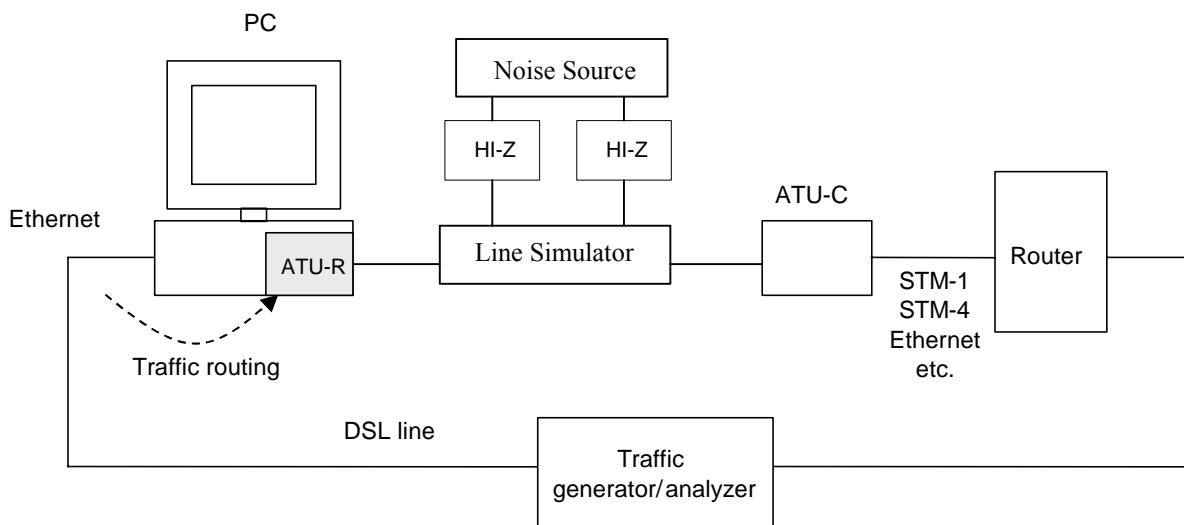


Figure 6/TR-100: Test set-up for internal modems

Notes for Figure 5 and Figure 6:

- The PC must 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.

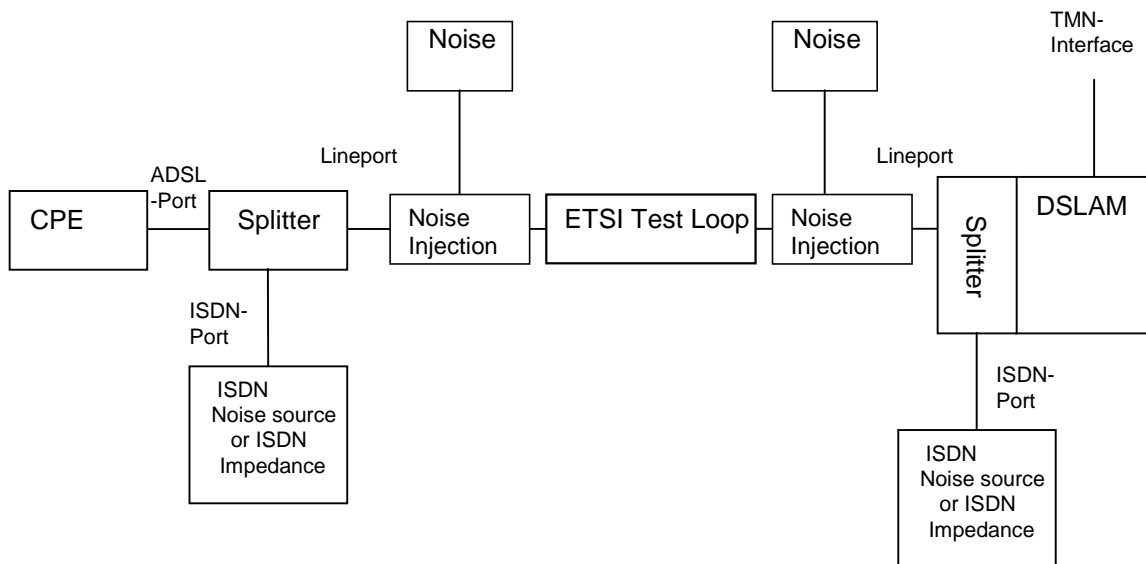


Figure 7/TR-100: Test set-up for European Annex B tests with splitters

7. Physical Layer Test Cases

The loop simulators shall be calibrated relative to the nominal attenuation as defined in chapter 3, section 3.1.1. 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 chapter 3, section 3.1.2.

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 7-1

General testprofiles define latency and INP settings as shown in table 7-2.

Specific testprofiles additionally define settings for DS/US net data rates, Operating mode(ATSE) and RA-Mode. These setting are shown in table 7-3.

Deviations from these testprofiles and/or common line settings are indicated in the description of each test or testsection.

Table 7-1/TR-100 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 19.3 dBm	Annex-A G.992.3/5 default value (A.1.3.2) Annex-B G.992.3/5 default value (B.1.3.2)
MAXNOMATPus	12.5 dBm 13.3 dBm	Annex-A G.992.3/5 default value (A.2.2.2) Annex-B G.992.3/5 default value (B.2.2.2)

Parameter	Setting	Description
CARMASKds	default	Testcase dependant
CARMASKus	default	Testcase dependant
PSDMASKds	default	only applicable for G.992.5
RFIBANDSds	none	only applicable for G.992.5
MAXBER	1E-7	

Table 7-2/TR-100: General Testprofiles

General Testprofile	Parameter	Setting	Description
Low delay profile "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.
Low delay profile "L-2/0"	Minimum INP	0 symbols	No impulse noise protection
	Maximum delay	2 ms	One way interleaving delay $\lceil S \cdot D \rceil / 4$
High delay profile A "I-16/2"	Minimum INP	2 symbols	
	Maximum delay	16 ms	One way interleaving delay $\lceil S \cdot D \rceil / 4$
High delay profile B "I-16/0.5"	Minimum INP	0.5 symbols	
	Maximum delay	16 ms	One way interleaving delay $\lceil S \cdot D \rceil / 4$

Table 7-3/TR-100 : Specific Testprofiles

Specific Testprofile	General test profile	ATSE	RA-Mode	DS net datarate(kbit/s) (max- min)	US net datarate(kbit/s) (max-min)
AU_RA_L_30000k	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	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	G.992.3 An.A	AT_INIT	16000-32	2016-32
A2_RA_I1/2_16000k	I-16/0.5	G.992.3 An.A	AT_INIT	16000-32	2016-32
A2L_RA_I_16000k	I-16/2	G.992.3 An.L, mask M1	AT_INIT	16000-32	2016-32
A2_Fix_F_7288k	F-1/0	G.992.3 An.A	MANUAL	7288-7288	800-800
A2_Fix_I_7288k	I-16/2	G.992.3 An.A	MANUAL	7288-7288	800-800
A2_Fix_F_5952k	F-1/0	G.992.3 An.A	MANUAL	5952-5952	640-640
A2_Fix_I_5952k	I-16/2	G.992.3 An.A	MANUAL	5952-5952	640-640
A2_Fix_F_2400k	F-1/0	G.992.3 An.A	MANUAL	2400-2400	352-352
A2_Fix_I_2400k	I-16/2	G.992.3 An.A	MANUAL	2400-2400	352-352
A2_Fix_I_1200k	I-16/2	G.992.3 An.A	MANUAL	1200-1200	224-224
B2_RA_F_16000k	F-1/0	G.992.3 An.B	AT_INIT	16000-32	2016-32
B2_RA_I_16000k	I-16/2	G.992.3 An.B	AT_INIT	16000-32	2016-32
B2_Fix_F_7288k	F-1/0	G.992.3 An.B	MANUAL	7288-7288	800-800
B2_Fix_I_7288k	I-16/2	G.992.3 An.B	MANUAL	7288-7288	800-800
B2_Fix_F_3456k	F-1/0	G.992.3 An.B	MANUAL	3456-3456	448-448
B2_Fix_I_3456k	I-16/2	G.992.3 An.B	MANUAL	3456-3456	448-448
B2_Fix_F_864k	F-1/0	G.992.3 An.B	MANUAL	864-864	160-160
B2_Fix_I_864k	I-16/2	G.992.3 An.B	MANUAL	864-864	160-160
A2P_RA_F_30000k	F-1/0	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P RA_I_30000k	I-16/2	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P RA_I1/2_30000k	I-16/0.5	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P_Fix_F_10000k	F-1/0	G.992.5 An.A	MANUAL	10000-10000	832-832
A2P_Fix_I_10000k	I-16/2	G.992.5 An.A	MANUAL	10000-10000	832-832
A2P Fix_F_7288k	F-1/0	G.992.5 An.A	MANUAL	7288-7288	800-800
A2P Fix_I_7288k	I-16/2	G.992.5 An.A	MANUAL	7288-7288	800-800
A2P Fix_F_5952k	F-1/0	G.992.5 An.A	MANUAL	5952-5952	640-640
A2P Fix_I_5952k	I-16/2	G.992.5 An.A	MANUAL	5952-5952	640-640
A2P_Fix_F_2400k	F-1/0	G.992.5 An.A	MANUAL	2400-2400	352-352

Specific Testprofile	General test profile	ATSE	RA-Mode	DS net datarate(kbit/s) (max- min)	US net datarate(kbit/s) (max-min)
A2P Fix_I_2400k	I-16/2	G.992.5 An.A	MANUAL	2400-2400	352-352
A2P Fix_F_600k	F-1/0	G.992.5 An.A	MANUAL	600-600	128-128
A2P Fix_I_600k	I-16/2	G.992.5 An.A	MANUAL	600-600	128-128
B2P_RA_F_30000k	F-1/0	G.992.5 An.B	AT_INIT	30000-32	2016-32
B2P RA_I_30000k	I-16/2	G.992.5 An.B	AT_INIT	30000-32	2016-32
B2P Fix_F_10000k	F-1/0	G.992.5 An.B	MANUAL	10000-10000	832-832
B2P Fix_I_10000k	I-16/2	G.992.5 An.B	MANUAL	10000-10000	832-832
B2P Fix_F_7288k	F-1/0	G.992.5 An.B	MANUAL	7288-7288	800-800
B2P Fix_I_7288k	I-16/2	G.992.5 An.B	MANUAL	7288-7288	800-800
B2P Fix_F_3456k	F-1/0	G.992.5 An.B	MANUAL	3456-3456	448-448
B2P Fix_I_3456k	I-16/2	G.992.5 An.B	MANUAL	3456-3456	448-448
B2P Fix_F_864k	F-1/0	G.992.5 An.B	MANUAL	864-864	160-160
B2P Fix_I_864k	I-16/2	G.992.5 An.B	MANUAL	864-864	160-160

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.

USB modems and NIC modems will be connected via an Ethernet card in a computer that has the minimum configuration per the modem's manufacturer.

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 must train within **a total of**

- 60 seconds, for single mode operation
- 120 seconds, for automode operation

Starting from the time that the ATU-C 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 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.

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 7-4 for reference.

Table 7-4/TR-100: Pointer to physical layer testcases

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

7.1 Bitswap performance test

Table 7-5 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.

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.

Table 7-5/TR-100: Bitswap performance test

Test Configuration	<p>[1] See Figure 3</p> <p>[2] Configure the DSLAM for testprofile A2_RA_F_16000k or B2_RA_F_16000k with the maximum downstream net data rate set to 6432kb/s and the maximum upstream net data rate set to 800kb/s.</p> <p>[3] Connect ATU-R and ATU-C with a stable connection at either</p> <ol style="list-style-type: none"> a. 9000 ft 26AWG (annex-A1) b. 2.5 km ETSI loop #1 (annex-A2) c. 2 km ETSI loop #1 (annex-B) <p>with -140dBm/Hz AWGN noise injected at both the ATU-C and ATU-R ends.</p> <p>[4] 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 ATU-R and ATU-C modems replaced with calibrated 100 Ohm $\pm 1\%$ resistors. Measurements performed into a 1kHz resolution bandwidth.</p> <p>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.</p>
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Method of Procedure	<p>[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.</p> <p>[2] Record and report the value of n used.</p> <p>[3] Connect the ATU-R and ATU-C as per test configuration details. The frequency of the interfering tone shall be set to $n \times 4.3125$ kHz. The power of the interfering tone shall be -110 dBm or less.</p> <p>[4] Activate the management port to record the downstream bits per tone map.</p> <p>[5] Increase the power of the interfering tone to -50 dBm.</p> <p>[6] 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.)</p> <p>[7] 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.</p> <p>[8] Record and report the value of n used.</p> <p>[9] Connect the ATU-R and ATU-C as per test configuration details. The frequency of the interfering tone shall be set to $n \times 4.3125$ kHz. The power of the interfering tone shall be -110 dBm or less.</p> <p>[10] Activate the management port to record the upstream bits per tone map.</p> <p>[11] Increase the tone power to -50dBm.</p> <p>[12] 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.)</p>
Expected Result	<p>The bit swap protocol re-deploys the allocation of bits among the sub-carriers.</p> <p>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.</p>

7.2 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).

7.2.1 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 7-6.

Table 7-6/TR-100: isolated noise burst test setting

Parameter	Value
Loop Length (26AWG)	3, 5, and 15kft
Target Noise Margin	6dB
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 7-7. The loops for these tests are 26 AWG.

Table 7-7/TR-100: isolated noise burst testloop and burst length

Loop Length (kft)	Burst length (msec)
3	4000
5	1000
15	100

7.2.2 Repetitive High level 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 7-8 and 7-9.

Table 7-8/TR-100 : REIN test procedure Rate Adaptive mode

Test Configuration	<p>[1] The ATU-C and ATU-R 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.</p> <p>[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.</p> <p>[3] The crosstalk noise impairment as defined in the REIN section of the regional annex shall be applied at both ATU-C and ATU-R.</p> <p>[4] The REIN noise impairment shall be applied at the ATU-R in addition to the crosstalk noise.</p>
Method of Procedure	<p>[1] The target margin is set according to the table in the relevant regional annex.</p> <p>[2] The link is trained in the presence of the crosstalk noise and REIN impairments.</p> <p>[3] Wait for 3 minutes after initialization for bitswaps to settle.</p> <p>[4] Record the net data rate R(kbps) and count the number of errored seconds in next period of 2min.</p>
Expected Result	<p>[1] The broadband link shall operate in the presence of the REIN.</p> <p>[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.</p> <p>[3] The number of errored seconds measured in this 2 min period shall be ≤ 1 for the test to pass.</p> <p>[4] The expected results in the regional tables A.1.8 for North America and in A.2.8 for Europe shall be met.</p>

Table 7-9/TR-100 : REIN test procedure - Fixed Rate mode

Test Configuration	<p>[1] The ATU-C and ATU-R 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.</p> <p>[2] The crosstalk noise impairment as defined in the REIN section of the regional annex shall be applied at both ATU-C and ATU-R.</p> <p>[3] The REIN noise impairment shall be applied at the ATU-R in addition to the crosstalk noise.</p>
Method of Procedure	<p>[1] The link is trained in the presence of the crosstalk noise and REIN impairments.</p> <p>[2] Wait for 3 minutes after initialization for bitswaps to settle.</p> <p>[3] Record the net data rate R(kbps) and count the number of errored seconds in the next period of 2min.</p>

Expected Result	<ul style="list-style-type: none"> [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.
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7.2.3 Common mode noise susceptibility test

For further study.

7.3 Stress Test

The purpose of the test described in table 7-10 is to verify the stability of the CPE/Drivers.

1 individual test – 1 must be passed

Table 7-10/TR-100: Stress Test

Test Configuration	<ul style="list-style-type: none"> [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 <ul style="list-style-type: none"> 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). <p>On this loop, the modems are expected to train without excess margin.</p> <ul style="list-style-type: none"> [5] Inject -130 dBm/Hz white noise disturber at both ends of the loop.
Method of Procedure	<ul style="list-style-type: none"> [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 $\text{MIN}(\text{initial_reported_margin (dB)} - 1 \text{ dB, target margin (dB)})$ 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	<ul style="list-style-type: none"> [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 7-12 Fast path.

7.4 Verification of CRC error reporting by ATU-R (Basic CRC Functionality Test)

The purpose of this test described in table 7-11 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 7-11/TR-100: Verification of CRC reporting by CPE

Test Configuration	<p>[1] The common line settings shall be according to Table 7.1.</p> <p>[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.</p> <p>[3] Testloops for Annex A.1:</p> <ul style="list-style-type: none"> • 0.4 kft, -140 dBm/Hz AWGN • 5 kft, NEXT – 5T1 (adj), -140 dBm/Hz AWGN • 13 kft, NEXT – 24HDSL, -140 dBm/Hz AWGN • 15 kft with 400 ft BT (24AWG), -140 dBm/Hz AWGN <p>Test loops for Annex A.2:</p> <ul style="list-style-type: none"> • 750m, noise FB ADSL2 impairment, A2_RA_F_16000k • 4750m, -140 dBm/Hz AWGN, A2_RA_F_16000k • 250m, noise FB ADSL2+ impairment, A2P_RA_F_30000k • 1750m, -140 dBm/Hz AWGN, A2P_RA_F_30000k <p>Test loops for Annex B:</p> <ul style="list-style-type: none"> • 750m, noise FB ADSL2 impairment, B2_RA_F_16000k • 3500m, -140 dBm/Hz AWGN, B2_RA_F_16000k • 250m, noise FB ADSL2+ impairment, B2P_RA_F_30000k • 1500m, -140 dBm/Hz AWGN, B2P_RA_F_30000k
Method of Procedure	<p>[1] Connect CPE and DSLAM under the first required loop for the regional annex and noise condition.</p> <p>[2] Force a new initialization and wait for modems to sync. Wait for 2 minutes after initialization for bitswaps to settle.</p> <p>[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.</p> <p>[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).</p> <p>[5] Repeat steps 2 to 4 for all remaining testloops required for the regional annex.</p>
Expected Result	<p>If each micro-interruption does not result in at least one reported downstream CRC error, then the ATU-R has failed the basic CRC error reporting test.</p>

7.5 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 7-12 shows how the BER shall be derived from the CRC count. Table 7-13 contains the testprocedure on margin verification.

Table 7-12/TR-100: The equations for estimating BER

Modem configuration	Equations for estimating BER
Fast path (maximum delay = S1)	$\text{BER} = \frac{\text{Number of bit errors}}{\text{Number of transmitted bits}} \cong \frac{15 * \text{CRC_error_count}}{\text{data_rate} * 1000 * \text{test_time} * 60}$
Interleaved path (maximum delay \neq S1)	$\text{BER} = \frac{\text{Number of bit errors}}{\text{Number of transmitted bits}} \cong \frac{40 * \text{CRC_error_count}}{\text{data_rate} * 1000 * \text{test_time} * 60}$

Since CRC error counts are the basis of margin verification tests, it is necessary to verify if the ATU-R accurately counts and reports CRC errors. A mandatory test procedure to verify CRC error reporting is required and defined in section 7.4.

Table 7-13/TR-100: Test procedure on Margin verification.

Test Configuration	<p>[1] The loop and noise conditions for the individual margin verification tests are described in the regional annexes.</p> <p>[2] 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 7-12 shows how the BER shall be derived from the CRC count.</p>
Method of Procedure	<p>[1] Configure CPE and DSLAM according to the testprofile as indicated in the regional annexes.</p> <p>[2] Connect CPE and DSLAM 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.</p> <p>[3] Force a new initialization and wait for modems to sync.</p> <p>[4] Wait for 3 minutes for bitswaps to settle.</p> <p>[5] Check reported margin and document as initial_reported_margin.</p> <p>[6] For CPE margin verification tests increase the noise power level by 1 dB at CPE side only. For CO margin verification tests increase the noise power level by 1 dB at CO side only.</p> <p>[7] Wait for 1 minute.</p> <p>[8] Repeat steps 6 and 7 until the noise power is increased by $\min(\text{initial_reported_margin} - 1, \text{target margin})$ dB.</p> <p>[9] At this point the power level of the noise is at the $\min(\text{initial_reported_margin} - 1, \text{target margin})$ dB level.</p> <p>[10] 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.</p> <p>[11] Repeat steps 2 to 10 for every test loop.</p> <p>In order for the BER result to be valid, the modems should not have re-initialized during steps 4 to 10. 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.</p>
Expected Result	<p>The CPE modem passes the margin verification test, if</p> <p>[1] for every test loop: Estimated BER is less than the limit value in the margin verification table of that loop option</p> <p>[2] No SES has been reported</p>

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 than 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 $\min(\text{initial_reported_margin} - 1, \text{target margin})$ 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 7-12. 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".

8. Higher Layer Test Cases

8.1 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.

8.1.1 Packet Throughput Test

The purpose of the test contained in table 8-2 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 specifically defines the packet or frame size in terms of the MAC frame, and hence is not the IP packet size.

Throughput shall be measured for MAC frame length (see RFC 1242 [17] Section 3.5).

The packet throughput requirements in the tables 8-3, 8-4 and 8-5 includes trailer overhead for AAL5 CPCS-PDU without preservation of the Ethernet FCS.

The DSLAM is configured similar to the fixed profile A2P_Fix_F_10000k, but with the bitrates configured as in table 8-1.

Table 8-1/TR-100: Packet Throughput Test bitrates

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

42 individual tests – 42 tests must be passed

Table 8-2/TR-100: Packet Throughput Test

Test Configuration	<ul style="list-style-type: none"> [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.
Method of Procedure	<ul style="list-style-type: none"> [1] Configure the DSLAM similar to the fixed profile A2P_Fix_F_10000k, but with the bitrates configured as in table 8-1 for each of the throughput tables 8-3 to 8-5. [2] Let the CPE train. [3] Setup traffic generator/analyzer to perform throughput test for selected frame length and connect rate. [4] Set the throughput rate of the upstream direction to 50% of the maximum theoretical value sustainable by the ADSL2/ADSL2plus net data rate. [5] 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. [6] Set the throughput rate of the downstream direction to 50% of the maximum theoretical value sustainable by the ADSL2/ADSL2plus net data rate. [7] 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. [8] Divide the analyzer frames per second by the maximum FPS for the connect rate and frame size. [9] 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 8-3/TR-100:Throughput Test Results: Connect Rates DS: 12000 kpbs US: 800 kbps.

Analyzer Recorded FPS			Max FPS		% of Max		Pass/Fail (85% limit)	
Frame Size	DS	US	DS	US	DS	US	DS	US
64			14150	943				
128			7075	471				
256			4716	314				
512			2358	157				
1024			1286	85				
1280			1010	67				
1514			884	58				

Table 8-4/TR-100:Throughput Test Results: Connect Rates DS: 18000 kpbs US: 800 kbps.

Analyzer Recorded FPS			Max FPS		% of Max		Pass/Fail (85% limit)	
Frame Size	DS	US	DS	US	DS	US	DS	US
64			21226	943				
128			10613	471				
256			7075	314				
512			3537	157				
1024			1929	85				
1280			1516	67				
1514			1326	58				

Table 8-5/TR-100: Throughput Test Results: Connect Rates DS: 24000 kpbs US: 800kbps.

Analyzer Recorded FPS			Max FPS		% of Max		Pass/Fail (85% limit)	
Frame Size	DS	US	DS	US	DS	US	DS	US
64			28301	943				
128			14150	471				
256			9433	314				
512			4716	157				
1024			2572	85				
1280			2021	67				
1514			1768	58				

8.2 RFC2516 [12] PPPoE Throughput Test

Table 8-6 describes the test procedure for the PPPoE packet throughput test

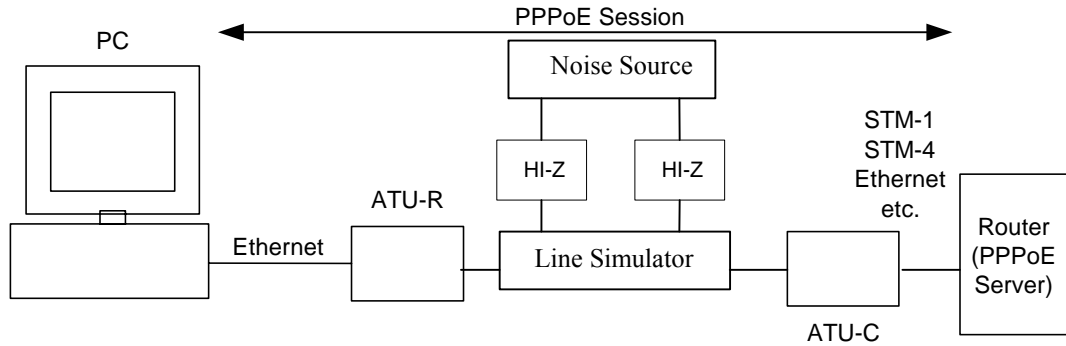


Figure 8/TR-100: Test setup for PPPoE testing with Ethernet modems

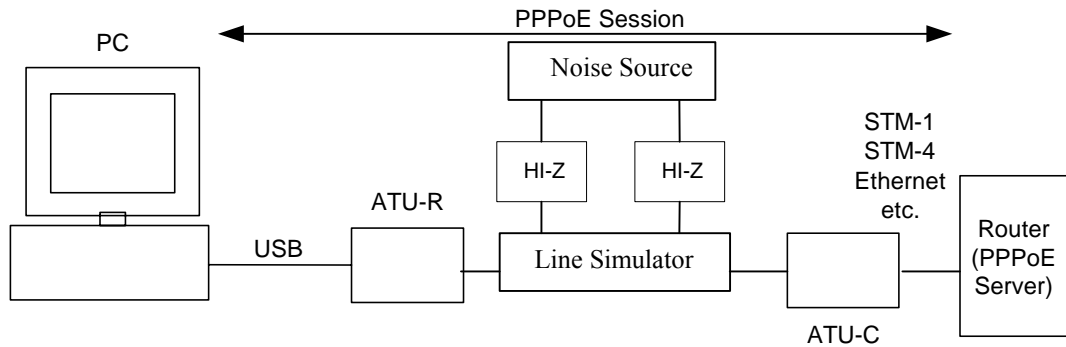


Figure 9/TR-100: Test setup for PPPoE testing with USB modems

2 individual tests – 2 tests must be passed

Table 8-6/TR-100: PPPoE Packet Throughput Test

Methodology	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.
Test Configuration	<ul style="list-style-type: none"> [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) must 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	<ul style="list-style-type: none"> [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 data rate.
Expected Result	[1] In both the upstream and downstream directions, the ratio shall equal or exceed 0.84.

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

Table 8-7 describes the testprocedure for the PPPoA end-to-end connectivity test.

1 individual test – 1 must be passed

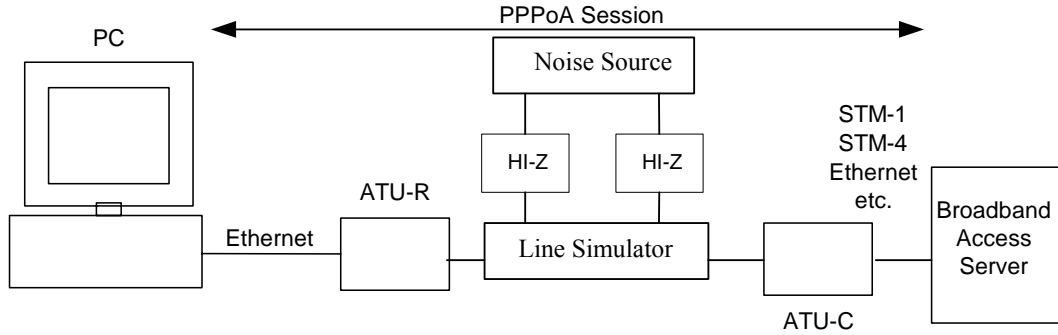


Figure 10/TR-100: Test setup for PPPoA testing with Ethernet modems

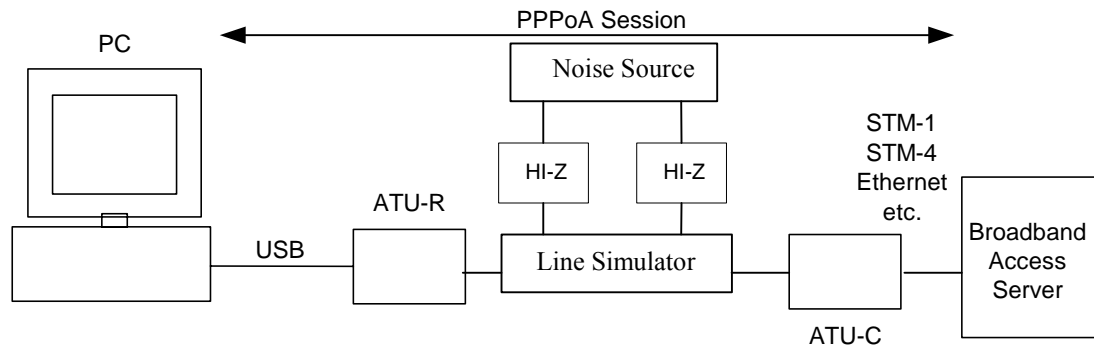


Figure 11/TR-100: Test setup for PPPoA testing with USB modems

Table 8-7/TR-100: 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.

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

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

1 individual test – 1 must be passed

Table 8-8/TR-100: Verify IP Bridged RFC 2684 [11]

Test Configuration	[1] See Figure 4, applicable to Ethernet modem only
Method of Procedure	<p>[1] Configure the test environment including the ATU-R and the computer so that the ATU-R/CPE Ethernet port terminates a bridge section.</p> <p>[2] The second termination of the bridge section should be implemented at an appropriate device within the testing environment (e.g. DSLAM, PoP).</p> <p>[3] Pass IP packets over the complete bridge section and verify the proper reception at the destination (e.g. PoP, Host PC).</p>
Expected Result	[1] Transmitted packets are received.

8.5 Power Cycle Test

Table 8-9 describes the testprocedure for the power cycle test.

1 individual test - 1 must be passed

Table 8-9/TR-100: Power Cycle Test

Test Configuration	The configuration shall be as shown in Figures 5 - 7, depending on customer interface of modem (no loop length, bridge tap nor noise injected)
Method of Procedure	<p>[1] Connect Modem to test setup.</p> <p>[2] Configure the DSLAM with testprofile AU_RA_I_30000k and the maximum delay set to 8 ms</p> <p>[3] Train modem.</p> <p>[4] Follow procedure to establish a data link, if necessary.</p> <p>[5] Send arbitrary data (verify received).</p> <p>[6] Disconnect power from modem for 30 seconds.</p> <p>[7] Allow modem to train.</p> <p>[8] Follow procedure to re-establish the data link.</p> <p>[9] Re-connect power cable.</p> <p>[10] Send arbitrary data (verify received).</p>
Expected Result	Modem re-powers. 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 12. A 0ft bridge tap may be attached to the ATU-R end of the straight loop during testing. Bridged Tap loops shall use the loop configuration shown in Figure 13.

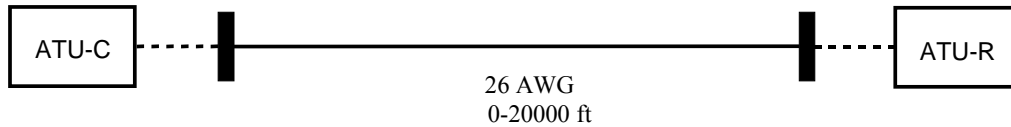


Figure 12/TR-100 Straight Loop Configuration

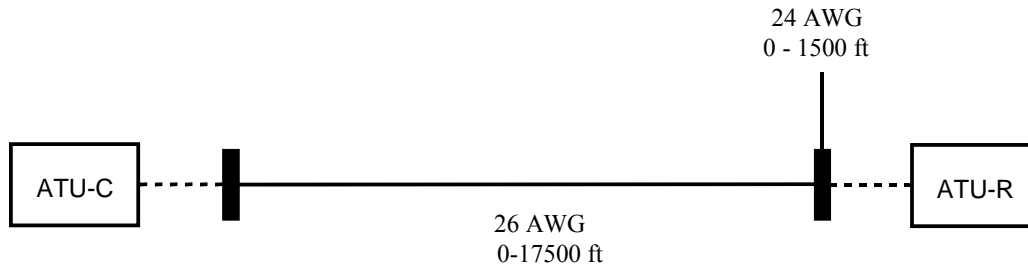


Figure 13/TR-100 Bridged Tap Loop Configuration

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/TR-100 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 testprocedure for the margin verification tests in tables A.1-2 up to A.1-8.

Table A.1-2/TR-100: 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 7-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
3	10				

Table A.1.3/TR-100: 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 7-12, interleaved path If: Estimated BER < 1.5e-7 then PASS else FAIL	Pass / Fail
5	10				

Table A.1-4/TR-100: 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 7-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
12 with 750ft BT (24AWG)	55				

Table A.1-5/TR-100: 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 7-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
13	45				

Table A.1-6/TR-100: 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 7-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
15 with 400ft BT (24WG)	55				

Table A.1-7/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: Operation in the Presence of Impulse Noise Events

Test Configuration	<ul style="list-style-type: none"> [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	<ul style="list-style-type: none"> [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/TR-100: Verification of downstream bi/gi values

Test Configuration	<p>The ATU-C and ATU-R are connected in turn through 3 randomly selected loops (one from each of the sets below)</p> <p><u>Testloops:</u></p> <p><u>Set 1 (short loops):</u></p> <ul style="list-style-type: none"> • 1 kft, FEXT – 12 ADSL2Plus, -140 dBm/Hz AWGN • 2 kft, -140 dBm/Hz AWGN • 9 kft, NEXT + FEXT - 12 ADSL2Plus, -140 dBm/Hz AWGN • 9 kft, NEXT - 5 T1 adjacent, -140 dBm/Hz AWGN • 9 kft, NEXT – 24HDSL, -140dBm/Hz AWGN <p><u>Set 2 (long loops):</u></p> <ul style="list-style-type: none"> • 12 kft, NEXT + FEXT - 12 ADSL2Plus, -140 dBm/Hz AWGN • 12 kft, -140 dBm/Hz AWGN • 13kft, NEXT – 24HDSL, -140dBm/Hz AWGN • 15 kft, NEXT - 5 T1 adjacent, -140 dBm/Hz AWGN • 18 kft, -140 dBm/Hz AWGN <p><u>Set 3 (bridge tap loops)</u></p> <ul style="list-style-type: none"> • 3 kft with 100 ft BT (24AWG), -140 dBm/Hz AWGN • 5 kft with 50 ft BT (24AWG), NEXT + FEXT - 12 ADSL2Plus, -140 dBm/Hz AWGN • 5 kft with 200 ft BT (24AWG), NEXT + FEXT - 12 ADSL2Plus, -140 dBm/Hz AWGN • 5 kft with 200 ft BT (24AWG), -140 dBm/Hz AWGN • 9 kft with 100 ft BT (24AWG), -140 dBm/Hz AWGN • 11 kft with 200 ft BT (24AWG), -140 dBm/Hz AWGN
Method of Procedure	<p>[1] Select randomly one testloop from the set 1 above.</p> <p>[2] Train the modem using the testprofile AU_RA_L_30000k.</p> <p>[3] From the DSLAM read the bi and gi values requested during initialization</p> <p>[4] Repeat steps 1 to 3 for one other randomly selected loop from set 2.</p> <p>[5] Repeat steps 1 to 3 for one other randomly selected loop from set 3.</p>
Expected Result to Pass	<p>The RMSGIDs shall be calculated in linear scale with g_i values as contained in the BiGi table and then rounded to nearest 100^{th} of a dB.</p> <p>The b_i and g_i values rounded to the nearest 100^{th} 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])</p> <p>[1] All b_i values shall be in the [0 to BIMAXds] (bits) range, where $8 \leq \text{BIMAXds} \leq 15$.</p> <p>[2] If $b_i > 0$, then g_i shall be in the $[-14.54 \text{ to } +2.50 + \text{EXTGIDs}]$ (dB) range where $0 \leq \text{EXTGIDs} \leq \text{MAXNOMPSDds} - \text{NOMPSDds}$.</p>

	<p>[3] RMSGIds \leq EXTGIds + 1/16th of a dB</p> <p>[4] If $b_i > 0$, then g_i shall be in the [RMSGIds - 2.60 to RMSGIds + 2.60] (dB) range.</p> <p>[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.</p> <p>BIMAXds, EXTGIds, MAXNOMPSDds, NOMPSDds, RMSGIds are defined in G.992.3[1] Sections 8.5.1 and 8.5.2.</p>
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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/TR-100: 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
≥ 6	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 ATU-C/ATU-R 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 ATU-C/ATU-R pair fails the *noise margin* requirements of that section.
- If more than 25% of the reported downstream noise margins are less than 6dB in a section, then the ATU-C/ATU-R 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 ATU-C/ATU-R 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 ATU-C/ATU-R 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/TR-100: Reported Margin Requirements

Section number	Number of test cases	10% limit	25% limit (applies to downstream 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 must be passed

Table A.1-13/TR-100: 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 dBm/Hz AWGN	-140 dBm/Hz AWGN	900				n/a	n/a	n/a	n/a	
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				

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			
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					
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	12 ADSL2plus Up Next+Dn	900				11001					

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	Fext, -140 dBm/Hz AWGN									
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 must be passed

Table A.1-14/TR-100: -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				

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		
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 must be passed

Table A.1-15/TR-100: -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 must be passed

Table A.1-16/TR-100: -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 must be passed

Table A.1-17/TR-100: 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 must be passed

Table A.1-18/TR-100: 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								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				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 ATU-C/ATU-R 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 ATU-C/ATU-R pair fails the *noise margin* requirements of that section.
- If more than 25% of the reported downstream noise margins are less than 6dB in a section, then the ATU-C/ATU-R 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 ATU-C/ATU-R pair fails the *data rate* requirements of that section.

If the ATU-C/ATU-R 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/TR-100: 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 must be passed

Table A.1-20/TR-100: 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 must be passed

Table A.1-21/TR-100: -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/TR-100: -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 must be passed

Table A.1-23/TR-100: 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 must be passed

Table A.1-24/TR-100: 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 6-14/G.9954 and is shown in [14] Figure 6-19/G.9954

SRA (seamless rate adaptation) capability shall be switched off during the test.

Table A.1-25/TR-100 : ADSL2plus and G.pnt coexistence

Test Configuration	The test set up is as shown in figure 14.
Details of Test Procedure	<p>[1] Configure CPE and DSLAM according to the testprofile AU_RA_I_30000k.</p> <p>[2] Configure a testloop of 3kft 26AWG. Connect CPE and DSLAM to the testloop. Apply the G.pnt noise at the ATU-R,</p> <p>[3] Force initialization and wait for modem to sync.</p> <p>[4] Wait for 3 minutes after initialization for bitswaps to settle.</p> <p>[5] Record the net data rate R(kbps).</p> <p>[6] Switch the noise to -140dBm/Hz AWGN and wait for 1 minute.</p> <p>[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:</p> $T = 400/(R*1000*1e-7*60) \text{ (min)}$ <p>and estimate the BER (P1) using Table7-12, interleaved path.</p> <p>[8] Switch the noise back to G.pnt and wait for 1 minute.</p> <p>[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 7-12, interleaved path.</p> <p>[10] Repeat steps [2] to [9] for testloops 5kft 26Awg and 7 kft 26AWG</p>
Expected Result	<p>The CPE modem passes the G.pnt co-existence test, if for each testloop,</p> <ul style="list-style-type: none"> (a) The modem does not re-initialize during the test (b) The estimated BER P1 and P2 are $< 1.5e-7$ (c) $R = R1 = R2$

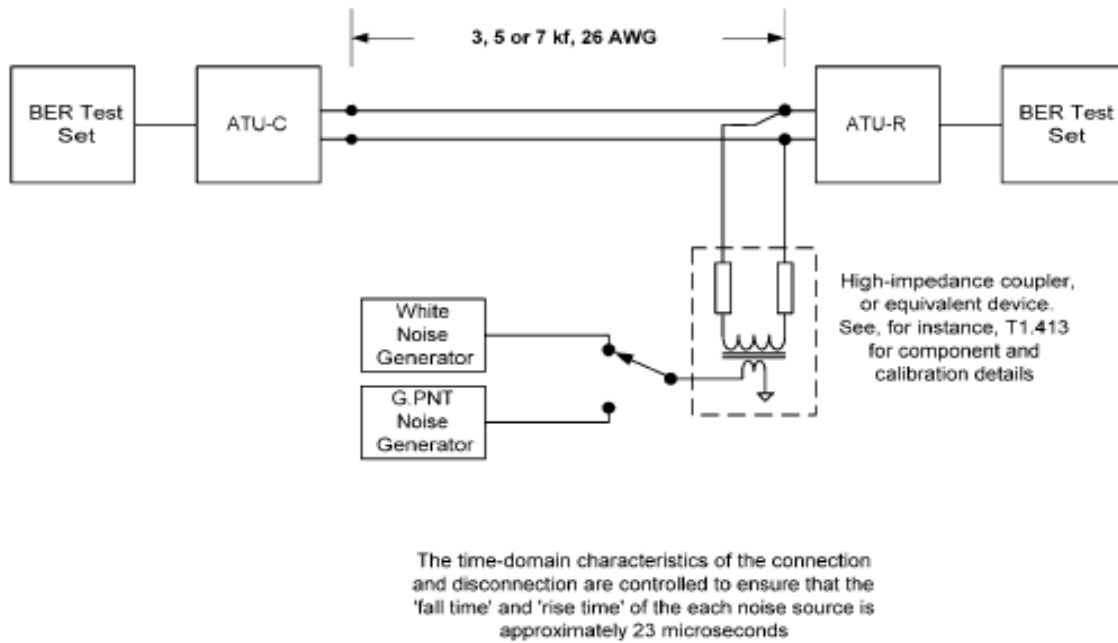


Figure 14/TR-100: G.pnt test setup

A.1.8 REIN noise impairment

This section is for further study.

A.2 European Test set

The specific test profiles 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 test section. 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 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 7-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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

**Table A.2-6/TR-100: Noise FB ADSL2plus impairment, testprofile
A2P_RA_I_30000k, at 1750 m.**

Loop length (m) 0.4mm	Test time (minutes)	Anticipated DS net data rate: >= 9296 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 7-12, 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 in section A.2.1.3, using testprofile A2P_RA_I_30000k

**Table A.2-7/TR-100: 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 7-12, 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 test procedure 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: Verification of downstream bi/gi values for ADSL2

Test Configuration	<p>The ATU-C and ATU-R are connected in turn through the following loops:</p> <ul style="list-style-type: none"> [1] ETSI loop #1, 1250 m, -140 dBm/Hz AWGN, testprofile A2_RA_F_16000k [2] ETSI loop #1, 3250 m, -140 dBm/Hz AWGN, testprofile A2_RA_I/2_16000k [3] ETSI loop #1, 750 m, noise FB, testprofile A2_RA_I_16000k [4] ETSI loop #1, 2750 m, noise FB, testprofile A2_RA_F_16000k
Method of Procedure	<ul style="list-style-type: none"> [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	<p>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])</p> <ul style="list-style-type: none"> [1] All b_i values shall be in the [0 to BIMAXds] (bits) range, where $8 \leq \text{BIMAXds} \leq 15$. [2] If $b_i > 0$, then g_i shall be in the [-14.54 to +2.50 + EXTGIds] (dB) range where $0 \leq \text{EXTGIds} \leq \text{MAXNOMPSDds} - \text{NOMPSDds}$. [3] $\text{RMSGIds} \leq \text{EXTGIds} + 1/16^{\text{th}}$ of a dB. [4] If $b_i > 0$, then g_i shall be in the [$\text{RMSGIds} - 2.60$ to $\text{RMSGIds} + 2.60$] (dB) range. [5] If $b_i = 0$, then g_i shall be equal to 0 (linear) or in the [-14.54 to $\text{RMSGIds} + 0.10$] (dB) range. <p>BIMAXds, EXTGIds, MAXNOMPSDds, NOMPSDds, RMSGIds are defined in G.992.3[1] Sections 8.5.1 and 8.5.2.</p>

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/TR-100: Verification of downstream b_i/g_i values for ADSL2plus

Test Configuration	<p>The ATU-C and ATU-R are connected in turn through the following loops:</p> <p>[1] ETSI loop #1, 250 m, -140 dBm/Hz AWGN, testprofile A2P_RA_F_30000k</p> <p>[2] ETSI loop #1, 1750 m, -140 dBm/Hz AWGN, testprofile A2P_RA_I_30000k</p> <p>[3] ETSI loop #1, 250 m, noise FB, testprofile A2P_RA_I_30000k</p> <p>[4] ETSI loop #1, 1750 m, noise FB, testprofile A2P_RA_F_30000k</p>
Method of Procedure	<p>[1] Select test loop 1 from the set above.</p> <p>[2] Train the modem in the test profile defined for the selected loop.</p> <p>[3] From the DSLAM read the b_i and g_i values requested during initialization</p> <p>[4] Repeat steps 1 to 3 for other test loops in the set.</p>
Expected Results	<p>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])</p> <p>[1] All b_i values shall be in the [0 to BIMAXds] (bits) range, where $8 \leq \text{BIMAXds} \leq 15$.</p> <p>[2] If $b_i > 0$, then g_i shall be in the [-14.54 to +2.50 + EXTGIds] (dB) range where $0 \leq \text{EXTGIds} \leq \text{MAXNOMPSDds} - \text{NOMPSDds}$.</p> <p>[3] $\text{RMSGIds} \leq \text{EXTGIds} + 1/16^{\text{th}}$ of a dB</p> <p>[4] If $b_i > 0$, then g_i shall be in the [RMSGIds - 2.60 to RMSGIds + 2.60] (dB) range.</p> <p>[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.</p> <p>BIMAXds, EXTGIds, MAXNOMPSDds, NOMPSDds, RMSGIds are defined in G.992.3[1] Sections 8.5.1 and 8.5.2.</p>

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/TR-100: Reported Margin Requirements

Section number	Number of test cases	10% limit	25% limit (applies to downstream 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 must be passed

Table A.2-15/TR-100: 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 must be passed

Table A.2-16/TR-100: 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 impairment

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 must be passed

Table A.2-17/TR-100: 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 must be passed

Table A.2-18/TR-100: 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 must be passed

Table A.2-19/TR-100: 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 must be passed (applies to Class A implementations only)

Table A.2-20/TR-100: 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 must be passed (optional for class A implementations)

Table A.2-21/TR-100: 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 must be passed

**Table A.2-22/TR-100: 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 must be passed (applies to Class A implementations only)

**Table A.2-23/TR-100: 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 must 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 must be passed

Table A.2-24/TR-100: 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 ≥ 4 dB and < 6 dB, 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 ≥ 6 dB.
- If the final upstream or downstream reported noise margin (from step 1 above) is less than 6dB on any test point, then the ATU-C/ATU-R 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/TR-100: 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)
0			
750			
1250			
1500			

b) Testprofile A2_Fix_F_5952k

4 individual tests – 4 shall be passed

Table A.2-26/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: Reported Margin Requirements

Section number	Number of test cases	10% limit	25% limit (applies to downstream 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 must be passed

**Table A.2-40/TR-100: 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 must be passed

Table A.2-41/TR-100: 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 ATU-C and ATU-R

In addition to the crosstalk noise at ATU-R, 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 must be passed

Table A.2-42/TR-100: REIN noise impairment, rate adaptive profile

A2P_RA_I_30000k with max delay=8ms							
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
1050	6		7644				
1750	9		3900				
2450	9		1900				
3150	9		600				

Table A.2-43/TR-100 : REIN noise impairment, fixed rate profile

Testprofile A2(P)_FIX_I_X, with max delay= 8ms						
Loop length (m, ETSI loop #1.)	Testprofile, with delay set to 8 ms.	Modem Trained and did not lose sync? (Y/N)	Downstream Noise Margin, Reported (dB)	Measured D/S Bit Rate	Measured D/S Errored Seconds	Pass / Fail
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/TR-100: Reported Margin Requirements

Section number	Number of test cases	10% limit	25% limit (applies to downstream 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 must be passed

Table A.3-2/TR-100: 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/TR-100: 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/TR-100: 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 must be passed

**Table A.3-5/TR-100: 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/TR-100: 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/TR-100: 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 must be passed

**Table A.3-8/TR-100: 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/TR-100: 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/TR-100: 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 must be passed

**Table A.3-11/TR-100: 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/TR-100: 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/TR-100: 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			

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 ATU-C and ATU-R 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:

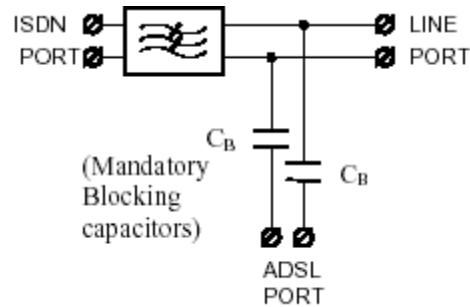


Figure B.1: structure of the ADSL/ISDN and ADSL/'ISDN or POTS' universal splitter

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,d G2 and G4 for ADSL2, Annex B

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 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

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/TR-100: Noise margin chart

Reported Noise Margin (dB)	Requirement
< 5	On no test point
>= 5 and < 6	On at most 10% of the test points
>= 6	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 ATU-C/ATU-R pair fails the noise margin requirements of that section.
- If more than 10% of the reported noise margins are less than 6dB in a section, then the ATU-C/ATU-R 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 ATU-C/ATU-R pair fails the data rate requirements of that section.
- If the ATU-C/ATU-R 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 6 dB, then the ATU-C/ATU-R 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 ATU-C/ATU-R pair fails the data rate requirements of that section.
- If the ATU-C/ATU-R 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/TR-100: 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 B.1.4.

Table B.1-3/TR-100: 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	28	3
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/TR-100: 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, interleaved path If: Estimated_BER < 1.5e-7 then PASS else FAIL	Pass / Fail
Loop Selected					

Note: The table B.2-4/TR-100 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/TR-100: 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 $\text{Min}(\text{initial_reported_margin} - 1, \text{target_margin})$ dB	Estimated BER, based on equations in Table 7-12, 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/TR-100: 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 $\text{Min}(\text{initial_reported_margin} - 1, \text{target_margin})$ dB	Estimated BER, based on equations in Table 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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 b_i/g_i Values

Table B.2-9 describes the test procedure for the verification of downstream b_i/g_i values in ADSL2 operating mode.

Table B.2-10/TR-100: Verification of downstream b_i/g_i values

Test Configuration	<p>The ATU-C and ATU-R are connected in turn through the following loops:</p> <ul style="list-style-type: none"> [1] ETSI loop #1, 750 m with -140 dBm/Hz AWGN, testprofile B2_RA_F_16000k [2] ETSI loop #1, 2750 m with -140 dBm/Hz AWGN, testprofile B2_RA_I_16000k [3] ETSI loop #1, 750 m with noise FB as defined in section B.1.3.1, testprofile B2_RA_I_16000k [4] ETSI loop #1, 2750 m with noise FB as defined in section B.1.3.1, testprofile B2_RA_F_16000k
Method of Procedure	<ul style="list-style-type: none"> [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	<p>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])</p> <ul style="list-style-type: none"> [1] All b_i values shall be in the [0 to BIMAXds] (bits) range, where $8 \leq \text{BIMAXds} \leq 15$. [2] If $b_i > 0$, then g_i shall be in the [-14.54 to +2.50 + EXTGIds] (dB) range where $0 \leq \text{EXTGIds} \leq \text{MAXNOMPSDds} - \text{NOMPSDds}$. [3] $\text{RMSGIds} \leq \text{EXTGIds} + 1/16^{\text{th}}$ 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. <p>BIMAXds, EXTGIds, MAXNOMPSDds, NOMPSDds, RMSGIds are defined in G.992.3[1] Sections 8.5.1 and 8.5.2.</p>

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 must be passed

Table B.2-11/TR-100: 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 must be passed

Table B.2-12/TR-100: 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 must be passed

Table B.2-13/TR-100: 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 must be passed

Table B.2-14/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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)
500						
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/TR-100: 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 than the failing loop length of step 5.) If the CPE connects record the reported upstream and downstream margin.
Expected Result to Pass	If the modem reaches showtime for a certain loop length, then the related reported noise margin must meet the pass/fail criteria for the rate adaptive tests (10% limit) as stated in section B.1.4.

Table B.2-22/TR-100: 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/TR-100: Target noise margin consideration downstream

Test Configuration	<p>[1] Rate parameters acc. B2_Fix_F_3456k.</p> <p>[2] Set noise generators G4 to apply white noise impairment as defined in section B1.3.</p>
Method of Procedure	<p>[1] Start test at maximum length from test B.2.5.1 b) at which the modem was able to train successfully</p> <p>[2] Allow to train for 60 seconds to achieve showtime.</p> <p>[3] Record the upstream and downstream reported noise margin in the table below. (Read the margin one minute after show time is reached.)</p> <p>[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</p> <p>[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.</p> <p>[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.</p>
Expected Result to Pass	If the modem reaches showtime for a certain loop length, then the related reported noise margin must meet the pass/fail criteria as stated in section B.1.4.

Table B.2-24/TR-100: 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/TR-100: ADSL2 performance in L2 mode

Test Configuration	<p>In addition to the configuration of section B.1 the following has to be defined:</p> <p>[1] Test configuration: Figure 4 to Figure 6, depending on customer interface of modem.</p> <p>[2] Configure the line with testprofile B2_RA_I_16000k (note 1).</p> <p>[3] PMMode: Low power state allowed (bit 0 = 0, bit 1 = 1).</p> <p>[4] PM-Parameters:</p> <ul style="list-style-type: none"> i. Minimum (Net) Data rate DS in Low Power state(L2Min): 128 kbps ii. L0-TIME: 60 sec. iii. L2-TIME: 15 sec. iv. L2-ATPR: 3 dB v. L2-ATPRT: 18 dB <p>[5] Set loop simulator to: 2000 m with ETSI loop #1.</p> <p>[6] Set noise generators for model ADSL2 FB impairment as defined in section B1.3.1.</p>
Method of Procedure	<p>[1] Traffic generator/analyzer switched off or 120kbps DS traffic</p> <p>[2] Synchronize the line with the required parameters and note the actual downstream sync rate and noise margin (first L0 noise margin) value.</p> <p>[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.</p> <p>[4] After 5 minutes: read the actual downstream noise margin value (L2 noise margin) and DS Tx power (ACTATPds)</p> <p>[5] Switch on traffic generator with 90% of DS sync rate, to exit from L2 state to L0 state.</p> <p>[6] Wait 60 seconds and read the actual DS noise margin (second L0 noise margin) value.</p>
Expected Result to Pass	<p>[1] First L0 noise margin \geq 5 dB.</p> <p>[2] L2 noise margin \geq 5 dB.</p> <p>[3] Second L0 noise margin \geq first L0 noise margin –1 dB.</p> <p>[4] No CRC error during the entire test.</p>

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/TR-100: 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: 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 7-12, 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/TR-100: Verification of downstream bi/gi values

Test Configuration	<p>The ATU-C and ATU-R are connected in turn through the following loops:</p> <ul style="list-style-type: none"> [1] ETSI loop #1, 250 m, -140 dBm/Hz AWGN, testprofile B2P_RA_F_30000k [2] ETSI loop #1, 1750 m, -140 dBm/Hz AWGN, testprofile B2P_RA_I_30000k [3] ETSI loop #1, 250 m, noise FB as defined in section B.1.3.3, testprofile B2P_RA_I_30000k [4] ETSI loop #1, 1750 m, noise FB as defined in section B.1.3.3, testprofile B2P_RA_F_30000k
Method of Procedure	<ul style="list-style-type: none"> [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	<p>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])</p> <ul style="list-style-type: none"> [1] All b_i values shall be in the [0 to BIMAXds] (bits) range, where $8 \leq \text{BIMAXds} \leq 15$. [2] If $b_i > 0$, then g_i shall be in the [-14.54 to +2.50 + EXTGIds] (dB) range where $0 \leq \text{EXTGIds} \leq \text{MAXNOMPSDds} - \text{NOMPSDds}$. [3] $\text{RMSGIds} \leq \text{EXTGIds} + 1/16^{\text{th}}$ 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 must be passed

Table B.3-12/TR-100: 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 must be passed

Table B.3-13/TR-100: 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 must be passed

Table B.3-14/TR-100: 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	1208				13000			
250	1152				13000			
750	1000				13000			
1250	816				11208			
1750	600				7856			
2500	280				2760			
2750	184				1520			

14 individual tests – 12 must be passed

**Table B.3-15/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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/TR-100: 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 to Pass	If the modem reaches showtime for a certain loop length, then the related reported noise margin must meet the pass/fail criteria as stated in section B.1.4.

Table B.3-25/TR-100: 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				
200				
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/TR-100: Target noise margin consideration downstream

Test Configuration	<p>[1] Rate parameters acc. B2P_Fix_F_3456k.</p> <p>[2] Set noise generators G4 to apply white noise impairment as defined in section B1.3.</p>
Method of Procedure	<p>[1] Start test at maximum length from test B.2.5.1 b) at which the modem was able to train successfully</p> <p>[2] Allow to train for 60 seconds to achieve showtime.</p> <p>[3] Record the upstream and downstream reported noise margin in the table below. (Read the margin one minute after show time is reached.)</p> <p>[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</p> <p>[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.</p> <p>[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.</p>
Expected Result to Pass	<p>If the modem reaches showtime for a certain loop length, then the related reported noise margin must meet the pass/fail criteria for the rate adaptive tests (10% limit) as stated in section B.1.4.</p>

Table B.3-27/TR-100: 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/TR-100: ADSL2plus performance in L2 mode

Test Configuration	<p>For this test the following parameters have to be configured in addition to the defined parameters in B1.3:</p> <p>[1] Test configuration: see figures 4 to 6, depending on customer interface of modem.</p> <p>[2] Configure the line with testprofile B2P_RA_I_30000k (note 1)</p> <p>[3] PMMode: Low power state allowed (bit 0 = 0, bit 1 = 1)</p> <p>[4] PM-Parameters:</p> <ul style="list-style-type: none"> i. Minimum (Net) Data rate DS in Low Power state(L2Min): 128 kbps ii. L0-TIME: 60 sec. iii. L2-TIME: 15 sec. iv. L2-ATPR: 3 dB v. L2-ATPRT: 18 dB <p>[5] Set loop simulator to: 1500 m with ETSI loop #1.</p> <p>[6] Set noise generators for model ADSL2plus FB impairment as defined in section B1.3.2.</p>
Method of Procedure	<p>[1] Traffic generator/analyzer switched off or 120 kbps DS traffic</p> <p>[2] Synchronize the line with the required parameters and note the actual downstream sync rate and noise margin (first L0 noise margin) value.</p> <p>[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.</p> <p>[4] After 5 minutes read the actual downstream noise margin value (L2 noise margin) and DS Tx power (ACTATPds).</p> <p>[5] Switch on traffic generator with 90% of DS sync rate, to exit from L2 state to L0 state.</p> <p>[6] Wait 60 seconds and read the actual DS noise margin (second L0 noise margin) value.</p>
Expected Result to Pass	<p>[1] first L0 noise margin ≥ 5.0 dB.</p> <p>[2] L2 noise margin ≥ 5.0 dB.</p> <p>[3] Second L0 noise margin \geq first L0 noise margin -1 dB.</p> <p>[4] No CRC error during the entire test.</p>

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/TR-100: 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: <ul style="list-style-type: none"> 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 to Pass	[1] fast and stable synchronization. [2] DS Bitrate: see table B.3-30. [3] noise margin \geq 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 must be passed

Table B.3-30/TR-100: performance requirements for Tests B.3.7

loop length [m, loop#1]	DS sync rate [kbps]		Downstream Noise Margin, Reported (dB)	Pass / Fail
	expected	measured		
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/TR-100: ADSL2plus performance with DS-PSD mask above ADSL

Test Configuration	<p>For this test the following parameters have to be configured in addition to the defined parameters in B1.2:</p> <p>[1] Testprofile: B2P_RA_F_30000k</p> <p>[2] RFIBANDds and PSDMASKds parameters:</p> <ul style="list-style-type: none"> ▪ 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, <p>[3] Set noise generators for model ADSL2plus FB impairment as defined in section B1.3.2.</p>
Method of Procedure	<p>Steps per loop length:</p> <p>[1] Synchronize the line with the required parameters.</p> <p>[2] Note the actual downstream bitrate.</p> <p>[3] After 60 seconds note the reported DS noise margin.</p>
Expected Result to Pass	<p>[1] Fast and stable synchronization</p> <p>[2] DS Bitrate: see table B.3-32</p> <p>[3] Noise margin ≥ 5.0 dB</p>

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 must be passed

Table B.3-32/TR-100: 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			

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/TR-100: 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/TR-100: 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/TR-100 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/TR-100 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/TR-100 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/TR-100 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/TR-100 19ADSL2plus 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/TR-100: 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/TR-100: 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	3001.5	-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	3001.5	-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		

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 test methodology 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 were 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 (R_r) which is determined by taking the lowest rates out of N rates ($R_i: I=1\dots N$) 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 below equation:

$$\begin{aligned} Prob(R_r) = & Prob(R1=R_r) * Prob(R1 < All other Ri) + \\ & Prob(R2=R_r) * Prob(R2 < All other Ri) + \\ & \dots \\ & Prob(RN=R_r) * Prob(RN < All other Ri) + \end{aligned}$$

Therefore:

$$PDF(R_r) = N * PDF_gaussian(R_r) * (CDF_gaussian(R_r))^{(N-1)}$$

This is illustrated in Figure 1. In this figure the distributions are plotted in function of the “normalised R”:

$$\text{Normalised_R} = (R - R_mean) / R_sigma$$

With

R_mean = mean value of rates R - distribution

R_sigma = variance of rates R -distribution.

The solid curve gives the gaussian PDF of the individual rates R_i . The dashed curve gives the PDF of the rate-requirement R_r for $N=4$ as in [Annex Y].

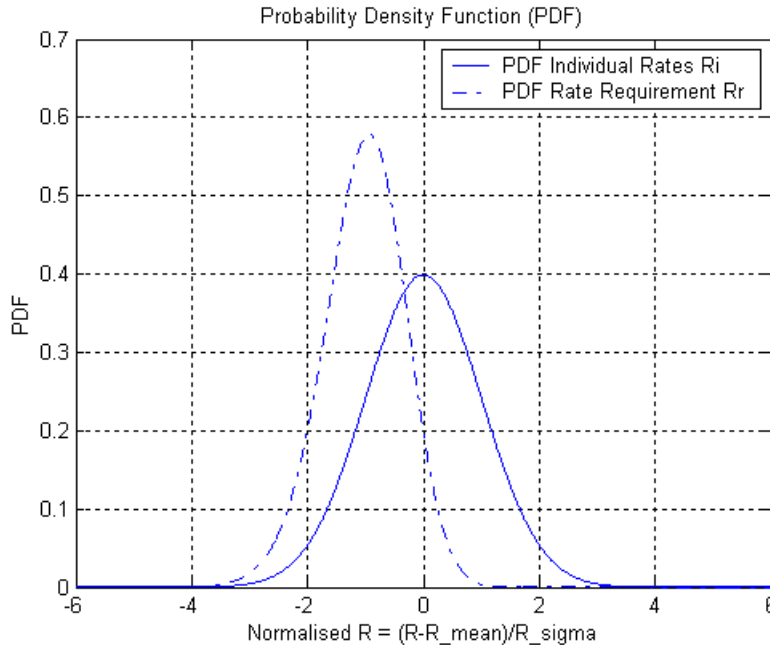


Figure W.1 PDF of the individual rates R_i , and the Rate-requirement R_r .

The overlapping part in Figure 1 correspond with modem-units for which $R_i < R_r$, 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 :

$$\text{Failprobability} = \int_{-\infty}^{+\infty} \text{Prob}(R_r) * \text{Prob}(R_i < R_r) * dR_r$$

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*)

The following logic was used to compute the Maximum number of Frames per Second (MAX FPS), testsection 8.1, given a data rate at the ATM layer, and a frame size. The RFC-2684 encapsulation (LLC bridging) process adds 10 bytes per frame. The AAL5 CPCS-PDU includes an 8-byte trailer. Therefore, the number of cells required, for each frame, is as follows:

$$\text{ATM cells per frame} = \text{ceil}\left(\frac{\text{frame size} + 18}{48}\right)$$

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

$$\text{ATM layer bits per frame} = 53 \times 8 \times \text{ATM cells per frame}$$

Finally, since the data rate is that rate available to the ATM layer, the Maximum number of Frames per Second (Max FPS) is:

$$\text{Max FPS} = \text{floor}\left(\frac{\text{data rate}}{\text{ATM layer bits per frame}}\right),$$

In the above, the data rate is in bits per second, and the *floor* function rounds down to the next integer value.

The calculated framerate in section 8 of this document is based on a frame size without preservation of Ethernet FCS.

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