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TECHNICAL REPORT

TR-105
ADSL2/ADSL2plus Functionality Test Plan

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Executive Summary

TR-105, as part of the Broadband Suite, provides a set of test methods to verify a significant subset of the transceiver functional requirements of ADSL2/ADSL2plus modems implemented in accordance with ITU-T G.992.3 "*Asymmetric digital subscriber line transceivers 2 (ADSL2)*" and ITU-T G.992.5 "*Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)*" as well as physical layer OAM configuration and performance monitoring parameters defined in ITU-T G.997.1. Its key value is in the verification of transceiver functionalities and management parameters such that network operators may deploy interoperable and successful ADSL2/ADSL2plus services in their networks.

TR-105 accompanies TR-100 "*ADSL2/ADSL2plus Performance Test Plan*" and TR-138 "*Accuracy Tests for Test Parameters*". TR-100 provides a set of region specific performance requirements and test methods for ADSL2/ADSL2plus modems implemented in accordance with ITU-T G.992.3 and G.992.5. TR-138 defines the tests for verification of the accuracy of the reported test (Physical Layer OAM configuration and performance monitoring) parameters defined in ITU T G.992.3, G.992.5 and G.997.1.

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1   Purpose and Scope

1.1   Purpose

This test plan describes a series of functionality tests that are used to verify that an ATU (ATU-C or ATU-R) is functionally compliant to ITU-T Recommendation G.992.3/G.992.5 (Asymmetric Digital Subscriber Line/Extended bandwidth transceiver). An ATU is functionally compliant to this test plan if it implements correctly the required functions and features of the ITU-T Recommendation G.992.3/G.992.5. In addition, if an ATU implements a feature that is optional in the standard, the ATU is functionally compliant if it implements the optional feature as specified in the Recommendation. This Technical Report also defines tests for some of the ADSL2/2plus optional features such as dual latency and Seamless Rate Adaptation (SRA).

This functionality test plan does not specify the rate/reach performance requirements for ADSL2/2plus transceivers. Instead, the reader is referred to Technical Report TR-100 (ADSL2/2plus performance test plan).

1.2   Scope

This test plan facilitates ADSL2/2plus over POTS and ISDN functional testing. This test plan embodies operators' definitions of ADSL2/ADSL2plus interoperability (between one ATU-C and one ATU-R at a time).

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

2   References and Terminology

2.1   Conventions

In this Technical Report, several words are used to signify the requirements of the specification. These words are always capitalized. More information can be found be in RFC 2119 [1].

SHALL
: This word, or the term "REQUIRED", means that the definition is an absolute requirement of the specification.

SHALL NOT
: This phrase means that the definition is an absolute prohibition of the specification.

SHOULD
: This word, or the adjective "RECOMMENDED", means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications need to be understood and carefully weighed before choosing a different course.

SHOULD NOT
: This phrase, or the phrase "NOT RECOMMENDED" means that there 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 this item is one of an allowed set of alternatives. An implementation that does not include this option SHALL be prepared to inter-operate with another implementation that does include the option.

2.2   References

The following references are of relevance to this Technical Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Technical Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.
A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

[1] RFC 2119	Key words for use in RFCs to Indicate Requirement Levels	IETF	1997
[2] G.992.3	Asymmetric digital subscriber line transceivers 2 (ADSL2)	ITU-T	2009
[3] G.992.5	Asymmetric Digital Subscriber Line (ADSL) transceivers – Extended bandwidth ADSL2	ITU-T	2009

	(ADSL2plus)		
[4] G.997.1	Physical Layer Management for Digital Subscriber Line (DSL) Transceivers.	ITU-T	2009
[5] RFC 2544	Benchmarking terminology for network interconnection devices (Test methodology).	IETF	1999
[6] O.9	Measuring arrangements to assess the degree of unbalance about earth	ITU-T	1999
[7] G.117	Transmission aspects of unbalance about earth	ITU-T	1996
[8] TR-100	ADSL2/ADSL2plus Performance Test Plan	Broadband Forum	2007
[9] TR-202	ADSL2/ADSL2plus Low-Power Mode Guidelines	Broadband Forum	2009
[10] T1.417 issue 2	Spectrum Management for Loop Transmission System	ANSI	2003
[11] TS 101 388 v1.3.1	ADSL – European Specific Requirements	ETSI	May, 2002
[12] TS 105 388 v1.1.1	ADSL2plus – European Specific Requirements	ETSI	April, 2008
[13] TS 101 271 v1.1.1	Very High Speed digital subscriber line system (VDSL2)	ETSI	January, 2009
[14] RFC 1242	Benchmarking Terminology for Network Interconnection Devices	IETF	1991
[15] G.996.1	Test procedures for digital subscriber line (DSL) transceivers	ITU-T	2001

2.3   Definitions

The following terminology is used throughout this Technical Report.

Net Data Rate	The sum of all frame bearer data rates over all latency paths in any one direction
$\mathbf{f_{min}}$ **to** $\mathbf{f_{max}}$	Frequency range for the longitudinal conversion loss (LCL)
Showtime	The state of either ATU C or ATU R, reached after all initialization and training is completed, in which frame bearer data are transmitted
L0 State	Full power management state achieved after the initialization procedure has completed successfully (the ADSL link is fully functional)
L2 State	Low power management state (the ADSL link is active but a low power signal conveying background data is sent from the ATU-C to the ATU-R)

L3 State	Link state (Idle) at the start of the initialization procedure (there is no signal transmitting, the ATU may be powered or unpowered)
NULL Loop	ATU-C/ATU-R wired "back to back" i.e. a zero length loop
Ethernet Frame Size	Size of Ethernet frame including the CRC Checksum. See Section 3.5/RFC 1242 [14].

2.4   Abbreviations

This Technical Report uses the following abbreviations:

ADSL	Asymmetric DSL
ANSI	American National Standards Institute
ATIS	Alliance for Telecommunications Industry Solutions
ATM	Asynchronous Transfer Mode
ATP	Aggregate Transmit Power
ATTNDR	Attainable Net Data Rate
ATU	ADSL Transceiver Unit
ATU-C	Central Office End
ATU-R	Remote Terminal End
AWG	American Wire Gauge
AWGN	Additive White Gaussian Noise
BALUN	BALanced to UNbalanced
BER	Bit Error Ratio
BS	Bit Swap
CARMASK	Carrier Masking
CRC	Cyclic Redundancy Check
CV	Code Violation
D-FMC	Downstream Framing-Memory Class
DPBO	Downstream Power Back-Off
DRR	Dynamic Rate Repartitioning
DS	Downstream
DSL	Digital Subscriber Line
EE	Energy Efficiency
EOC	Embedded Operation Channel
ES	Errored Seconds
ETSI	European Telecommunications Standards Institute

EU	European Union
FTTB	Fiber to the Building
FTTCab	Fiber to the Cabinet
FTTCurb	Fiber to the Curb
HLIN	H(f) Linear Channel Characteristics Function
HLINps	H(f) linear representation
HLINSC	H(f) linear representation Scale
HLOG	H(f) Logarithmic Channel Characteristics Function
HLOGMT	H(f) logarithmic Measurement Time
HLOGps	H(f) logarithmic representation
ID	Identification
IETF	Internet Engineering Task Force
INP	Impulse Noise Protection
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
LATN	Loop Attenuation
LCL	Longitudinal Conversion Loss
LD	Loop Diagnostic
LDSF	Loop Diagnostic Mode Forced
LLC	Link Layer Control
L0-TIME	Minimum time between an Exit from the L2 state and the next Entry into the L2 state
L2-TIME	Minimum time between an Entry into the L2 state and the first Power Trim in the L2 state and between two consecutive Power Trims in the L2 State
L2-ATPR	Maximum aggregate transmit power reduction that can be performed at transition of L0 to L2 state
L2-ATPRT	Total maximum aggregate transmit power reduction that can be performed in an L2 state
MAC	Media Access Control
MAXBER	Maximum BER
MAXNOMATP	Maximum Nominal Aggregate Transmit Power
MAXNOMPSD	Maximum Nominal transmit Power Spectral Density
MAXSNRM	Maximum Signal to Noise Ratio Margin
MIB	Management Information Base
MINSNRM	Minimum Signal to Noise Ratio Margin

MSGMIN	Message based overhead Minimum rate
NA	North America
NOMPSD	Nominal transmit Power Spectral Density
OAM	Operations, Administration and Maintenance
OHC	Overhead Channel
OLR	Online Reconfiguration
PE	Poly Ethylene (cable type)
PMMode	Power Management State Enabling
PMSF	Power Management State Forced
POTS	Plain Old Telephone Service
PSD	Power Spectral Density
PTM	Packet Transfer Mode
QLN	Quiet Line Noise
QLNMT	Quiet Line Noise PSD Measurement Time
QLNps	Quiet Line Noise representation
RBW	Resolution Bandwidth
RFC	Request for Comments
RFIBANDS	Radio Frequency Interference Notches
EOC	Embedded Operations Channel
SATN	Signal Attenuation
SES	Severely Errored Second
SNR	SNR(f) Signal to Noise Ratio
SNRM	Signal to Noise Ratio Margin
SNRMT	SNR(f) Measurement Time
SNRps	SNR(f) representation
SRA	Seamless Rate Adaptation
SUT	System Under Test
TARSNRM	Target Signal to Noise Ratio Margin
TR	Technical Report
UAS	Un-Available Seconds
US	Upstream
VDSL2	Very high speed digital subscriber line transceivers 2
VN	Virtual Noise
XTSE	xTU Transmission System Enabling

2.5   G.997.1 Parameters

Parameter	Section in G.997.1
Actual Data Rate	7.5.2.1
ACTATPds, ACTATPus	7.5.1.24, 7.5.1.25
ATTNDRds, ATTNDRus	7.5.1.19, 7.5.1.20
BITSpsds, BITSpsus	7.5.1.29.1, 7.5.1.29.2
CARMASKds, CARMASKus	7.3.1.2.6, 7.3.1.2.7
CV-C	7.2.2.1.1
CV-CFE	7.2.2.2.1
DPBO	7.3.1.2.13
ES-L	7.2.1.1.2
ES-LFE	7.2.1.2.2
FORCEINP	7.3.2.5
Full initialization count	7.2.1.3.1
Failed full initialization count	7.2.1.3.2
HLINSCds, HLINSCus	7.5.1.26.1, 7.5.1.26.7
HLINpsds, HLINpsus	7.5.1.26.3, 7.5.1.26.9
HLOGMTds, HLOGMTus	7.5.1.26.4, 7.5.1.26.10
HLOGpsds, HLOGpsus	7.5.1.26.6, 7.5.1.26.12
LATNds, LATNus	7.5.1.9, 7.5.1.10
LDSF	7.3.1.1.8
Line power management state	7.5.1.5
L0-TIME	7.3.1.1.5
L2-TIME	7.3.1.1.6
L2- ATPR	7.3.1.1.7
L2- ATPRT	7.3.1.1.8
LSYMB	7.5.2.6.3
MAXBER	7.3.2.6
MAXNOMATPds, MAXNOMATPus	7.3.1.2.3, 7.3.1.2.4
MAXNOMPSDds, MAXNOMPSDus	7.3.1.2.1, 7.3.1.2.2
MAXSNRMds, MAXSNRMus	7.3.1.3.3, 7.3.1.3.4
MINSNRMds, MINSNRMus	7.3.1.3.5, 7.3.1.3.6
MSGMINds, MSGMINus	7.3.1.5.2, 7.3.1.5.1
NFEC	7.5.2.6.1
PMSF	7.3.1.1.3

PMMode	7.3.1.1.4
Previous Data Rate	7.5.2.2
PSDMASKds, PSDMASKus	7.3.1.2.9, 7.3.1.2.12
QLNMTds, QLNMTus	7.5.1.27.1, 7.5.1.27.4
QLNpsds, QLNpsus	7.5.1.27.3, 7.5.1.27.6
RA-DSNRMds, RA-DSNRMus	7.3.1.4.7, 7.3.1.4.8
RA-DTIMEds, RA-DTIMEus	7.3.1.4.9, 7.3.1.4.10
RA-MODEds, RA-MODEus	7.3.1.4.1, 7.3.1.4.2
RA-USNRMds, RA-USNRMus	7.3.1.4.3, 7.3.1.4.4
RA-UTIMEds, RA-UTIMEus	7.3.1.4.5, 7.3.1.4.6
RFEC	7.5.2.6.2
RFIBANDS	7.3.1.2.10
SATNds, SATNus	7.5.1.11, 7.5.1.12
SES-L	7.2.1.1.3
SES-LFE	7.2.1.2.3
SNRMds, SNRMus	7.5.1.13, 7.5.1.16
SNRMODEds, SNRMODEus	7.3.1.7.1, 7.3.1.7.2
SNRMTds, SNRMTus	7.5.1.28.1, 7.5.1.28.4
SNRpsds, SNRpsus	7.5.1.28.3, 7.5.1.28.6
TARSNRMds, TARSNRMus	7.3.1.3.1, 7.3.1.3.2
UAS-L	7.2.1.1.5
UAS-LFE	7.2.1.2.5
XTSE	7.3.1.1.1

3   Technical Report Impact

3.1   Energy Efficiency

TR-105 contains a test to verify the functionality of the L2 low power mode. L2 mode is the basic tool for enabling power reduction. Its usage may lead to a significant reduction of power consumption in ADSL2/2plus systems. For details on guidelines for configuration of the L2 mode refer to TR-202 "*ADSL2/ADSL2plus Low-Power Mode Configuration Guidelines*" [9].

3.2   IPv6

TR-105 has no impact on IPv6.

3.3   Security

TR-105 has no impact on Security.

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4   Test Structure

This chapter contains all the specifications and information required for building the basic testing environment (e.g. test configurations, setup of the simulated network environment, main settings of the equipment under test) for ADSL2/2plus test cases defined in this test plan. Different configurations and settings needed for specific test cases are defined in the related section.

4.1   Test Configurations

For tests that do not require data layer Figure 4-1 SHALL be used. For tests that do require data layer Figure 4-2 SHALL be used. When using the test setup with traffic analyzer present, the traffic switch or simulator MAY be removed if traffic simulator/analyzer in use is capable of terminating the traffic directly from the ATU-C. The high impedance crosstalk injection circuit (HI-Z) SHALL be used for injecting the impairment (section 5.1.2.1/G.996.1 [15]) and it MAY be integrated in the noise sources as well.
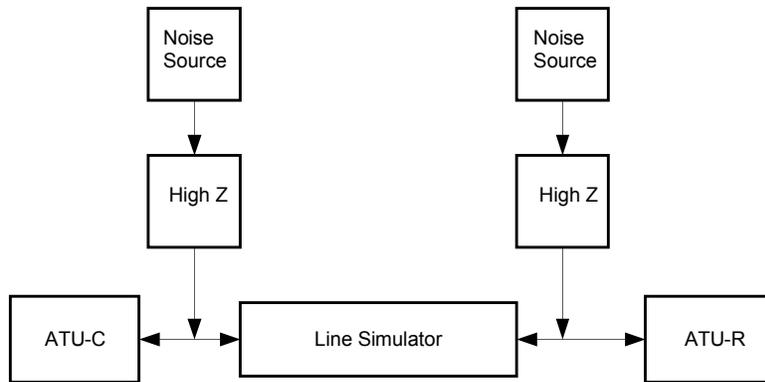
Figure 4-1 General Test Configuration
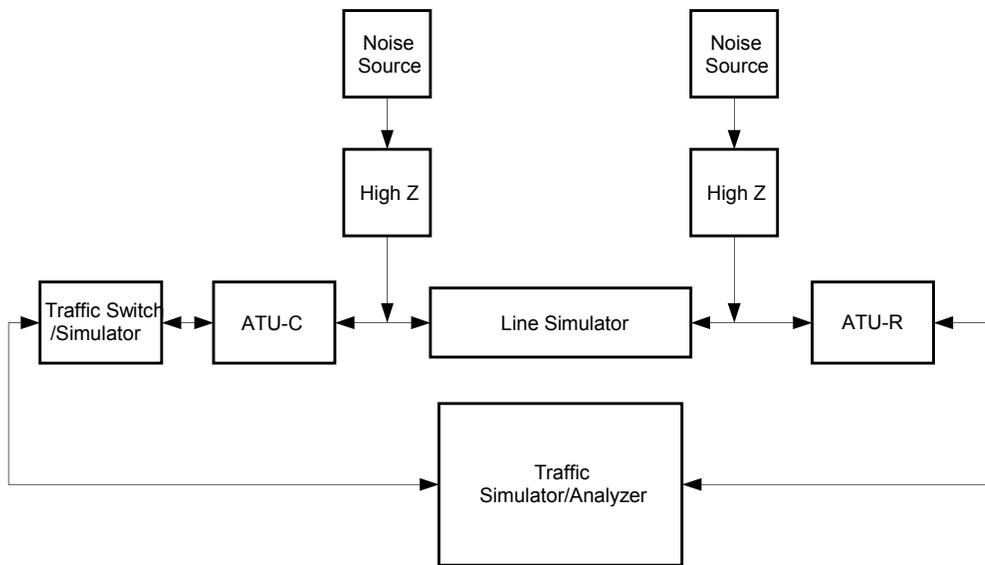
Figure 4-2 Test Setup for Configurations Using Data Layer
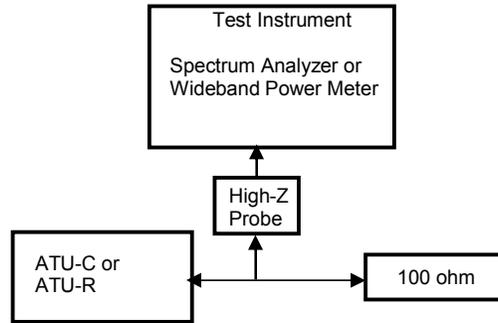
Figure 4-3 - Test Configuration for PSD Measurement Tests
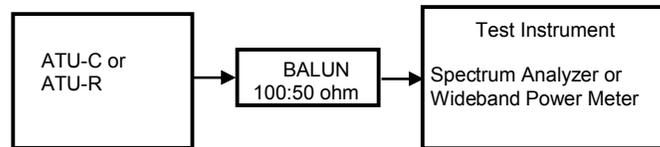
Figure 4-4- Alternative Test Configuration for PSD Measurement Tests

4.2   System Under Test (SUT) Settings

Configuration is based on a set of common line settings as defined in Table 4-1 and Table 4-2. General line settings define latency and INP settings as shown in Table 4-3. Specific test profiles additionally define settings for net data rates, operation mode (XTSE) and rate adaptation mode (RA-Mode). These setting are shown in Table 4-4 and Table 4-5. Deviations from these test profiles and/or common line settings are indicated in the description of each test or test section.

For configuration and reporting parameters the nomenclature as defined in G.997.1 [4] is used. As this is a transceiver test plan the use of a MIB is not implied. Any parameter may be translated into a local parameter.

4.2.1   Line Settings

Table 4-1 List of Common Line Settings for ADSL2/2plus Functionality Tests

Parameter	Setting	Description
All parameters but those specified below	Default value	
Power management state forced (PMSF)	0	
Power management state enabling (PMMode)	0	
Loop diagnostic mode forced (LDSF)	0	
Automode cold start forced	0	
DPBO	off	
Latency/Bearer	one/one	Single latency path and Single Frame Bearer operation
MSGMINds	6 kbps	
MSGMINus	6 kbps	
TARSNRMds	6 dB	
TARSNRMus	6 dB	
MAXSNRMds	511	511 is a special value that indicates that the maximum noise margin value is effectively infinite
MAXSNRMus	511	
MINSNRMds	0 dB	
MINSNRMus	0 dB	
MAXNOMPSDds	-40 dBm/Hz	default value
MAXNOMPSDus	-38 dBm/Hz	default value
NOMPSDds	-40 dBm/Hz	default value
NOMPSDus	-38 dBm/Hz	default value
MAXNOMATPds	19.9 dBm 19.3 dBm	Annex A default value (A.1.3.2/G.992.3, G.992.5) Annex B default value (B.1.3.2/G.992.3, G.992.5)
MAXNOMATPus	12.5 dBm 13.3 dBm	Annex A default value (A.2.2.2/G.992.3, G.992.5) Annex B default value (B.2.2.2/G.992.3, G.992.5)
CARMASKds	default-no masking used	
CARMASKus	default-no masking used	
PSDMASKds	default - no additional PSD restrictions	G.992.5 MIB PSD mask
PSDMASKus	default - no additional PSD restrictions	G.992.5 MIB PSD mask applicable to Annex M

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Table 4-1 (continued)

Parameter	Setting	Description
Upstream PSD mask selection	EU-56	Applicable to G.992.5 Annex M
RFIBANDS	none	G.992.5 MIB RFI notches for PSDMASKds
MAXBER	1E-7	
FORCEINP	TRUE	INP shall be computed as INP_no_erasure according to formula in Table 7-7/G.992.3.
SNRMODEds	1	
SNRMODEus	1	

Table 4-2 Common Line Settings with DPBO for Band-profiles A2P_CAB27, A2P_CAB72, B2P_CAB27, B2P_CAB72

Parameter	A2P_CAB27	A2P_CAB72	B2P_CAB27	B2P_CAB72	Description
All parameters but those below	G.992.5 Annex A as per Table 7-1/TR-100 [8]		G.992.5 Annex B as per Table 7-1/TR-100 [8]		
DPBOEPSD	ADSL2plus Annex A	ADSL2plus Annex A	ADSL2plus Annex B	ADSL2plus Annex B	PSD mask at the exchange
DPBOESEL	27dB@1MHz	72dB@1MHz	27dB@1MHz	72dB@1MHz	E-side electrical length
DPBOESCMA	0.1924	0.1924	0.1924	0.1924	Model of loss of E-side cable (NOTE)
DPBOESCMB	0.5960	0.5960	0.5960	0.5960	
DPBOESCMC	0.2086	0.2086	0.2086	0.2086	
DPBOMUS	-95 dBm/Hz	-95 dBm/Hz	-95 dBm/Hz	-95 dBm/Hz	Minimum usable receive PSD
DPBOFMIN	138 kHz	138 kHz	254 kHz	254 kHz	Minimum frequency from which on the DPBO SHALL be applied
DPBOFMAX	2208 kHz	2208 kHz	2208 kHz	2208 kHz	Maximum frequency up to which the DPBO SHALL be applied

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

4.2.2   Test Profiles

Table 4-3 General line settings

General line settings	Parameter	Setting	Description
F-1/0	Minimum INP	0 symbols	
	Maximum delay	S1	Special value S1 as defined in G.997.1 section 7.3.2.2 indicates that S and D SHALL be selected such that $S \leq 1$ and D=1
I-2/0	Minimum INP	0 symbols	
	Maximum delay	2 ms	One way interleaving delay $\lceil S*D \rceil /4$
I-16/0.5	Minimum INP	0.5 symbols	
	Maximum delay	16 ms	One way interleaving delay $\lceil S*D \rceil /4$
I-16/2	Minimum INP	2 symbols	
	Maximum delay	16 ms	One way interleaving delay $\lceil S*D \rceil /4$
I-8/8	Minimum INP	8 symbols	
	Maximum delay	8 ms	One way interleaving delay $\lceil S*D \rceil /4$
I-16/4	Minimum INP	4 symbols	
	Maximum delay	16 ms	One way interleaving delay $\lceil S*D \rceil /4$
I-8/1	Minimum INP	1 symbol	
	Maximum delay	8 ms	One way interleaving delay $\lceil S*D \rceil /4$
I-8/0.5	Minimum INP	0.5 symbols	
	Maximum delay	8 ms	One way interleaving delay $\lceil S*D \rceil /4$

Table 4-4 Specific Test Profiles

Specific Test Profile	General line setting DS	General line setting US	XTSE	RA-Mode	DS net data rate(kbit/s) (max- min)	US net data rate(kbit/s) (max-min)
A2_RA_F_16000k	F-1/0	F-1/0	G.992.3 An.A	AT_INIT	16000-32	2016-32
A2_RA_I1/2_16000k	I-16/0.5	I-16/0.5	G.992.3 An.A	AT_INIT	16000-32	2016-32
A2_Fix_F_7288k	F-1/0	F-1/0	G.992.3 An.A	MANUAL	7288-7288	800-800
A2_Fix_I_7288k	I-16/2	I-16/2	G.992.3 An.A	MANUAL	7288-7288	800-800
A2_Fix_F_5952k	F-1/0	F-1/0	G.992.3 An.A	MANUAL	5952-5952	640-640
A2_Fix_I_5952k	I-16/2	I-16/2	G.992.3 An.A	MANUAL	5952-5952	640-640
A2_Fix_F_2400k	F-1/0	F-1/0	G.992.3 An.A	MANUAL	2400-2400	352-352

Table 4-4 (continued)

Specific Test Profile	General line setting DS	General line setting US	XTSE	RA-Mode	DS net data rate(kbit/s) (max- min)	US net data rate(kbit/s) (max-min)
A2_Fix_I_2400k	I-16/2	I-16/2	G.992.3 An.A	MANUAL	2400-2400	352-352
A2_Fix_I_1200k	I-16/2	I-16/2	G.992.3 An.A	MANUAL	1200-1200	224-224
B2_RA_F_16000k	F-1/0	F-1/0	G.992.3 An.B	AT_INIT	16000-32	2016-32
B2_RA_I_16000k	I-16/2	I-16/2	G.992.3 An.B	AT_INIT	16000-32	2016-32
B2_Fix_F_7288k	F-1/0	F-1/0	G.992.3 An.B	MANUAL	7288-7288	800-800
B2_Fix_I_7288k	I-16/2	I-16/2	G.992.3 An.B	MANUAL	7288-7288	800-800
B2_Fix_F_3456k	F-1/0	F-1/0	G.992.3 An.B	MANUAL	3456-3456	448-448
A2P_RA_F_30000k	F-1/0	F-1/0	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P_SRA_F_30000k	F-1/0	F-1/0	G.992.5 An.A	DYNAMIC	30000-32	2016-32
A2P RA_I_30000k	I-16/2	I-16/2	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P RA_I1/2_30000k	I-16/0.5	I-16/0.5	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P_Fix_F_10000k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	10000-10000	832-832
A2P_Fix_I_10000k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	10000-10000	832-832
A2P Fix_F_7288k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	7288-7288	800-800
A2P Fix_I_7288k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	7288-7288	800-800
A2P Fix_F_5952k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	5952-5952	640-640
A2P Fix_I_5952k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	5952-5952	640-640
A2P_Fix_F_2400k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	2400-2400	352-352
A2P Fix_I_2400k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	2400-2400	352-352
B2P_RA_F_30000k	F-1/0	F-1/0	G.992.5 An.B	AT_INIT	30000-32	2016-32
B2P_SRA_F_30000k	F-1/0	F-1/0	G.992.5 An.B	DYNAMIC	30000-32	2016-32
B2P RA_I_30000k	I-16/2	I-16/2	G.992.5 An.B	AT_INIT	30000-32	2016-32
B2P_Fix_F_10000k	F-1/0	F-1/0	G.992.5 An.B	MANUAL	10000-10000	832-832
B2P_Fix_I_10000k	I-16/2	I-16/2	G.992.5 An.B	MANUAL	10000-10000	832-832
B2P Fix_F_7288k	F-1/0	F-1/0	G.992.5 An.B	MANUAL	7288-7288	800-800
B2P Fix_I_7288k	I-16/2	I-16/2	G.992.5 An.B	MANUAL	7288-7288	800-800
B2P Fix_F_3456k	F-1/0	F-1/0	G.992.5 An.B	MANUAL	3456-3456	448-448
B2P Fix_I_3456k	I-16/2	I-16/2	G.992.5 An.B	MANUAL	3456-3456	448-448
A2P RA_I8_30000k	I-8/8	I-8/2	G.992.5 An.A	AT_INIT	30000-32	2016-32
B2P RA_I8_30000k	I-8/8	I-8/2	G.992.5 An.B	AT_INIT	30000-32	2016-32
A2P_Fix_F_600k	F-1/0	F-1/0	G.992.5 An.A	MANUAL	600-600	128-128
A2P_Fix_I_600k	I-16/2	I-16/2	G.992.5 An.A	MANUAL	600-600	128-128
A2_RA_I4_30000k	I-16/4	I-16/2	G.992.3 An.A	AT_INIT	30000-32	2016-32
A2P_RA_I4_30000k	I-16/4	I-16/2	G.992.5 An.A	AT_INIT	30000-32	2016-32
B2P_Fix_F_864k	F-1/0	F-1/0	G.992.5 An.B	MANUAL	864-864	160-160
B2P_Fix_I_864k	I-16/2	I-16/2	G.992.5 An.B	MANUAL	864-864	160-160
B2_RA_I4_30000k	I-16/4	I-16/2	G.992.3 An.B	AT_INIT	30000-32	2016-32
B2P_RA_I4_30000k	I-16/4	I-16/2	G.992.5 An.B	AT_INIT	30000-32	2016-32
M2P RA_I1_30000k	I-8/1	I-8/0.5	G.992.5 An.M	AT_INIT	30000-32	4032-32

Table 4-5 Specific Test Profiles with DPBO

Specific Test Profile	Band-profile	General line setting DS	General line setting US	XTSE	RA-Mode	DS net data rate(kbit/s) (max- min)	US net data rate(kbit/s) (max-min)
A2P_CAB27_RA_F_30000k	A2P_CAB27	F-1/0	F-1/0	G.992.5 An.A	AT_INIT	30000-32	2016-32
A2P_CAB72_RA_F_30000k	A2P_CAB72	F-1/0	F-1/0	G.992.5 An.A	AT_INIT	30000-32	2016-32
B2P_CAB27_RA_F_30000k	B2P_CAB27	F-1/0	F-1/0	G.992.5 An.B	AT_INIT	30000-32	2016-32
B2P_CAB72_RA_F_30000k	B2P_CAB72	F-1/0	F-1/0	G.992.5 An.B	AT_INIT	30000-32	2016-32

4.2.3   Downstream Framing-Memory Classes

Downstream framing memory classes are defined in Table 4-6.

Table 4-6 Downstream Framing memory Classes

Classes of supported downstream framing set/memory	Parameter/ condition (DS)	Value
G.992.5 mandatory (ITU) standard framing set 16k memory (FC1): **1. G.992.5 Annex A ClassB_16k 2. G.992.5 Annex B ClassB_16k**	D value	1, 2, 4, 8, 16, 32, 64
	1/S value	$1/3 \le S < 64$
	DS delay octets $(N_{FEC}-1)*(D-1)$	16002
G.992.5 mandatory (ETSI) extended framing set 16k memory (FC2): **1. G.992.5 Annex A ClassAmand_16k 2. G.992.5 Annex B ClassAmand_16k**	D value	1, 2, 4, 8, 16, 32, 64, 96, 128, 160, 192, 224, 256, 288, 320
	1/S value	$1/11 \le S < 64$
	DS delay octets $(N_{FEC}-1)*(D-1)$	16002
G.992.5 mandatory (ETSI) extended framing set 24k memory (FC3): **1. G.992.5 Annex A ClassAmand_24k 2. G.992.5 Annex B ClassAmand_24k**	D value	1, 2, 4, 8, 16, 32, 64, 96, 128, 160, 192, 224, 256, 288, 320, 352, 384
	1/S value	$1/11 \le S < 64$
	DS delay octets $(N_{FEC}-1)*(D-1)$	24000
G.992.5 optional (ITU) extended framing set 16k memory (FC4): **1. G.992.5 Annex A ClassAopt_16k 2. G.992.5 Annex B ClassAopt_16k**	D value	1, 2, 4, 8, 16, 32, 64, 96, 128, 160, 192, 224, 256, 288, 320, 352, 384, 416, 448, 480, 511
	1/S value	$1/16 \le S < 64$
	DS delay octets $(N_{FEC}-1)*(D-1)$	16002

Table 4-6 (continued)

Classes of supported downstream framing set/memory	Parameter/ condition (DS)	Value
G.992.5 optional (ITU) extended framing set 24k memory (FC5): **1. G.992.5 Annex A ClassAopt_24k** **2. G.992.5 Annex B ClassAopt_24k**	D value	1, 2, 4, 8, 16, 32, 64, 96, 128, 160, 192, 224, 256, 288, 320, 352, 384, 416, 448, 480, 511
	1/S value	$1/16 \leq S < 64$
	DS delay octets $(N_{FEC}-1)*(D-1)$	24000

4.3   Test Plan Passing Criteria

For an SUT to pass this Test Plan for one of the ADSL Annexes in this test plan, it is required that the SUT passes the mandatory test cases applicable to that operation mode and supported type of the TPS-TC layer.

4.4   Test Setup

4.4.1   Loop Models

The common loop model for the Annex A North American testing is straight 26 AWG loop defined in ANSI T1.417 issue 2 [10].

The common loop models for the Annex A European testing are straight homogeneous loops ETSI loop #1 (PE04) defined in ETSI TS 101 388 [11] and ETSI loop #1 (TP100) defined in ETSI TS 101 271 [13].

The common loop model for the Annex B testing is straight homogeneous loops ETSI loop #1 defined in ETSI TS 101 388 [11].

4.4.2   Noise Models

The noise model for the Annex A North American testing is defined in Annex A.1/TR-100 [8].

The noise model for the Annex A European testing is defined in Annex A.2/TR-100 [8] and Annex A A.3/TR-100 [8].

The noise model for the Annex B testing is defined in Annex B/TR-100 [8].

4.5   Equipment Feature Tables

The listed tables SHALL be filled with the requested information before starting the tests in order to have all the information about the system under test and to have a reproducible test environment.

Table 4-7 - ATU-C Feature Table

Feature	Specification
System Vendor ID	
G.994.1 Vendor ID	
Version Number	
Serial Number	
ADSL operation mode tested	
ADSL optional features tested	
TPS-TC encapsulation tested (ATM, PTM)	

Table 4-8 - ATU-R Feature Table

Feature	Specification
System Vendor ID	
G.994.1 Vendor ID	
Version Number	
Serial Number	
ADSL operation mode tested	
ADSL optional features tested	
TPS-TC encapsulation tested (ATM, PTM)	

4.6   Equation for Estimating BER

See Table 7-12/TR-100 [8] *The equations for estimating BER.*

5   Physical –Layer Tests

5.1   Net Data Rate Test

5.1.1   Fixed data rate operation in the interleaved mode

Table 5-1 Fixed data rate operation in the interleaved mode

Test Configuration	(1) See Section 4.1 for the test configuration. (2) According to the Annex to be tested, configure the SUT for operation in a fixed interleaved specific test profile with general line setting I-16/2 in downstream and upstream. (3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1km PE04 for Annex A EU and Annex B. (4) Set the noise generator to -140dBm/Hz AWGN at both ends of the loop.
Method of Procedure	(1) Force a new initialization and wait for modems to sync. (2) Wait 1 minute following synchronization for bit swaps to settle. (3) Document the reported actual data rate, interleaving delay and impulse noise protection. (4) Record the CV counts and SES counts for 1 minute. (5) Repeat steps (1) to (4) with general line settings I-2/0, I-16/0.5, I-8/8 and I-16/4.
Expected Result	For each general test profile: (1) Reported actual net data rate in downstream (net_act_ds) SHALL be: net_min_ds $\leq$ net_act_ds $\leq$ (net_min_ds + 8) kbps, where net_min_ds is the minimum data rate in DS specified for the test profile under test. (2) Reported actual net data rate in upstream (net_act_us) SHALL be: net_min_us $\leq$ net_act_us $\leq$ (net_min_us + 8) kbps, where net_min_us is the minimum data rate in US specified for the test profile under test. (3) Reported actual INP SHALL be $\geq$ INP_min. (4) Reported actual interleaving delay SHALL be $\leq$ delay_max. (5) Actual number of reported CVs SHALL not increase by more than 1 during the measurement period. (6) Actual number of reported SESs SHALL not increase during the measurement period.

5.1.2   Fixed data rate operation in the fast mode

Table 5-2 Fixed data rate operation in the fast mode

Test Configuration	(1) See Section 4.1 for the test configuration. (2) According to the Annex to be tested, configure the SUT for operation in the fixed rate specific test profile with general line setting F-1/0 in downstream and upstream. (3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1km PE04 for Annex A EU and Annex B. (4) Set the noise generator to -140dBm/Hz AWGN at both ends of the loop.

Method of Procedure	(1) Force a new initialization and wait for modems to sync. (2) Wait 1 minute following synchronization for bit swaps to settle. (3) Document the reported actual data rate. (4) Record the CV counts and SES counts for 1 minute.
Expected Result	(1) Reported actual net data rate in downstream (net_act_ds) SHALL be: net_min_ds ≤ net_act_ds ≤ (net_min_ds + 8) kbps, where net_min_ds is the minimum data rate in DS specified for the test profile under test. (2) Reported actual net data rate in upstream (net_act_us) SHALL be: net_min_us ≤ net_act_us ≤ (net_min_us + 8) kbps, where net_min_us is the minimum data rate in US specified for the test profile under test. (3) Actual number of reported CVs shall not increase by more than 1 during the measurement period. (4) Actual number of reported SESs SHALL not increase during the measurement period.

5.1.3   Rate adaptive operation in the interleaved mode

Table 5-3 Rate adaptive operation in the interleaved mode

Test Configuration	(1) See Section 4.1 for the test configuration. (2) According to the Annex to be tested, configure the SUT for operation in a rate adaptive specific test profile with general line setting I-16/2 in downstream and upstream. (3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1km PE04 for Annex A EU and Annex B. (4) Set the noise generator to -140dBm/Hz AWGN at both ends of the loop.
Method of Procedure	(1) Force an initialization and wait for modems to sync. (2) Wait 1 minute following synchronization for bit swaps to settle. (3) Document the reported actual data rate, interleaving delay and impulse noise protection. (4) Record the CV counts and SES counts for 1 minute. (5) Repeat steps (1) to (4) with general line settings I-2/0, I-16/0.5, I-8/8 and I-16/4.
Expected Result	For each general line setting: (1) Reported actual net data rate in downstream (net_act_ds) SHALL be: net_min_ds ≤ net_act_ds ≤ net_max_ds kbps, where net_min_ds and net_max_ds are the minimum and maximum downstream data rate specified for the test profile under test. (2) Reported actual net data rate in upstream (net_act_us) SHALL be: net_min_us ≤ net_act_us ≤ net_max_us kbps, where net_min_us and and net_max_us are the minimum and maximum upstream data rate specified for the test profile under test. (3) Reported actual INP SHALL be ≥ INP_min. (4) Reported actual interleaving delay SHALL be ≤ delay_max. (5) Actual number of reported CVs SHALL not increase by more than 1 during the measurement period. (6) Actual number of reported SESs SHALL not increase during the measurement period.

5.1.4   Rate adaptive operation in the fast mode

Table 5-4 Rate adaptive operation in the fast mode

Test Configuration	(1) See Section 4.1 for the test configuration. (2) According to the Annex to be tested, configure the SUT for operation in the rate adaptive specific test profile with general line setting F-1/0 in downstream and upstream. (3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1km PE04 for Annex A EU and Annex B. (4) Set the noise generator to -140dBm/Hz AWGN at both ends of the loop.
Method of Procedure	(1) Force an initialization and wait for modems to sync. (2) Wait 1 minute following synchronization for bit swaps to settle. (3) Document the reported actual data rate. (4) Record the CV counts and SES counts for 1 minute.
Expected Result	(1) Reported actual net data rate in downstream (net_act_ds) SHALL be: net_min_ds ≤ net_act_ds ≤ net_max_ds kbps, where net_min_ds and net_max_ds are the minimum and maximum downstream data rate specified for the test profile under test. (2) Reported actual net data rate in upstream (net_act_us) SHALL be: net_min_us ≤ net_act_us ≤ net_max_us kbps, where net_min_us and net_max_us are the minimum and maximum upstream data rate specified for the test profile under test. (3) Actual number of reported CVs shall not increase by more than 1 during the measurement period. (4) Actual number of reported SESs SHALL not increase during the measurement period.

5.2   Interleaving Delay Test

The purpose of this test is to verify the validity of interleaving delay. It assumes that the system delay without the interleaving delay is constant within a tolerance of 1ms and that the reported interleaving delay is equal to the actual delay.

Table 5-5 Interleaving Delay Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) According to the Annex to be tested, configure the SUT for operation in the specific test profile using the general line setting I-8/2. (3) Set loop for NULL loop without noise. (4) Set 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. (5) Set the ATU-R modem for bridged mode with LLC encapsulation.
Method of Procedure	(1) Force a new initialization and wait for modems to sync. (2) Wait 1 minute after reaching Showtime. (3) Record the actual interleaving delay for upstream (reported_delay_1_US) and downstream (reported_delay_1_DS). (4) Run Section 26.2/RFC 2544 [5] delay test using traffic analyzer, use an Ethernet frame size of 512 bytes. Set the throughput rate to 90% of the maximum achievable net data rate.

	(5) Record the result as system_delay_1_US and system_delay_1_DS. (6) Define "delta_delay_1" as the system delay without the interleaving delay in upstream and downstream: delta_delay_1_US = system_delay_1_US- reported_delay_1_US delta_delay_1_DS = system_delay_1_DS- reported_delay_1_DS (7) Configure the SUT in the specific test profile using the general line setting I-16/2, which otherwise is the same as the specific test profile of TC(2). (8) Force a new initialization and wait for modems to sync. (9) Wait 1 minute after reaching Showtime. (10) Record the actual interleaving delay for upstream (reported_delay_2_ US) and downstream (reported_delay_2_DS). (11) Run Section 26.2/RFC 2544 [5] delay test using traffic analyzer, use an Ethernet frame size of 512 bytes. Set the throughput rate to 90% of the maximum achievable net data rate. (12) Record the result as system_delay_2_US and system_delay_2_DS. (13) Define "delta_delay_2" as the system delay without the interleaving delay in upstream and downstream: delta_delay_2_US = system_delay_2_US- reported_delay_2_US delta_delay_2_DS = system_delay_2_DS- reported_delay_2_DS
Expected Result	(1) reported_delay_1_US ≤ 8 ms and reported_delay_1_DS ≤ 8 ms (2) reported_delay_2_US ≤ 16 ms and reported_delay_2_DS ≤ 16 ms (3) |delta_delay_1_US - delta_delay_2_US| ≤ 1 ms (4) |delta_delay_1_DS - delta_delay_2_DS| ≤ 1 ms

5.3   Impulse Noise Protection Test

The purpose of this test is to verify the presence of impulse noise protection controls and their correct functional implementation.

Table 5-6 Impulse Noise Protection Test

Test Configuration	(1) See Section 4.1 the test configuration. (2) Configure the SUT for operation in the Annex specific test profile in rate adaptive mode and in general line settings I-16/2 and I-16/4. (3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1 km PE04 for Annex A EU and Annex B. (4) Set the noise generator to -140dBm/Hz AWGN at the ATU-R and -110dBm/Hz at the ATU-C.
Method of Procedure	(1) Force an initialization and wait for modems to sync. (2) Wait for 1 minute after initialization. (3) Inject 15 impulses spaced at least 1 second apart into the circuit at the ATU-C end of the line simulator over a maximum of one minute period. Each impulse SHALL be a "burst of pseudorandom AWGN" of length (INP_min-1)×240µs – 15µs at a level of -90dBm/Hz differential mode. (4) Document the actual interleaving delay and impulse noise protection. (5) Record the CV, ES count and SES count for 1 minute during step (3). (6) Test the ATU-R modem by repeating step (1) to (5), and injecting -140dBm/Hz AWGN at the ATU-C. -110dBm/Hz and 15 impulses

	defined in (3) SHALL be injected at the ATU-R.
Expected Result	(1) Reported actual INP SHALL be $\geq$ INP_min.
	(2) Reported actual interleaving delay SHALL be $\leq$ delay_max.
	(3) The number of reported ES SHALL be $\leq$ 1.
	(4) The number of reported CV SHALL be $\leq$ 1.
	(5) No SES SHALL be observed during the test.

5.4   Dual Latency Test (OPTIONAL)

Table 5-7 Dual Latency Test

Test Configuration	(1) See Section 4.1 for the test configuration.
	(2) Configure the SUT for ADSL2plus Annex specific test profile in the rate adaptive dual latency operation (PMS-TC path #0 and #1).Configure channel 1 (path #0) in general line setting I-16/2, and channel 2 (path #1) in F-1/0.
	(3) Set up the line simulator for 2400 ft 26AWG or 750 m PE 0.4
	(4) Set the noise generator to -140dBm/Hz AWGN at the ATU-R and -110dBm/Hz at the ATU-C.
Method of Procedure	(1) Force an initialization and wait for modems to sync.
	(2) Wait for 1 minute after initialization.
	(3) Run Section 26.2/RFC 2544 [5] delay test using traffic analyzer in both channels, use an Ethernet frame size of 1518 bytes . Record the result delay_1 for channel 1 and delay_2 for channel 2.
	(4) Inject 15 impulses spaced at least 1 second apart into the circuit at the ATU-C end of the line simulator over a maximum of a one minute period. Each impulse SHALL be a "burst of pseudorandom AWGN" of 225μs duration at a level of -90dBm/Hz differential mode.
	(5) Record the CV count and SES count for 1 minute during step (4) in both channels.
	(6) Test the ATU-R modem by repeating step(1) to (5), and injecting -140dBm/Hz AWGN at the ATU-C. -110dBm/Hz and 15 impulses defined in (4) SHALL be injected at the ATU-R.
Expected Result	(1) The measured delay in channel 2 SHALL be lower than that of channel 1.
	(2) The number of reported CV in channel 1 SHALL be $\leq$ 1.
	(3) The number of reported CV in channel 1 SHALL be less than that of channel 2.
	(4) No SES SHALL be observed during the test.

5.5   On-Line Reconfiguration Test

5.5.1   Bitswapping Test

The purpose of this test is to verify that the ATU-C and ATU-R support the bit swapping, the Type 1 OLR on-line reconfiguration operation as defined in section 10.2 of G.992.3 [2].

Table 5-8 DS Bit Swapping Test

Test Configuration	(1) See Section 4.1 for the test configuration.
	(2) Configure the SUT for operation in the Annex specific test profile in a rate adaptive mode and general line settings F-1/0 and I-16/2, and maximum net data rates:

	• ADSL2: 7000 kbps in downstream, 512 kbps in upstream • ADSL2plus: 16000 kbps in downstream, 800 kbps in upstream (3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1km PE04 for Annex A EU and Annex B. (4) Set the noise generator to -140dBm/Hz AWGN at both ends of the loop. (5) All single frequency tones SHALL be sine-shaped at a constant frequency while the tone amplitude applied is 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 ±1% resistors. Measurements performed into a 1kHz resolution bandwidth. Note that with a 1kHz resolution bandwidth the power spectral density value (in dBm/Hz) will be 30 dB less than the power level (in dBm), limited by the noise floor of the test equipment used for calibration.
Method of Procedure	(1) Force an initialization and wait for modems to sync. (2) Wait for 1 minute for bit swapping to settle. (3) Randomly select an integer value, n, the tone number in the range of 70 to 100 for ADSL2, and 300 to 400 for ADSL2plus. Ensure that the tone selected has assigned bits as described in the relevant bits per tone map. The power of the interfering tone SHALL be -110 dBm or less. (4) Record and report the value of n used. (5) Record the bits allocation table as per section 7.5.1.29.1/G.997.1 [4]. (6) Increase the power of the interfering tone selected in (3) to -50 dBm. (7) Wait for 1 minute for bit swapping to settle. (8) Record the bits allocation table as per section 7.5.1.29.1/G.997.1 [4]. (9) Record the CV and SES counts for 1 minute in the downstream direction.
Expected Result	(1) There SHALL be no retrain during the test. (2) The bit allocation recorded in step (8) SHALL differ from the bit allocation in step (5). (3) The number of reported CV SHALL be <= 1. (4) No SES shall be recorded during the measurement period.

Table 5-9 US Bit Swapping Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in the Annex specific test profile in a rate adaptive mode and general line settings F-1/0 and I-16/2, and maximum net data rates: • ADSL2: 7000 kbps in downstream, 512 kbps in upstream • ADSL2plus: 16000 kbps in downstream, 800 kbps in upstream (3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1km PE04 for Annex A EU and Annex B. (4) Set the noise generator to -140dBm/Hz AWGN at both ends of the loop. (5) All single frequency tones SHALL be sine-shaped at a constant frequency while the tone amplitude applied is 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 ±1% resistors. Measurements performed into a 1kHz resolution bandwidth. Note that with a 1kHz resolution bandwidth the power spectral density value (in dBm/Hz) will be 30 dB less than the power level (in dBm), limited by the noise floor of the test equipment used for calibration.
Method of Procedure	(1) Force an initialization and wait for modems to sync. (2) Wait for 1 minute for bit swapping to settle. (3) Randomly select an integer value, n, the tone number in the range of 10 to 20 for Annex A and 40 to 50 for Annex B. Ensure that the tone selected has assigned bits as described in the relevant bits per tone map. The power of the interfering tone SHALL be -110 dBm or less. (4) Record and report the value of n used. (5) Record the bits allocation table as per section 7.5.1.29.2/G.997.1 [4]. (6) Increase the power of the interfering tone selected in (3) to -50 dBm. (7) Wait for 1 minute for bit swapping to settle. (8) Record the bits allocation table as per section 7.5.1.29.2/G.997.1 [4]. (9) Record the CV and SES counts for 1 minute in the upstream direction.
Expected Result	(1) There SHALL be no retrain during the test. (2) The bit allocation recorded in step (8) SHALL differ from the bit allocation in step (5). (3) The number of reported CV SHALL be <= 1. (4) No SES shall be recorded during the measurement period.

5.5.2   Seamless Rate Adaptation Test (OPTIONAL)

The purpose of this test is to verify the functionality of the SRA. The test SHALL be performed for general line setting F-1/0, for the G.992.5 Annex under test. For each profile the test SHALL be performed for both parameter sets: 1 and 2.

Table 5-10 DSLAM Functional SRA test configuration

Parameter Set	RA-USNRM (dB)	RA-UTIME (s)	RA-DSNRM (dB)	RA-DTIME (s)	TARSNRM (dB)
1	9	30	3	10	6
2	21	60	9	20	15

This test is divided into 2 sub-tests:

1. Functional SRA test – Downstream
2. Functional SRA test – Upstream

All sub-tests are REQUIRED for the SUT to pass the SRA test.

Table 5-11 Functional SRA test - Downstream

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT with the Annex relevant test profile A2P_SRA_F_30000k or B2P_SRA_F_30000k, and SRA parameter set 1 from Table 5-10. (3) Set up the line simulator to 5 kft 26AWG for Annex A NA or 1500m PE04 for Annex A EU and Annex B. (4) Set the noise generator to -120dBm/Hz AWGN at both ends of the loop.

Method of Procedure	(1) Force a new initialization and wait for modems to sync. (2) Wait for 1 minute for bitswaps to settle. (3) Check the reported margin. Document DS net data rate as rate_ds. ***Downshift functionality sub-test*** (4) Increase the noise power level by 1 dB at ATU-R side only. (5) Wait for 1 minute, then check reported margin. (6) Repeat step (4) and (5) until: RA-DSNRM + 0.5dB < reported margin at the side under test < RA-DSNRM + 1.5dB. (7) Increase the noise power level by 3 dB at ATU-R side only. (8) Wait for (RA-DTIME + 30) s for SRA to settle. (9) Check reported DS margin, and document as SRA_reported_margin _downshift_ds. Document DS net data rate as SRA_downshift_rate_ds. (10) Execute a BER test for 7 minutes. 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 estimated BER. ***Upshift functionality sub-test*** (11) Decrease the noise power level by 1 dB at ATU-R side only. (12) Wait for 1 minute, then check the reported margin. (13) Repeat step (11) and step (12) until: RA-USNRM - 1.5dB < reported margin at the side under test < RA-USNRM - 0.5dB. (14) Decrease the noise power level by 3 dB at ATU-R side only. (15) Wait for (RA-UTIME + 30) s for SRA to settle. (16) Check reported DS margin, and document as SRA_reported_ margin_upshift_ds. Document DS net data rate as SRA_upshift_rate_ds. (17) Execute a BER test for 7 minutes. 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 estimated BER. (18) Repeat the test steps (1) to (17) for SRA parameter set 2.

Expected Result	(1) No retrain SHALL occur during the test.
	
	(2) SRA_reported_margin_downshift_ds ≥ RA-DSNRM.
	    SRA_reported_margin_upshift_ds ≤ RA-USNRM.
	
	(3) SRA_downshift_rate_ds < rate_ds.
	    SRA_upshift_rate_ds > rate_ds.
	
	(4) Estimated BER SHALL NOT exceed 1e-7, and no SES SHALL be reported.

Table 5-12 Functional SRA test - Upstream

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT with the Annex relevant test profile. A2P_SRA_F_30000k or B2P_SRA_F_30000k, and SRA parameter set 1 from Table 5-10. (3) Set up the line simulator to 5 kft 26AWG for Annex A NA or 1500m PE04 for Annex A EU and Annex B. (4) Set the noise generator to -120dBm/Hz AWGN at both ends of the loop.
Method of Procedure	(1) Force a new initialization and wait for modems to sync. (2) Wait for 1 minute for bitswaps to settle. (3) Check the reported margin. Document US net data rate as rate_us. ***Downshift functionality sub-test*** (4) Increase the noise power level by 1 dB at ATU-C side only. (5) Wait for 1 minute, then check reported margin. (6) Repeat step (4) and (5) until: RA-DSNRM + 0.5dB < reported margin at the side under test < RA-DSNRM + 1.5dB. (7) Increase the noise power level by 3 dB at ATU-C side only. (8) Wait for (RA-DTIME + 30) s for SRA to settle. (9) Check reported US margin, and document as SRA_reported_margin _downshift_us. Document US net data rate as SRA_downshift_rate_us. (10) Execute a BER test for 7 minutes. 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 estimated BER. ***Upshift functionality sub-test*** (11) Decrease the noise power level by 1 dB at ATU-C side only. (12) Wait for 1 minute, then check reported margin. (13) Repeat step (11) and (12) until: RA-USNRM - 1.5dB < reported margin at the side under test < RA-USNRM - 0.5dB. (14) Decrease the noise power level by 3 dB at ATU-C side only. (15) Wait for (RA-UTIME + 30) s for SRA to settle. (16) Check reported US margin, and document as SRA_reported_margin _upshift_us. Document US net data rate as SRA_upshift_rate_us. (17) Execute a BER test for 7 minutes. 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 estimated BER. (18) Repeat the test steps (1) to (17) for SRA parameter set 2.
Expected Result	(1) No retrain SHALL occur during the test. (2) SRA_reported_margin_downshift_us ≥ RA-DSNRM. SRA_reported_margin_upshift_us ≤ RA-USNRM.

	(3) SRA_downshift_rate_us < rate_us. SRA_upshift_rate_us > rate_us.
	(4) Estimated BER SHALL NOT exceed 1e-7, and no SES SHALL be reported.

5.5.3   Dynamic Rate Repartitioning Test (OPTIONAL)

For further study.

5.6   Loop Diagnostics Mode Test

The purpose of this test is to verify the functionality of the Loop Diagnostic mode. Loop Diagnostic mode is intended to identify channel conditions at both ends of the loop without transitioning to the L0 state. The modems SHALL return to L3 state after completion of the Loop Diagnostic mode. Test parameters exchanged during the Loop Diagnostic mode are defined in Section 8.15.1/G.992.3, G.992.5 ([2], [3]) and Section 7.5.1/G.997.1 [4].

This test is divided into 9 sub-tests:
    (1) Linear Channel Characteristics Function (HLIN)
    (2) Logarithmic Channel Characteristics Function (HLOG) Test
    (3) Quiet Line Noise (QLN) Test
    (4) Signal-to-Noise Ratio (SNR) Test
    (5) Loop Attenuation (LATN) Test
    (6) Signal Attenuation (SATN) Test
    (7) Signal-to-Noise Ratio Margin (SNRM) Test
    (8) Attainable Net Data Rate (ATTNDR) Test
    (9) Actual Aggregate Transmit Power (ACTATP) Test

All sub-tests are REQUIRED for the SUT to pass the loop diagnostics mode test.

5.6.1   Linear Channel Characteristics Function (HLIN) Test

Table 5-13 HLIN Test requested by ATU-C

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-C side to the L3 state. (2) Force the ATU-C to perform the loop diagnostic mode. (3) Collect and record the following parameters for the linear channel characteristics function per subcarrier: HLINSC, HLINps, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream linear representation scale factor (HLINSCds, HLINSCus) SHALL be within the range specified in Section 7.5.1.26.1 and 7.5.1.26.3 of G.997.1.

	(4) Downstream and upstream H(f) linear representation (HLINpsds, HLINpsus) SHALL be within the specified format and range as defined in Section 7.5.1.26.3 and 7.5.1.26.9 of G.997.1.

Table 5-14 HLIN Test requested by ATU-R

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-R side to the L3 state. (2) Force the ATU-R to perform the loop diagnostic mode. (3) Collect and record the following parameters for the linear channel characteristics function per subcarrier: HLINSC, HLINps, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream linear representation scale (HLINSCds, HLINSCus) SHALL be within the range specified in Section 7.5.1.26.1 and 7.5.1.26.3 of G.997.1. (4) Downstream and upstream H(f) linear representation (HLINpsds, HLINpsus) SHALL be within the specified format and range as defined in Section 7.5.1.26.3 and 7.5.1.26.9 of G.997.1.

5.6.2 Logarithmic Channel Characteristics Function (HLOG) Test

Table 5-15 HLOG Test requested by ATU-C

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-C side to the L3 state. (2) Force the ATU-C to perform the loop diagnostic mode. (3) Collect and record the following parameters: HLOGMT, HLOGps, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream HLOG measurement time (HLOGMTds, HLOGMTus) SHALL be within the range specified in Section 7.5.1.26.4 and 7.5.1.26.10 of G.997.1. (4) Downstream and upstream H(f) logarithmic representation

	(HLOGpsds, HLOGpsus) SHALL be within the specified format and range as defined in Section 7.5.1.26.6 and 7.5.1.26.12 of G.997.1.

Table 5-16 HLOG Test requested by ATU-R

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	1) Force the line at the ATU-R side to the L3 state. 2) Force the ATU-R to perform the loop diagnostic mode. 3) Collect and record the following parameters: HLOGMT, HLOGps, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream HLOG measurement time (HLOGMTds, HLOGMTus) SHALL be within the range specified in Section 7.5.1.26.4 and 7.5.1.26.10 of G.997.1. (4) Downstream and upstream H(f) logarithmic representation (HLOGpsds, HLOGpsus) SHALL be within the specified format and range as defined in Section 7.5.1.26.6 and 7.5.1.26.12 of G.997.1.

5.6.3 Quiet Line Noise (QLN) Test

Table 5-17 QLN Test requested by ATU-C

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-C side to the L3 state. (2) Force the ATU-C to perform the loop diagnostic mode. (3) Collect and record the following parameters: QLNMT, QLNps, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream QLN measurement time (QLNMTds, QLNMTus) SHALL be within the range specified in Section 7.5.1.27.1 and 7.5.1.27.4 of G.997.1. (4) Downstream and upstream QLN(f) representation (QLNpsds,

	QLNpsus) SHALL be within the specified format and range as defined in Section 7.5.1.27.3 and 7.5.1.27.6 of G.997.1.

Table 5-18 QLN Test requested by ATU-R

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-R side to the L3 state. (2) Force the ATU-R to perform the loop diagnostic mode. (3) Collect and record the following parameters: QLNMT, QLNps, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream QLN measurement time (QLNMTds, QLNMTus) SHALL be within the range specified in Section 7.5.1.27.1 and 7.5.1.27.4 of G.997.1. (4) Downstream and upstream QLN(f) representation (QLNpsds, QLNpsus) SHALL be within the specified format and range as defined in Section 7.5.1.27.3 and 7.5.1.27.6 of G.997.1.

5.6.4 Signal-to-Noise Ratio (SNR) Test

Table 5-19 SNR Test requested by ATU-C

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-C side to the L3 state. (2) Force the ATU-C to perform the loop diagnostic mode. (3) Collect and record the following parameters: SNRMT, SNRps in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream SNR measurement time (SNRMTds, SNRMTus) SHALL be within the range specified in Section 7.5.1.28.1 and 7.5.1.28.4 of G.997.1. (4) Downstream and upstream SNR(f) representation (SNRpsds, SNRpsus) SHALL be within the specified format and range as defined in Section 7.5.1.28.3 and 7.5.1.28.6 of G.997.1.

Table 5-20 SNR Test requested by ATU-R

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-R side to the L3 state. (2) Force the ATU-R to perform the loop diagnostic mode. (3) Collect and record the following parameters: SNRMT, SNRps in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream SNR measurement time (SNRMTds, SNRMTus) SHALL be within the range specified in Section 7.5.1.28.1 and 7.5.1.28.4 of G.997.1. (4) Downstream and upstream SNR(f) representation (SNRpsds, SNRpsus) SHALL be within the specified format and range as defined in Section 7.5.1.28.3 and 7.5.1.28.6 of G.997.1.

5.6.5 Loop Attenuation (LATN) Test

Table 5-21 LATN Test requested by ATU-C

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-C side to the L3 state. (2) Force the ATU-C to perform the loop diagnostic mode. (3) Collect and record the LATN parameter, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream LATN parameter (LATNds, LATNus) SHALL be within the specified format and range as defined in Section 7.5.1.9 and 7.5.1.10 of G.997.1.

Table 5-22 LATN Test requested by ATU-R

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode.

	(3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-R side to the L3 state. (2) Force the ATU-R to perform the loop diagnostic mode. (3) Collect and record the LATN parameter, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream LATN parameter (LATNds, LATNus) SHALL be within the specified format and range as defined in Section 7.5.1.9 and 7.5.1.10 of G.997.1.

5.6.6 Signal Attenuation (SATN) Test

Table 5-23 SATN Test requested by ATU-C

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-C side to the L3 state. (2) Force the ATU-C to perform the loop diagnostic mode. (3) Collect and record the SATN parameter, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream SATN parameter (SATNds, SATNus) SHALL be within the specified format and range as defined in Section 7.5.1.11 and 7.5.1.12 of G.997.1.

Table 5-24 SATN Test requested by ATU-R

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-R side to the L3 state. (2) Force the ATU-R to perform the loop diagnostic mode. (3) Collect and record the SATN test parameter, in both downstream

	and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream SATN parameter (SATNds, SATNus) SHALL be within the specified format and range as defined in Section 7.5.1.11 and 7.5.1.12 of G.997.1.

5.6.7   Signal-to-Noise Ratio Margin (SNRM) Test

Table 5-25 SNRM Test requested by ATU-C

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-C side to the L3 state. (2) Force the ATU-C to perform the loop diagnostic mode. (3) Collect and record the SNRM parameter, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream SNRM parameter (SNRMds, SNRMus) SHALL be within the specified format and range as defined in Section 7.5.1.13 and 7.5.1.16 of G.997.1.

Table 5-26 SNRM Test requested by ATU-R

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-R side to the L3 state. (2) Force the ATU-R to perform the loop diagnostic mode. (3) Collect and record the SNRM test parameter, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (4) The line SHALL return to the L3 state. (5) Line configuration parameter LDSF SHALL be set to 0. (6) Downstream and upstream SNRM parameter (SNRMds, SNRMus) SHALL be within the specified format and range as defined in Section 7.5.1.13 and 7.5.1.16 of G.997.1.

5.6.8 Attainable Net Data Rate (ATTNDR) Test

Table 5-27 ATTNDR Test requested by ATU-C

Test Configuration	(1) See Section 4.1 for the test configuration.
	(2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode.
	(3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region.
	(4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1.
	(5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-C side to the L3 state.
	(2) Force the ATU-C to perform the loop diagnostic mode.
	(3) Collect and record the ATTNDR parameter, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode:
	(1) The line SHALL return to the L3 state.
	(2) Line configuration parameter LDSF SHALL be set to 0.
	(3) Downstream and upstream ATTNDR parameter (ATTNDRds, ATTNDRus) SHALL be within the specified format and range as defined in Section 7.5.1.19 and 7.5.1.20 of G.997.1.

Table 5-28 ATTNDR Test requested by ATU-R

Test Configuration	(1) See Section 4.1 for the test configuration.
	(2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode.
	(3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region.
	(4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1.
	(5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-R side to the L3 state.
	(2) Force the ATU-R to perform the loop diagnostic mode.
	(3) Collect and record the ATTNDR test parameter, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode:
	(1) The line SHALL return to the L3 state.
	(2) Line configuration parameter LDSF SHALL be set to 0.
	(3) Downstream and upstream ATTNDR parameter (ATTNDRds, ATTNDRus) SHALL be within the specified format and range as defined in Section 7.5.1.19 and 7.5.1.20 of G.997.1.

5.6.9 Actual Aggregate Transmit Power (ACTATP) Test

Table 5-29 ACTATP Test requested by ATU-C

Test Configuration	(1) See Section 4.1 for the test configuration.
	(2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode.
	(3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region.

	(4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-C side to the L3 state. (2) Force the ATU-C to perform the loop diagnostic mode. (3) Collect and record the ACTATP parameter, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream ACTATP parameter (ACTATPds, ACTATPus) SHALL be within the specified format and range as defined in Section 7.5.1.24 and 7.5.1.25 of G.997.1.

Table 5-30 ACTATP Test requested by ATU-R

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per ADSL2/2plus Annex to be tested, configure the SUT for operation in rate adaptive mode. (3) Set up the line simulator to 1350 ft 26AWG for the NA region or 450m PE04 or TP100 for the EU region. (4) Specific settings to force the ATU to perform the LD mode: set the line configuration parameter LDSF to 1. (5) Set the noise generator to -120 dBm/Hz at both ends of the loop.
Method of Procedure	(1) Force the line at the ATU-R side to the L3 state. (2) Force the ATU-R to perform the loop diagnostic mode. (3) Collect and record the ACTATP test parameter, in both downstream and upstream.
Expected Result	After successful completion of the Loop Diagnostic mode: (1) The line SHALL return to the L3 state. (2) Line configuration parameter LDSF SHALL be set to 0. (3) Downstream and upstream ACTATP parameter (ACTATPds, ACTATPus) SHALL be within the specified format and range as defined in Section 7.5.1.24 and 7.5.1.25 of G.997.1.

5.7   Power Management Mode Transition Test

The purpose of this test is to make sure that the power management mode transition procedures L0-to-L2 and L2-to-L0 are implemented according to requirements from section 9.5 of G.992.3 [2]. In the description of these power modes L0 mode refers to the normal (full power/full rate operation), while L2 mode refers to the power saving mode that conveys reduced traffic sent from the ATU-C to the ATU-R. A normal data carrying signal is transmitted from the ATU-R to the ATU-C.

During the entire L2 mode, i.e. after L2 entry and before L2 exit, the overhead rate, the delay, and overhead channel period do not need to obey the limits configured for L0 Showtime operation.

This test assumes that the modem remains in L2 for a specific duration. Should the modem exit the L2 state to perform a bit swap, this is not considered to be a failure and the intermediate L0 state SHALL be ignored.

This test is divided into two sub-tests, low power entry test and low power exit test. Both sub-tests are REQUIRED for the SUT to pass the power management mode transition test.

5.7.1 Low Power Entry Test

The purpose of this test is to verify that ATU-C and ATU-R can operate in the power saving mode after the ATU-C initiates the transition to L2 link state. ATU-C SHALL initiate a transition to L2 low power mode with the configured "Minimum Data Rate in low power state", L2-ATPR and L2-ATPRT.

Table 5-31 Low Power Entry Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in the Annex specific test profile in rate adaptive mode and general line setting I-16/2. (3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1km PE04 for Annex A EU and Annex B. (4) Set the noise generator to -120dBm/Hz AWGN at both ends of the loop. (5) Additional test conditions SHALL be as follows: - ADSL2: "Minimum Data Rate in low power state"=1000kbps, L2-ATPR=2dB, L2-ATPRT=4dB - ADSL2plus: "Minimum Data Rate in low power state"=2000kbps, L2-ATPR=2dB, L2-ATPRT=4dB (6) Set the power management state enabling parameter PMMode to 1.
Method of Procedure	(1) Force an initialization and wait for modems to sync. (2) Wait 1 minute following synchronization. (3) Document the reported Line power management state and aggregate transmit power in DS (ATP_L0). (4) If available record the reported LSYMB, RFEC and NFEC. (5) Let the ATU-C initiate transition to L2 state. (6) Document the reported Line power management state and aggregate transmit power (ATP_L2) in DS. (7) If available record the reported LSYMB, RFEC and NFEC. (8) Calculate the data rate DR = LSYMB*4*(1-RFEC/NFEC). (9) Record the CV count for 1 minute.
Expected Result	(1) No loss of synchronization SHALL occur during the test. (2) Line power management state reported in step (5) SHALL be L2. (3) Calculated data rate DR in step (5) SHALL be above ≥ "Minimum Data Rate in low power state". (4) The Reduction of DS transmit power reported in step (3) and (5) SHALL be ≤ L2-ATPRT dB. (5) The number of reported CVs SHALL be ≤ 1.

5.7.2 Low Power Exit Test

The purpose of this test is to verify that the ATUs can initiate the transition from L2 to L0 state.

Table 5-32 ATU-C Initiated Low power exit test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in the Annex specific test profile in

	rate adaptive mode and general line setting I-16/2.
	(3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1km PE04 for Annex A EU and Annex B.
	(4) Set the noise generator to -120dBm/Hz AWGN at both ends of the loop.
	(5) Additional test conditions SHALL be as follows:
	• ADSL2: "Minimum Data Rate in low power state"=1000kbps, L2-ATPR=2dB, L2-ATPRT=4dB
	• ADSL2plus: "Minimum Data Rate in low power state"=2000kbps, L2-ATPR=2dB, L2-ATPRT=4dB
	(6) Set the power management state enabling parameter PMMode to 1.
Method of Procedure	(1) Force an initialization and wait for modems to sync.
	(2) Wait 1 minute following synchronization.
	(3) Document the reported Line power management state, the actual data rate (RATE_L0) and aggregate transmit power in DS (ATP_L0).
	(4) Let the ATU-C initiate transition to L2 state.
	(5) Wait for 3 minutes in low power mode.
	(6) Let the ATU-C initiate transition to L0 state.
	(7) Document the reported Line power management state, the actual data rate (RATE_L20) and aggregate transmit power in DS (ATP_L20).
	(8) Record the CV count for 1 minute.
Expected Result	(1) No loss of synchronization SHALL occur during the test.
	(2) The Line power management state reported in step (3) and (7) SHALL be L0.
	(3) RATE_L0 SHALL be equal to RATE_L20.
	(4) ATP_L0 SHALL be equal to ATP_L20 within 1 dB.
	(5) The number of reported CVs SHALL be ≤ 1.

Table 5-33 ATU-R Initiated Low power exit test

Test Configuration	(1) See Section 4.1 for the test configuration.
	(2) Configure the SUT for operation in the Annex specific test profile in rate adaptive mode and general line setting I-16/2.
	(3) Set up the line simulator to 3 kft 26AWG for Annex A NA or 1km PE04 for Annex A EU and Annex B.
	(4) Set the noise generator to -120dBm/Hz AWGN at both ends of the loop.
	(5) Additional test conditions SHALL be as follows:
	• ADSL2: "Minimum Data Rate in low power state"=1000kbps, L2-ATPR =2dB, L2-ATPRT=4dB
	• ADSL2plus: "Minimum Data Rate in low power state"=2000kbps, L2-ATPR=2dB, L2-ATPRT=4dB
	(6) Set the power management state enabling parameter PMMode to 1.
Method of Procedure	(1) Force an initialization and wait for modems to sync.
	(2) Wait 1 minute following synchronization.
	(3) Document the reported Line power management state, the actual data rate (RATE_L0) and aggregate transmit power in DS (ATP_L0).

	(4) Let the ATU-C initiate transition to L2 state. (5) Wait for 3 minutes in low power mode. (6) Let the ATU-R initiate transition to L0 state. (7) Document the reported Line power management state, the actual data rate (RATE_L20) and aggregate transmit power in DS (ATP_L20). (8) Record the CV count for 1 minute
Expected Result	(1) No loss of synchronization SHALL occur during the test. (2) The Line power management state reported in step (3) and (7) SHALL be L0. (3) RATE_L0 SHALL be equal to RATE_L20. (4) ATP_L0 SHALL be equal to ATP_L20 within 1 dB. (5) The number of reported CVs SHALL be ≤ 1.

5.8   Low power (L2) mode

The purpose of this test is to verify the functionality of the L2 mode. The test SHALL be performed for the following general line settings: F-1/0 and either I-16/0.5 or 16/2 for G.992.5 Annex A, and F-1/0 and 16/2 for G.992.5 Annex B. The test SHALL be performed for two out of the three following parameter sets.

Table 5-34 L2 mode test parameter sets

Parameter Set	L0-TIME (s)	L2-TIME (s)	L2-ATPR (dB)	L2-ATPRT (dB)
1	10	10	5	20
2	30	30	1	5
3	10	10	3	12

Table 5-35 L2 mode test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in the following specific test profiles associated to the ADSL operation mode to be tested: • G.992.5 Annex A: A2P_RA_F_30000k, A2P_RA_I1/2_30000k or A2P_RA_I_30000k • G.992.5 Annex B: B2P_RA_F_30000k, B2P_RA_I_30000k (2) Set up the line simulator to 4 kft 26AWG for Annex A NA or 1250m PE04 for Annex A EU and Annex B. (3) Configure one of the L2 mode parameter sets defined in Table 5-34. (4) Set the noise generator to -120dBm/Hz AWGN at both ends of the loop. (5) Set the power management state enabling parameter PMMode to 1. (6) Following additional parameters are to be used for this test: Minimum data rate in low power state = 128kbps.
Method of Procedure	(1) Force a new initialization and wait for modems to sync. (2) Directly after synchronization, inject bi-directional traffic at rate > 75% of maximum theoretical throughput. (3) Wait for 1 minute for bitswaps to settle. (4) Note down the L2 mode parameter set. (5) Note down the Line power management state as LS1, ACTATPds1, actual SNRMds1 and net data rate DS as rateDS1. (6) Reduce traffic to a rate less than 64kbps. (7) Wait for ((L2-ATPRT / L2-ATPR) * L2-TIME + L0-TIME + 30s)

	for L2 mode transition and maximum power reduction. (8) Note down the Line power management state as LS2, ACTATPds2, actual SNRMds2 and net data rate DS as rateDS2. (9) Wait a further 5 minutes. (10) Note down the Line power management state as LS3, ACTATPds3, actual SNRMds3 and net data rate DS as rateDS3. (11) Note down the values of CV and SES counters as CV1 and SES1, respectively. (12) Reduce traffic to a rate less than 64kbps. (13) Wait for 1 min and note down the values of CV and SES counters as CV2 and SES2, respectively. (14) Note down the Line power management state as LS4, ACTATPds4, actual SNRMds4 and net data rate DS as rateDS4. (15) Repeat steps (1) to (14) with another L2 mode parameter set, different from the set reported in (4).
Expected Result	(1) No loss of synchronization SHALL occur during the test. (2) LS2 = L2 and LS3 =L2. (3) LS1 = L0 and LS4 =L0. (4) ACTATPds2 < ACTATPds1. (5) ACTATPds2 = ACTATPds3. (6) | ACTATPds4 – ACTATPds1 | <= 1dB. (7) | SNRMds1 – SNRMds4 | <= 1dB. (8) rateDS4 = rateDS1. (9) rateDS2 = rateDS3. (10) SES2 – SES1 = 0. (11) CV2 – CV1 <=1.

5.9   PSD Tests

5.9.1   PSD Mask Test

The purpose of this test is to verify that the ATU-C and ATU-R power spectral density (PSD) mask in Showtime does not exceed the mask set forth by ITU-T ADSL2/ADSL2plus recommendations. This measurement SHALL include both the passband and stopband frequencies, up to 11.04 MHz for ADSL2 and 12.0 MHz for ADSL2plus.

Table 5-36 PSD Mask Test

Test Configuration	(1) See Section 4.1 for the Annex specific test configuration. (2) The test setup SHALL support the PSD mask measurement over the entire downstream and upstream bands and SHALL provide enough dynamic range to allow the measurements be done over both the passband and stopband frequencies into a resolution bandwidth less than or equal to 10 kHz. (3) Configure the SUT for operation in the Annex specific test profile in rate adaptive mode and general line setting F-1/0. Note: this PSD test is conceived for specific test profile with DPBO disabled. (4) Line simulator SHALL be set up for the straight homogeneous loop specified for the regional annex, Section 4.4. Its length SHALL be varied in 5 steps from the NULL loop to the length at which the loop

	is the equivalent of 11dB@ 300kHz. Alternatively, a flat attenuator MAY be used to perform the measurements, provided its value matches the attenuation of the equivalent loop at 300kHz.

Method of Procedure	(1) Connect and configure the ATU-C and ATU-R as per test configuration details.
	(2) Set spectrum analyzer for the requested frequency range, resolution bandwidth and input attenuation range to prevent it from being over driven.
	(3) Force initialization and wait for modems to synchronize.
	(4) Wait 1 minute following synchronization. Disconnect the line. The ADSL link SHOULD stay in L0 stay long enough for the PSD to be measured. If it does not see the NOTE below.
	(5) PSD SHALL be measured in one of the following ways:
	   a. over a resistive load of 100 Ohm (the same value as the ATU termination impedance) and a high-impedance differential probe
	   b. over a wideband 50:100 BALUN transformer (assumes 50 Ohm analyser)
	If the characteristic of the balun or resistor is not calibrated out, it SHALL have an affect of <= 0.5dB on the PSD measurement.
	(6) Take a note of the measured downstream and upstream PSD data.
	(7) Repeat the test steps (3) – (6) for all five loop lengths (between NULL loop and the defined maximum loop) according to test configuration TC(4).
	
	NOTE: If the ATUs can not operate in a mode described in step (4), the test setup SHALL provide adequate isolation of the downstream and upstream transmit signals between the two transceivers to allow for an accurate measurement to be made, while both transceivers remain connected and in state L0. If mode described in step (4) is unavailable, the measurements will not be made on loops or attenuation settings not providing adequate isolation, and the measurement method used will be noted within the test report.

Expected Result	Measured PSD SHALL not exceed the maximum passband transmit PSD level for non-overlapped spectrum operation specified in Annex A and B of G.992.3/G.992.5, Annex L of G.992.3 and Annex M of G.992.5.

5.9.2   Aggregate Transmit Power Test

The purpose of this test is to verify that the ATU-C and ATU-R does not transmit the total amount of transmit power that exceeds the maximum downstream/upstream transmit power specified in ITU-T ADSL2/ADSL2plus recommendations. The aggregate transmit power SHALL be measured over the entire passband and stopband frequencies, up to 11.04 MHz for ADSL2 and 12.0 MHz for ADSL2plus.

Table 5-37 Aggregate Transmit Power Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) The test setup SHALL support the aggregate transmit power (ATP) mask measurement over the entire downstream and upstream bands and SHALL provide enough dynamic range to allow the measurements be done over both the passband and stopband

	frequencies into a resolution bandwidth less than or equal to 10 kHz. (3) Configure the SUT for operation in the Annex specific test profile in rate adaptive mode and general line setting F-1/0. (4) Line simulator SHALL be set up for the straight homogeneous loop specified for the regional annex, Section 4.4. Its length SHALL be varied in 5 steps from the NULL loop to the length at which the loop is the equivalent of 11dB@ 300kHz. Alternatively, a flat attenuator MAY be used to perform the measurements, provided its value matches the attenuation of the equivalent loop at 300kHz.

Method of Procedure	(1) Connect and configure the ATU-C and ATU-R as per test configuration details.
	(2) Force initialization and wait for modems to synchronize.
	(3) Wait 1 minute following synchronization. Disconnect the line. The ADSL link SHOULD stay in L0 stay long enough for the ATP to be measured. If it does not see the NOTE in Table 5-36.
	(4) ATP SHALL be measured in one of the following ways:
	   a. over a resistive load of 100 Ohm (the same value as the ATU termination impedance) and a high-impedance differential probe
	   b. over a wideband 50:100 BALUN transformer (assumes 50 Ohm analyser)
	   If the characteristic of the balun or resistor is not calibrated out, it SHALL have an affect of <= 0.5dB on the power measurement.
	(5) Take a note of the measured downstream and upstream aggregate transmit power.
	(6) Repeat the test steps (2) – (5) for all five loop lengths (between NULL loop and the defined maximum loop) according to test configuration TC(4).

Expected Result	Measured aggregate transmit power SHALL not exceed the aggregate transmit power for non-overlapped spectrum operation specified in Annex A and B of G.992.3/5, Annex L of G.992.3 and Annex M of G.992.5.

5.9.3   In-Band Spectral Shaping Test

For further study.

5.9.4   Downstream Power Back-off Test

The purpose of this test is to verify the modified CO-MIB transmit PSD mask based on the downstream power back-off configuration parameters and procedure described in Section 7.3.1.2.13 in G.997.1 [4]. The modified PSD mask is used instead of PSDMASKds to configure the downstream PSD mask applicable at the U-C2 reference point.

As for FTTCab/FTTB/Curb deployments, for which it is relevant to test with shaping, the following Common Line Settings are defined for ADSL2plus operation with DPBO PSD shaping. These functionalities are adopted in real networks to guarantee spectral compatibility of xDSL systems deployed from the Cabinet, Curb or Building with legacy ADSL2/ADSL2plus (or new VDSL2) systems from the Exchange.

Table 5-38 Downstream Power Back-Off test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) The test setup SHALL support the PSD mask and aggregate transmit power (ATP) measurements over the entire downstream band and SHALL provide enough dynamic range to allow the measurements be done over both the passband and stopband frequencies into a resolution bandwidth less than or equal to 10 kHz. (3) Configure the SUT for operation in the Annex specific test profile in rate adaptive mode, with the cable electrical length (DPBOESEL) of 27 dB and general line setting F-1/0 (see Table 4-2). (4) Line simulator SHALL be set up for the straight homogeneous loop specified for the regional annex, Section 4.4. Its length SHALL be set to the length at which the loop is the equivalent of 20dB@ 1MHz. Alternatively, a flat attenuator MAY be used to perform the measurements, provided its value matches the attenuation of the equivalent loop at 1MHz.

Method of Procedure	(1) Connect and configure the ATU-C and ATU-R as per test configuration details.
	(2) Set spectrum analyzer for the requested frequency range, resolution bandwidth and input attenuation range to prevent it from being over driven.
	(3) Force initialization and wait for modems to synchronize.
	(4) Wait 1 minute following synchronization. Disconnect the line. The ADSL link SHOULD stay in L0 stay long enough for the PSD to be measured. If it does not see the NOTE in Table 5-36.
	(5) PSD SHALL be measured, while ATP could be measured or calculated from the PSD in one of the following ways:
	    a. over a resistive load of 100 Ohm (the same value as the ATU termination impedance) and a high-impedance differential probe
	    b. over a wideband 50:100 BALUN transformer (assumes 50 Ohm analyser)
	If the characteristic of the balun or resistor is not calibrated out, it SHALL have an affect of <= 0.5dB on the measurement.
	(6) Take a note of the measured PSD data. Take a note of the measured PSD data.
	(7) Take a note of the measured or calculated ATP.
	(8) Repeat the test steps (3) – (7) for DPBOESEL set to 72 dB.
	(9) Repeat the test steps (3) – (7) for one additional DPBOESEL between 40 and 60 dB.

Expected Result	(1) ATU-C and ATU-R shall synchronize in all tested DPBO configurations. (2) Measured PSD mask SHALL comply with the requirements and a procedure to generate a modified downstream PSD mask described in G.997.1 [4] and SHALL not exceed the resultant mask (RESULTMASKds). (3) Measured aggregate transmit power SHALL not exceed the aggregate transmit power for non-overlapped spectrum operation specified in Annex A and B of G.992.5 [3].

5.10   Longitudinal Balance Test

This test will verify the ATU-x interface is balanced well enough to reject common mode noise that may be present on the physical media and fulfills the requirement from section A.4.3.3.1 and B.4.1.3.1 in G.992.3 [2]. LCL is a measure in dB of the degree of unwanted transversal signal produced at the input of the ADSL transceiver (e_m) due to the presence of a longitudinal signal (e_l) on the connecting leads. This measurement SHALL be made over the passband.

$$\text{Longitudinal Balance} = 20\log_{10}\left(\frac{e_l}{e_m}\right)$$

The test setup SHOULD ideally exhibit 20 dB better balance than is REQUIRED of the device under test (if less is achieved, a greater error will be present in the measurement).

Table 5-39 Longitudinal Balance Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in the Annex specific test profile in rate adaptive mode and general line setting F-1/0. (3) During the test, the transceiver under test SHALL be powered and not transmitting any signal (L3 state).
Method of Procedure	Measure the LCL as specified in ITU-T Recommendation G.117 [7] and O.9 [6] in the frequency range f_{min} to f_{max}: • ADSL2 Annex A: 30kHz to 1104kHz • ADSL2 Annex B: 120kHz to 1104kHz • ADSL2plus Annex A: 30kHz to 2208kHz • ADSL2plus Annex B: 120kHz to 2208kHz
Expected Result	The measured longitudinal balance SHALL meet the following requirements: • ADSL2 Annex A: (1) ATU-C SHALL have an LCL of at least 50dB in the frequency range from 30kHz to 138kHz and at least 40dB above and up to 1104kHz. (2) ATU-R SHALL have an LCL of at least 50dB in the frequency range from 30kHz to 1104kHz. • ADSL2 Annex B: (1) ATU-C SHALL have an LCL of at least 50dB in the frequency range from 120kHz to 276kHz and at least 40dB above and up to 1104kHz.

	(2) ATU-R SHALL have an LCL of at least 50dB in the frequency range from 120kHz to 1104kHz. • ADSL2plus Annex A: (1) ATU-C SHALL have an LCL of at least 50dB in the frequency range from 30kHz to 138kHz and at least 40dB above and up to 2208kHz. (2) ATU-R SHALL have an LCL of at least 50dB in the frequency range from 30kHz to 1104kHz and at least 40dB above and up to 2208kHz. • ADSL2plus Annex B: (1) ATU-C SHALL have an LCL of at least 50dB in the frequency range from 120kHz to 276kHz and at least 40dB above and up to 2208kHz. (2) ATU-R SHALL have an LCL of at least 50dB in the frequency range from 120kHz to 1104kHz and at least 40dB above and up to 2208kHz.

5.11   Virtual Noise Test

For further study.

5.12   ATU-R Inventory Information Test

The purpose of this test is to verify that the ATU-R inventory formatting is correct according to Section 7.4 of G.997.1 [4] and the information contained within the fields is consistent with the equipment identification information provided by the equipment supplier to the test lab.

Table 5-40 ATU-R Inventory Information Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in one of the specific test profiles defined in Section 4.2.2 associated to the ADSL operation mode to be tested..
Method of Procedure	(1) Connect ATU-R and ATU-C with NULL loop and no noise injected. (2) Force a new initialization and wait for modems to sync. Wait for 1 minute after initialization for OHC data to be exchanged. (3) Read out the ATU-R identification information at the ATU-C.

Expected Result	(1) ATU-R G.994.1 Vendor ID is correct as specified in Section 7.4.2 of G.997.1 [4]
	    • The T.35 country code (2 octets) is correct for the country of the vendor of the ATU-R DSL Chipset.
	    • The T.35 provider code (vendor identification) (4 octets) correctly identifies the vendor of the ATU-R DSL Chipset.
	
	 (2) ATU-R System Vendor ID is correct as specified in Section 7.4.4 of G.997.1 [4]
	    • The T.35 country code (2 octets) is correct for the country of the system integrator (ATU-R vendor)
	    • The T.35 provider code (vendor identification) (4 octets) correctly identifies ATU-R vendor
	
	 (3) ATU-R version number is correct as specified in Section 7.4.6 of G.997.1 [4]

	• It contains the ATU-R firmware version and the ATU-R model. Both SHALL be encoded in this order and separated by a space character, i.e. "<ATU-R firmware version> <ATU-R model>".
	(4) ATU-R serial number is correct as specified in Section 7.4.8 of G.997.1 [4] • It contains the equipment serial number, the equipment model and the equipment firmware version. All SHALL be encoded in this order and separated by space characters, i.e. "<equipment serial number> <equipment model> <equipment firmware version>".

5.13   EOC Communication Test

The purpose of this test is to verify that the operational statistics reported by the ATU-R match those reported at the ATU-C.

Table 5-41 EOC Communication Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in one of the specific test profiles defined in Section 4.2.2 associated to the ADSL operation mode to be tested.

Method of Procedure	(1) Connect ATU-R and ATU-C with PE04 1500m or 5000ft 26AWG, with no noise injected.
	 (2) Force a new initialization and wait for modems to sync. Wait for 1 minute after initialization.
	 (3) Use the software supplied by the ATU-R vendor or a web browser, which ever is recommended by the vendor, to retrieve operational parameters of the modem. Verify the following parameters and their counterparts on the ATU-C:
	     • Actual data rate (DS, US)
	     • Signal-to-Noise Ratio Margin (SNRMds, SNRMus)
	     • Line attenuation (LATNds, LATNus)
	     • Signal attenuation (SATNds, SATNus)
	     • Transmission system type (XTSE)

Expected Result	(1) Data rates reported by ATU-R SHALL differ by no more than 1kbps from the rates reported by ATU-C. (2) SNR margin values reported by ATU-R SHALL differ by no more than 1dB from the values reported by ATU-C. (3) Line attenuation values reported by ATU-R SHALL differ by no more than 1dB from the values reported by ATU-C. (4) Signal attenuation values reported by ATU-R SHALL differ by no more than 1dB from the values reported by ATU-C. (5) Transmission system type reported by ATU-R SHALL match the type reported by ATU-C.

6   Configuration Parameters

These tests verify the G.997.1 configuration parameters.

6.1   Configuration Parameter MAXSNRM

A test procedure for verification of the MAXSNRM noise margin configuration parameter is shown in Table 6-1. Parameters MAXSNRMds and MAXSNRMus define the maximum noise margin the ATU-R/ATU-C receiver SHALL try to sustain. This test procedure SHALL be applied for both directions of transmission.

Table 6-1 MAXSNRM control test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT with A2P_Fix_I_600k or B2P_Fix_I_864k profile depending on the G.992.5 Annex under test.
Method of Procedure	(1) Connect ATU-R and ATU-C with PE04 2500m or 8500ft 26AWG, and -120dBm/Hz AWGN noise. (2) Force a new initialization and wait for modems to sync. (3) Wait for 1 minute after initialization. (4) Note down the reported downstream and upstream SNR margin and aggregate ATP named SNRMds1, SNRMus1, ACTATPds1 and ACTATPus1. (5) Configure MAXSNRMus and MAXSNRMds to 12dB. (6) Force a new initialization and wait for modems to sync. (7) Wait for 1 minute after initialization. (8) Note down the reported downstream and upstream SNR margin and aggregate ATP named SNRMds2, SNRMus2, ACTATPds2 and ACTATPus2. (9) Calculate difference between the reported SNRMds in step (4) and (8) as ΔSNRMds = SNRMds1 – SNRMds2. (10) Calculate difference between the reported SNRMus in step (4) and (8) as ΔSNRMus = SNRMus1– SNRMus2. (11) Calculate difference between the reported ACTATPds in step (4) and (8) as ΔACTATPds = ACTATPds1 – ACTATPds2. (12) Calculate difference between the reported ACTATPus in step (4) and (8) as ΔACTATPus = ACTATPus1 – ACTATPus2.
Expected Result	(1) ΔSNRMds SHALL be > 9dB. (2) ΔSNRMus SHALL be > 9dB. (3) ΔACTATPds SHALL be > 9dB. (4) ΔACTATPus SHALL be > 9dB.

6.2   Configuration parameter MINSNRM

A test procedure for verification of the MINSNRM noise margin configuration parameter is shown in Table 6-2. Parameters MINSNRMds and MINSNRMus define the minimum noise margin the ATU-R/ATU-C receiver SHALL tolerate. This test procedure SHALL be applied to both downstream and upstream direction.

Table 6-2 MINSNRM control test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) According to the Annex to be tested, configure the SUT in one of the rate adaptive specific test profiles. (3) Additionally, set MINSNRM to 1dB.
Method of Procedure	(1) Connect ATU-R and ATU-C through the shortest loop length defined for the chosen specific test profile in the regional annex of TR-100 [8]. (2) Inject -120dBm/Hz AWGN noise added at both the ATU-R and ATU-C ends. This power level is considered the 0dB noise power. (3) Force a new initialization and wait for modems to sync. Wait for 1 minute after initialization. (4) Record the reported SNR margin (SNRMds and SNRMus). (5) Increase the noise power level by 1dB at the ATU side under test. Wait for 1 minute for bitswaps to settle. (6) Record the reported SNR margin. (7) Repeat steps (5) and (6) until the reported SNR margin becomes lower than MINSNRM. (8) Repeat steps (3) - (7) with MINSNRM value set to 2 and 3dB.
Expected Result	For each MINSNRM value modems SHALL retrain if the reported SNR margin is lower than MINSNRM.

6.3   Configuration parameter TARSNRM

A test procedure for verification of the TARSNRM noise margin configuration parameter is shown in Table 6-3.Parameters TARSNRMds and TARSNRMus define the noise margin the ATU-R/ATU-C receiver SHALL achieve to successfully complete initialization. This test procedure SHALL be applied to both downstream and upstream direction.

Table 6-3 TARSNRM control test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) According to the Annex to be tested, configure the SUT in one of the rate adaptive specific test profiles.
Method of Procedure	(1) Connect ATU-R and ATU-C through 5kft 26AWG or 1250m PE04. (2) Inject the crosstalk noise defined for the chosen test profile in the regional annex of TR-100 [8] at both ends of the loop. (3) Force a new initialization and wait for modems to sync. Wait for 1 minute after initialization. (4) Record the reported SNR margin, SNRMds and SNRMus. (5) Repeat the test 3 times. (6) Set TARSNRM to value different than 6dB and repeat step (3) to (5).
Expected Result	(1) For both values of TARSNRM, the MEAN value of the reported SNR margin over the 3 tests SHALL be ≥ (TARSNRM- 0.5) dB. (2) For Annex A: For both values of TARSNRM, each reported SNR margin SHALL be ≥ (TARSNRM – 2) dB. (3) For Annex B: For both values of TARSNRM, each reported SNR margin SHALL be ≥ (TARSNRM – 1) dB.

6.4   Configuration Parameter PSDMASK

This section applies only to G.992.5 PSDMASK testing. A test procedure for verification of the PSDMASK configuration parameter is shown in Table 6-4 (for PSDMASKds) and Table 6-5 (for PSDMASKus, applicable to Annex M only). Parameters PSDMASKds and PSDMASKus define the MIB PSD mask and it MAY impose additional PSD restrictions for the passband compared to the Limit PSD mask defined in the relevant Annex of G.992.5 Recommendation. The downstream PSD mask specified through the CO MIB shall satisfy the requirements defined in section 8.5.1 of G.992.5 [3].

Table 6-4 G.992.5 PSDMASKds control test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in one of the specific test profiles defined in Section 4.2.2 associated to the ADSL2plus operation mode to be tested. (3) Additional test conditions: Set the PSDMASK for the passband only and restrict the transmit PSD to levels below those allowed by the applicable Limit PSD mask.

Method of Procedure	(1) Connect ATU-C and ATU-R through the 5kft 26AWG for Annex A NA or 1500m PE04 for Annex A EU and Annex B and no noise injected.
	(2) Force a new initialization and wait for modems to sync.
	(3) Wait for 1 minute after initialization.
	(4) Disconnect the line. The ADSL2plus link SHOULD stay in L0 stay long enough for the PSD to be measured. If it does not see the NOTE in Table 5-36.
	(5) The PSD SHALL be measured across the passband in one of the following ways:
	   a. over a resistive load of 100 Ohm (the same value as the ATU termination impedance) and a high-impedance differential probe
	   b. over a wideband 50:100 BALUN transformer (assumes 50 Ohm analyser)
	If the characteristic of the balun or resistor is not calibrated out, it SHALL have an effect of ≤ 0.5dB on the PSD measurement.

Expected Result	Measured PSD SHALL NOT exceed the MIB PSD mask and the Limit PSD mask as defined in section 8.5.1 of G.992.5 [3].

Table 6-5 G.992.5 PSDMASKus control test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in one of the specific test profiles defined in Section 4.2.2 associated to the ADSL2plus Annex M operation mode to be tested. (3) Additional test conditions: Set the PSDMASK for the passband only and restrict the transmit PSD to levels below those allowed by the applicable Limit PSD mask.
Method of Procedure	(1) Connect ATU-C and ATU-R through the 5kft 26AWG for Annex A NA or 1500m PE04 for Annex A EU and Annex B and no noise injected. (2) Force a new initialization and wait for modems to sync.

	(3) Wait for 1 minute after initialization.
	(4) Disconnect the line. The ADSL2plus link SHOULD stay in L0 stay long enough for the PSD to be measured. If it does not see the NOTE in Table 5-36.
	(5) The PSD SHALL be measured across the passband in one of the following ways:
	   a. over a resistive load of 100 Ohm (the same value as the ATU termination impedance) and a high-impedance differential probe
	   b. over a wideband 50:100 BALUN transformer (assumes 50 Ohm analyser)
	If the characteristic of the balun or resistor is not calibrated out, it SHALL have an effect of $\leq$ 0.5dB on the PSD measurement

Expected Result	Measured PSD SHALL NOT exceed the MIB PSD mask and the Limit PSD mask as defined in Annex M of G.992.5 [3].

6.5   Configuration Parameter CARMASK

A test procedure for verification of the CARMASK configuration parameter is shown in Table 6-6. This parameter defines the restrictions in the downstream (CARMASKds) and upstream (CARMASKus) frequency ranges to determine the set of subcarriers allowed for transmission. It is coded as 1 if subcarrier with index I, sc(i), is masked for transmission, and 0 if the subcarrier is not masked.

The following CARMASK settings associated to the ADSL operation mode to be tested SHALL be configured:

a. G.992.3 Annex A:
  - CARMASKus: sc(20)…sc(28) = 1, all remaining sc(i) = 0
  - CARMASKds: sc (32)…sc(122) = 0, sc(123)…sc(210) = 1, sc(211)…sc(256) = 0

b. G.992.5 Annex A:
  - CARMASKus: sc (20)…sc(28) = 1, all remaining sc(i) = 0
  - CARMASKds: sc (32)…sc(122) = 0, sc(123)…sc(371) = 1, sc(372)…sc(512) = 0.

c. G.992.3 Annex B:
  - CARMASKus: sc (40)…sc(48) = 1, all remaining sc(i) = 0
  - CARMASKds: sc (64)…sc(122) = 0, sc(123)…sc(210) = 1, sc(211)…sc(256) = 0

d. G.992.5 Annex B:
  - CARMASKus: sc (40)…sc(48) = 1, all remaining sc(i) = 0
  - CARMASKds: sc (64)…sc(122) = 0, sc(123)…sc(371) = 1, sc(372)…sc(512) = 0.

Table 6-6 CARMASK control test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT for operation in one of the following specific test profiles associated to the ADSL operation mode to be tested: • G.992.3 Annex A: A2_RA_I1/2_16000k • G.992.5 Annex A: A2P RA_I1/2_30000k or A2P RA_I_30000k • G.992.3 Annex B: B2_RA_I_16000k • G.992.5 Annex B: B2P_RA_I_30000k

	(3) Set the CARMASK setting to the one that is associated with the used test profile.
Method of Procedure	(1) Connect ATU-C and ATU-R with 100m PE04 or 400ft 26AWG and no noise injected. (2) Force a new initialization and wait for modems to sync. (3) Wait for 1 minute after initialization. (4) Record the bits allocation tables BITSpsds and BITSpsus.
Expected Result	(1) No loss of synchronization SHALL occur during the test. (2) The reported bits BITSpsds and BITSpsus of the masked subcarriers SHALL be set to 0.

6.6 Configuration Parameter MAXNOMPSD

A test procedure for verification of the MAXNOMPSD configuration parameter is shown in Table 6-7. This test procedure SHALL be applied to both directions.

Table 6-7 MAXNOMPSD control test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) According to the Annex to be tested, configure the SUT in one of the rate adaptive specific test profiles.

Method of Procedure	(1) Connect ATU-C and ATU-R through the 2.5kft 26AWG for Annex A NA or 750m PE04 for Annex A EU and Annex B and no noise injected.
	 (2) Force a new initialization and wait for modems to sync.
	 (3) Wait for 1 minute after initialization.
	 (4) Disconnect the line. The ADSL link SHOULD stay in L0 stay long enough for the PSD to be measured. If it does not see the NOTE in Table 5-36.
	 (5) The PSD SHALL be measured across the passband in one of the following ways:
	    a. over a resistive load of 100 Ohm (the same value as the ATU termination impedance) and a high-impedance differential probe
	    b. over a wideband 50:100 BALUN transformer (assumes 50 Ohm analyser)
	 If the characteristic of the balun or resistor is not calibrated out, it SHALL have an effect of ≤ 0.5dB on the PSD measurement.

Expected Result	Measured PSD SHALL be $\leq$ MAXNOMPSD + 3.5 dB.

6.7 Configuration Parameter MAXNOMATP

A test procedure for verification of the MAXNOMATP configuration parameter is shown in Table 6-8. This test procedure SHALL be applied to both directions.

Table 6-8 MAXNOMATP control test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) According to the Annex to be tested, configure the SUT in one of the rate adaptive specific test profiles.
Method of Procedure	(1) Connect ATU-C and ATU-R through the 2.5kft 26AWG for Annex A NA or 750m PE04 for Annex A EU and Annex B and no noise injected. (2) Force a new initialization and wait for modems to sync.

	(3) Wait for 1 minute after initialization.
	 (4) Disconnect the line. The ADSL link SHOULD stay in L0 stay long enough for the power to be measured. If it does not see the NOTE in Table 5-36.
	 (5) The power SHALL be measured across the passband in one of the following ways:
	     a. over a resistive load of 100 Ohm (the same value as the ATU termination impedance) and a high-impedance differential probe
	     b. over a wideband 50:100 BALUN transformer (assumes 50 Ohm analyser)
	 If the characteristic of the balun or resistor is not calibrated out, it SHALL have an effect of ≤ 0.5dB on the power measurement.

Expected Result	Measured power SHALL be ≤ MAXNOMATP + 0.5dB.

7   Performance Monitoring Counters

This section defines a set of test procedures for verification of the G.997.1 [4] line and channel performance monitoring parameters (section 7.1 to 7.5) and verification of the previous data.

7.1   Performance Monitoring Counters for Code Violations and Errored Seconds

Table 7-1 Code Violation and Errored Second Test - Fast Mode

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT with A2P_Fix_F_600k or B2P_Fix_F_864k profile depending on the G.992.5 Annex under test. (3) Additional test conditions: OPTIONAL OLR (SRA, DRR) SHALL not be used.
Method of Procedure	(1) Connect ATU-R and ATU-C through NULL loop and no noise injected. (2) Force an initialization and wait for modem to sync. Wait 1 minute following synchronization. (3) Note down the initial value of performance monitoring counters CV-C, CV-CFE, ES-L, ES-LFE, SES-L, SES-LFE, UAS-L and UAS-LFE at the ATU-C, and CV-C, ES-L, SES-L and UAS-L at the ATU-R. (4) Force a "micro-interruption" of 3ms (+ or – 0.5ms) every 10 seconds for 2.5min (for a total of 15 micro-interruptions). (5) Force performance monitoring counters update and wait 30 seconds for the counters to be read out. (6) Note down the value of counter CV-C, ES-L, SES-L and UAS-L at the ATU-R. Note down the value of counters CV-C and CV-CFE, ES-L and ES-LFE, and UAS-L and UAS-LFE at the ATU-C. (7) Calculate the increase of these counters between step (6) and step (3).
Expected Result	(1) No loss of synchronization SHALL occur during the test. (2) No increase of SES-L, SES-LFE, UAS-L and UAS-LFE at the ATU-C SHALL be reported. (3) If available, no increase of SES-L and UAS-L at the ATU-R SHALL be reported. (4) The increase of CV-C counter at the ATU-R SHALL be equal to the increase of CV-CFE counter at the ATU-C. (5) The increase of CV-C counter at the ATU-R, as well as the increase of both CV-CFE and CV-C counters at the ATU-C SHALL be at least equal to 15 and $\leq$ 32 for DS and $\leq$ 31 for US (NOTE). (6) The increase of ES-L counter at the ATU-R SHALL be equal to the increase of ES-LFE counter at the ATU-C. (7) The increase of ES-L counter at the ATU-R, as well as the increase of both ES-LFE and ES-L counters at the ATU-C SHALL be at least equal to 15 and $\leq$ 32 for DS and $\leq$ 31 for US.

NOTE: The numbers in step (5) and (7) are computed taking into account up to 2 CRC for DS and up to 1 CRC for US due to 10^{-7} BER in the fast mode in 3 minutes test duration.

Table 7-2 Code Violation and Errored Second Test – Interleaved Mode

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT with A2P_Fix_I_600k or B2P Fix_I_864k profile depending on the G.992.5 Annex under test, with delay_max set to 2ms and INP_min to 0.5. (3) Additional test conditions: OPTIONAL OLR (SRA, DRR) SHALL not be used.
Method of Procedure	(1) Connect ATU-R and ATU-C through NULL loop and no noise injected. (2) Force an initialization and wait for modem to sync. Wait 1 minute following synchronization. (3) Note down the initial value of performance monitoring counters CV-C, CV-CFE, ES-L, ES-LFE, SES-L, SES-LFE, UAS-L and UAS-LFE at the ATU-C, and CV-C, ES-L, SES-L and UAS-L at the ATU-R. (4) Force one "micro-interruption" of 1ms every 10 seconds for 2.5 min (for a total of 15 micro-interruptions). (5) Force performance monitoring counters update and wait 30 seconds for the counters to be read out. (6) Note down the value of counter CV-C, ES-L, SES-L and UAS-L at the ATU-R. Note down the value of counters CV-C and CV-CFE, ES-L and ES-LFE, SES-L and SES-LFE, and UAS-L and UAS-LFE at the ATU-C. (7) Calculate the increase of these counters between step (6) and step (3).
Expected Result	(1) No loss of synchronization SHALL occur during the test. (2) No increase of SES-L, SES-LFE, UAS-L and UAS-LFE at the ATU-C SHALL be reported. (3) If available, no increase of SES-L and UAS-L at the ATU-R SHALL be reported. (4) The increase of CV-C counter at the ATU-R SHALL be equal to the increase of CV-CFE counter at the ATU-C. (5) The increase of CV-C counter at the ATU-R, as well as the increase of both CV-CFE and CV-C counters at the ATU-C, SHALL be at least equal to 15 and $\leq$ 31 for DS and $\leq$ 31 for US (NOTE). (6) The increase of ES-L counter at the ATU-R SHALL be equal to the increase of ES-LFE counter at the ATU-C. (7) The increase of ES-L counter at the ATU-R, as well as the increase of both ES-LFE and ES-L counters at the ATU-C, SHALL be at least equal to 15 and $\leq$ 31 for DS and $\leq$ 31 for US.

7.2   Performance Monitoring Counters for SES

Table 7-3 Severely Errored Second Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT with A2P_Fix_I_600k or B2P_Fix_I_864k profile depending on the G.992.5 Annex under test. (3) Additional test conditions: OPTIONAL OLR (SRA, DRR) SHALL not be used.
Method of Procedure	(1) Connect ATU-R and ATU-C through NULL loop and no noise injected. (2) Force an initialization and wait for modem to sync. Wait 1 minute following synchronization. (3) Note down the initial value of the SES-L, SES-LFE, UAS-L and UAS-LFE performance monitoring counters at the ATU-C and the initial value of the SES-L and UAS-L counters at the ATU-R. (4) Force one 330ms "micro-interruption" every 1s for 2 seconds (a total of 2 micro-interruptions). (5) Repeat previous event 14 times (14 x 2 micro-interruptions) with 10s between each event. (6) Force performance monitoring counters update and wait 30 seconds for the counters to be read out. (7) Note down the value of the counter SES-L and UAS-L at the ATU-R Note down the value of the counters SES-L and SES-LFE, and UAS-L and UAS-LFE at the ATU-C. (8) Calculate the increase of these counters between the values from step (7) and step (3).
Expected Result	(1) No loss of synchronization SHALL occur during the test. (2) No increase of UAS-L and UAS-LFE at the ATU-C SHALL be reported during the test time. (3) If available, no increase of UAS-L at the ATU-R SHALL be reported. (4) The increase of SES-L counter at the ATU-R SHALL be equal to the increase of SES-LFE counter at the ATU-C. (5) The increase of SES-L counter at the ATU-R, as well as the increase of both SES-LFE and SES-L counters at the ATU-C, SHALL be at least equal to 30 and ≤ 45.

7.3   Performance Monitoring Counters for Full Initialization, LOSS-L and LOSS-LFE

Table 7-4 Correct reporting of the Full Initialization and LOSS-L, LOSS-LFE counters

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the SUT with A2P_Fix_I_600k or B2P_Fix_I_864k profile depending on the G.992.5 Annex under test.

Method of Procedure	(1) Connect ATU-R and ATU-C with NULL loop and no noise injected. (2) Force an initialization and wait for modem to sync. Wait 1 minute following synchronization. (3) Note down the initial value of the Full initialization count, LOSS-L and LOSS-LFE performance monitoring counters at the ATU-C and the initial value of the LOSS-L counter at the ATU-R. (4) Disconnect the line for at least 7s until the modems retrain. (5) Wait for 1 min following synchronization. (6) Repeat steps (4) and (5) 4 times. (7) Note down the final value of the Full initialization count, LOSS-L and LOSS-LFE at the ATU-C and LOSS-L at the ATU-R. (8) Calculate the increase of the full initialization count, LOSS-L and LOSS-LFE as the difference between the values from step (7) and step (3).
Expected Result	(1) The increase of the Full initialization count value at the ATU-R SHALL be equal to the increase of the Full initialization count reported by the ATU-C. (2) The increase of the Full initialization count SHALL be ≥ 5 (NOTE). (3) The difference between increase of the LOSS-LFE counter at the ATU-C and LOSS-L counter at the ATU-R SHALL be ≤ 35. (4) The increase of the LOSS-L at the ATU-C and, if available, LOSS-L at the ATU-R SHALL be ≥ 20. NOTE: The count MAY be >5 in case of failed full initialization.

7.4 Performance Monitoring Counters for Unavailable Seconds

Table 7-5- Unavailable Seconds Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the ATU-C with A2P_Fix_I_600k or B2P_Fix_I_864k profile depending on the G.992.5 Annex under test. (3) Additional test conditions: OPTIONAL OLR (SRA, DRR) SHALL not be used.
Method of Procedure	(1) Connect ATU-R and ATU-C through NULL loop and no noise injected. (2) Wait 1 minute following synchronization. (3) Note down the initial value of the UAS-L and UAS-LFE performance monitoring counters at the ATU-C and the initial value of the UAS-L counter at the ATU-R. (4) Disconnect the line and wait for modem to transit from L0 to L3 state. Wait at least 60s before reconnecting the line and wait for the transition back to L0 state. (5) Measure the duration between the line disconnection and the moment that the operational state of the line at the ATU-C is reported as 'in Showtime'. (6) Force performance monitoring counters update and wait 30 seconds for the counters to be read out. (7) Note down the value of these counters (UAS-L and UAS-LFE) on the ATU-C and the value of the UAS-L counter at the ATU-R. (8) Calculate the increase of the UAS counters between step (7) and step (3).

Expected Result	(1) The modem SHALL drop the connection after the disconnection of the line. (2) ΔUAS-L calculated at the ATU-C SHALL not differ from the value measured in step (5) by more than 10s. (3) If, available, the ΔUAS-L calculated at the ATU-R SHALL not differ from the value measured in step (5) by more than 10s. (4) ΔUAS-LFE calculated at the ATU-C SHALL not differ from the value measured in step (5) by more than 14s. (5) If available, ΔUAS-L calculated at the ATU-R SHALL not differ from the value of ΔUAS-LFE calculated at the ATU-C by more than 13s.

7.5   Performance Monitoring Counters for Failed Full Initialization

Table 7-6 Correct reporting of the Failed Full Initialization counter

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Configure the ATU-C with A2_Fix_I_7288k or B2_Fix_I_7288k profile depending on the G.992.3 Annex under test.
Method of Procedure	(1) Connect ATU-R and ATU-C with PE0.4 4000m length loop for Annex A or 3000m for Annex B and -140dBm/Hz White Noise injected on both sides. (2) Verify that the modem doesn't sync (wait for 3 minutes). If it does, increase loop length by 150m and redo the test from step (1). (3) Note down the initial value of failed full initialization counter at the ATU-R and ATU-C. (4) Wait for 3 minutes. If the modem synchronizes within this period, go back to step (2) and increase loop length by 150m. (5) Note down the value of failed full initialization counter at the ATU-R and ATU-C. (6) Calculate the increase of failed full initialization counter between the values from step (5) and step (3).
Expected Result	The increase of the failed full initialization counter SHALL be greater than or equal to 2.

7.6   Verification of the Previous data rate parameter
Table 7-7 Previous data rate test

Test Configuration	(1) See Section 4.1 for the test configuration.
	(2) Configure the SUT for operation in one of the following specific test profiles associated to the ADSL operation mode to be tested:
	  • ADSL2: A2_RA_I1/2_16000k or B2_RA_I_16000k
	  • ADSL2plus: A2P_RA_I_30000k or B2P_RA_I_30000k
	(3) Set up the line simulator to 2500 m PE04.
	(4) Set the noise generator to -120dBm/Hz AWGN at both ends of the loop.

Method of Procedure	(1) Force an initialization and wait for modem to sync. Wait 1 minute following synchronization. (2) Note down the reported actual data rate in upstream and downstream. (3) Disconnect the line. (4) Increase the AWGN noise by 5dB on both sides. (5) Reconnect the line and wait for modem to sync. (6) Note down the reported actual data rate in upstream and downstream. (7) Verify that both upstream and downstream actual data rates after disconnection (in step (6)) are different from the initial actual data rates (in step (2)). If not, increase the loop length by 150m and redo the test from step (1). (8) Note down the reported previous data rate in upstream and downstream.
Expected Result	Reported upstream and downstream previous data rates in step (8) SHALL be equal to the initial upstream and downstream actual data rates in step (2).

8   Downstream Framing-Memory Class (D-FMC) Verification Test

The purpose of this test is to verify that the measured data rate in downstream is consistent with the achievable data rate for the framing memory class that is identified with the equipment information provided to the test lab by the equipment supplier. This test applies to the G.992.5 framing memory classes (FC1 to FC5) defined in section 4.2.3.

8.1   D-FMC Test for G.992.5 Annex A

SUT that claims to support one of the G.992.5 Annex A framing memory classes SHALL pass the data rate requirements for specific test profiles A2P_RA_I8_30000k and A2P_RA_I4_30000k in the applicable framing class. Data rate requirements are defined in Table 8-1 and Table 8-2.

1 individual test – 1 test SHALL be passed per framing-memory class applicable to the SUT

Table 8-1 Test profile A2P_RA_I8_30000k

A2P_RA_I8_30000k					
		DS Sync Rate (kbps)			DS Noise Margin, Reported (dB)
Framing-memory class	Loop Length (m, ETSI loop 1)	Expected	Measured	Pass/ Fail	
G.992.5 Annex A ClassB _16k (ITU, FC1)	100	1000			
G.992.5 Annex A ClassA mand_16k (ETSI, FC2)	100	3000			
G.992.5 Annex A ClassA mand_24k (ETSI, FC3)					
G.992.5 Annex A ClassA opt_16k (ITU, FC4)	100	5000			
G.992.5 Annex A ClassA opt_24k (ITU, FC5)					

1 individual test – 1 test SHALL be passed per framing-memory class applicable to the SUT

Table 8-2 Test profile A2P_RA_I4_30000k

A2P_RA_I4_30000k					
		DS Sync Rate (kbps)			DS Noise Margin, Reported (dB)
Framing-memory class	Loop Length (m, ETSI loop 1)	Expected	Measured	Pass/ Fail	
G.992.5 Annex A ClassB _16k (ITU, FC1)	100	3000			
G.992.5 Annex A ClassA mand_16k (ETSI, FC2)	100	12000			
G.992.5 Annex A ClassA mand_24k (ETSI, FC3)	100	16000			
G.992.5 Annex A ClassA opt_16k (ITU, FC4)	100	13500			
G.992.5 Annex A ClassA opt_24k (ITU, FC5)	100	18000			

8.2   D-FMC Test for G.992.5 Annex B

SUT that claims to support one of the G.992.5 Annex B framing memory classes SHALL pass the data rate requirements for specific test profiles B2P_RA_I8_30000k and B2P_RA_I4_30000k in the applicable framing class. Data rate requirements are defined in Table 8-3 and Table 8-4.

1 individual test – 1 test SHALL be passed per framing-memory class applicable to the SUT

Table 8-3 Test profile B2P_RA_I8_30000k

B2P_RA_I8_30000k					
		DS Sync Rate (kbps)			DS Noise Margin, Reported (dB)
Framing-memory class	Loop Length (m, ETSI loop 1)	Expected	Measured	Pass/ Fail	
G.992.5 Annex B ClassB _16k (ITU, FC1)	100	1000			
G.992.5 Annex B ClassA mand_16k (ETSI, FC2)	100	3000			
G.992.5 Annex B ClassA mand_24k (ETSI, FC3)					
G.992.5 Annex B ClassA opt_16k (ITU, FC4)	100	5000			
G.992.5 Annex B ClassA opt_24k (ITU, FC5)					

1 individual test – 1 test SHALL be passed per framing-memory class applicable to the SUT

Table 8-4 Test profile B2P_RA_I4_30000k

B2P_RA_I4_30000k					
		DS Sync Rate (kbps)			DS Noise Margin, Reported (dB)
Framing-memory class	**Loop Length (m, ETSI loop 1)**	**Expected**	**Measured**	**Pass/ Fail**	
G.992.5 Annex B ClassB _16k (ITU, FC1)	100	3000			
G.992.5 Annex B ClassA mand_16k (ETSI, FC2)	100	12000			
G.992.5 Annex B ClassA mand_24k (ETSI, FC3)	100	16000			
G.992.5 Annex B ClassA opt_16k (ITU, FC4)	100	13500			
G.992.5 Annex B ClassA opt_24k (ITU, FC5)	100	18000			

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