TECHNICAL REPORT

TR-114
VDSL2 Performance Test Plan

Issue: **3 Amendment 3**
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Issue History

Issue Number	Approval Date	Publication Date	Issue Editor	Changes
1	November 2009	November 2009	Arlynn Wilson, ADTRAN	Original
2	26 November 2012	17 December 2012	Aleksandra Kozarev, Lantiq	See Executive Summary
3	13 March 2017	1 May 2017	Aleksandra Kozarev, Intel	See Executive Summary
3 Amendment 1	8 May 2017	9 June 2017	Aleksandra Kozarev, Intel	See Executive Summary
3 Amendment 2	16 March 2018	10 May 2018	Aleksandra Kozarev, Intel	See Executive Summary
3 Amendment 4	13 June 2018	8 August 2018	Aleksandra Kozarev, Intel	See Executive Summary
3 Amendment 3	26 November 2019	26 November 2019	Aleksandra Kozarev, Intel Herman Verbueken, Nokia	See Executive Summary

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Table of Contents

List of Tables

Executive Summary

See *Executive Summary/TR-114 Issue* 3.

This amendment to TR-114 Issue 3 defines in Annex L performance requirements for systems operating as VDSL2 Long Reach (VDSL2-LR) with vectored operation disabled, according to Annex D of ITU-T G.993.2 (2019) [2].

1 Purpose and Scope

1.1 Purpose

See *Purpose/TR-114 Issue* 3.

1.2 Scope

See *Scope/TR-114 Issue* 3.

This amendment to TR-114 Issue 3 defines in Annex L performance requirements for systems operating as Long Reach VDSL2 (VDSL2-LR) with vectored operation disabled, according to Annex D of ITU-T G.993.2 (2019)[2].

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 [3].

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 could exist valid reasons in particular circumstances to ignore this item, but the full implications need to be understood and carefully weighed before choosing a different course.
SHOULD NOT	This phrase, or the phrase "NOT RECOMMENDED" means that there could exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications need to be understood and the case carefully weighed before implementing any behavior described with this label.
MAY	This word, or the 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.

See *References/TR-114 Issue*3[1].

Document		Title	Source	Year
[1]	TR-114 Issue 3	*VDSL2 Performance Test Plan*	BBF	2017
[2]	G.993.2	*Very high speed subscriber line transceivers 2 (VDSL2)*	ITU-T	2019
[3]	RFC 2119	*Key words for use in RFCs to Indicate Requirement*	IETF	1997

Levels

2.3 Definitions

See *Definitions/TR-114 Issue* 3[1].

2.4 Abbreviations

See *Abbreviations/TR-114 Issue* 3[1].

3 Technical Report Impact

3.1 Energy Efficiency

TR-114 has no impact on Energy Efficiency.

3.2 Security

TR-114 has no impact on Security.

3.3 Privacy

Any issues regarding privacy are not affected by TR-114.

4 Noise Models for Annex L testing

Add new section 6.3.3.4 on Noise Models for Annex L testing.

6.3.3.4 Noise Models for Annex L testing

Noise models for Annex L testing of Long Reach VDSL2 over POTS consist of purely self crosstalk. The noise model defined in Table 19.1 represents three scenarios where the SUT is deployed:

- from the local exchange
- from a cabinet located at 36dB attenutation (at 1MHz) from the local exchange
- from a cabinet located at 72dB attenutation (at 1MHz) from the local exchange;

Noise models for the band-profiles with the activated DPBO and UPBO are defined in appropriate performance sections.

Table 19.1: Noise model for Annex L testing

Noise model	Band-profile	ETSI noise scenario	Number of self disturbers	Alien noise disturber frequency profiles
n_BA17ade_LR	BA17ade	N/A	19	N/A

5 Annex L VDSL2 Long Reach Test Cases

Add new Annex on Physical Layer Test Cases for long reach VDSL2 (VDSL2-LR).

L Annex L Physical Layer Test Cases for VDSL2 Long Reach (VDSL2-LR)

L.1 Annex L-specific Test Setup Information

Test configurations associated with the VDSL2 Long Reach over POTS (VDSL2-LRoPOTS) deployments are defined in Table L.1.

Table L.1 – Annex L test configurations

Type of VDSL2 deployment	Band-profile	Test configuration
VDSL2-LR	BA17ade_LR	Figure 1
	BA17ade_LR36 _D&UPBO	
	BA17ade_LR72 _D&UPBO	

The specific SUT's settings as defined in in section 6.2 SHALL be used.

L.1.1 Pass/fail criteria for Annex L testing

Tests SHALL be performed according to the general procedure described in section 8. Testing is defaulted to no PBO unless specified in specific test procedure.

- For sections with more than 3 test loops, if more than 10% of the data rates are less than the data rate requirements in a section, then the DSLAM/CPE pair fails the data rate requirements of that section.
- For sections with less than 4 test loops, the data rate requirement is indicated per table.

In addition to achieving the required rate, both downstream and upstream noise margin values are to be considered in determining the result of an individual section. It is acknowledged that achieving a desired noise margin is primarily the responsibility of the receiver. That is, the DSLAM is primarily responsible for achieving desired upstream noise margins, while the CPE is primarily responsible for achieving desired downstream noise margins. Table L.2 outlines the pass/fail criteria on the reported noise margin.

Table L.2 – Noise margin pass/fail requirements

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

All values SHALL be collected at the DSLAM.

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

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

Table L.3 lists the number of test points per section or table corresponding to the 10% limit mentioned above.

Table L.3 – Data rate pass/fail requirements for rate adaptive testing

Section number	Number of test cases	10% limit
L.3	18	2
L.4	36	4

L.1.2 Noise impairments

The noise is specified in TS 101 271 [7] and includes the crosstalk noise and the white noise (NEXT noise generator G1, FEXT noise generator G2 and the white noise generator G4).

Noise generators G1 and G2 are injected on loop lengths shorter than 2400m and one side at a time. On all loop lengths, noise generator G2 SHALL be reduced by 25dB.

The white noise generator G4 SHALL be set to –140dBm/Hz at both ends of the loop.

L.1.2.1 Crosstalk Impairment G1 and G2

See section B.1.2.1.

L.2 Long Term Stability Testing for Annex L

This test applies only to VDSL2 modems that support the PTM-TC functionality.

L.2.1 Long Term Stability Test

Table L.4 – Long term stability test procedure

<table>
<tr><td>Test Configuration</td><td>(1)Depending on the band-profile under test, select the appropriate profile-line combination and either the PE04 or TP100 loop length from the below table:
<table>
<tr><th>Band-profile</th><th>Loop Length (m, PE04)</th><th>Loop Length (m, TP100)</th></tr>
<tr><td>BA17ade_LR_RA_R-17/2/41_150_150</td><td>3000</td><td>4200</td></tr>
<tr><td>BA17ade_LR36_D&UPBO_RA_R-17/2/41_150_150</td><td>3000</td><td>4200</td></tr>
<tr><td>BA17ade_LR72_D&UPBO_RA_R-17/2/41_150_150</td><td>3000</td><td>4200</td></tr>
</table>
(2) Configure the SUT for PTM transport.
(3) The following parameters SHALL be indicated as follows:
• TARSNMRds = 3 dB
• MAXSNRMds = 18 dB
• packet size: 1500 bytes
(4) The loop simulator SHALL be configured to the value chosen above.
(5) Inject -140 dBm/Hz white noise at both ends of the loop.</td></tr>
<tr><td>Method of Procedure</td><td>(1) Train the CPE with the DSLAM.
(2) Wait for 1 minute after initialization.
(3) Check the reported margin and document as the initial reported margin.
(4) Adjust the noise level at the CPE side until the reported CPE-side margin is approximately 9 dB.
(5) Configure the traffic generator/analyzer to provide MAC frames, both upstream and downstream, at 85% of the net data rate.
(6) Run for four hours with constant noise level.
(7) If there are more than 2 ES, then the measurement SHALL be extended for up to an additional four-hour period (for a maximum of 8 hours).</td></tr>
<tr><td>Expected Result</td><td>(1) The customer end modem SHALL NOT lose synchronization at any time during the test.
(2) If during any 4 hour sliding window there are fewer than 3 ES and no SES then the CPE passes the test.</td></tr>
</table>

L.3 Rate adaptive performance tests for Long Reach VDSL2 without DPBO and UPBO

The tests with retransmission-enabled profiles are designed to be passed by implementations with a MAXDELAYOCTET-split parameter (MDOSPLIT) set to 80%.

Table L.5 provides the profile-line combination that SHALL be configured on the equipment under test:

Table L.5 – Profile-line combination for BA17ade_LR

Profile number	Profile-line combination	Band-profile	Specific line-setting
1	BA17ade_LR_RA_R-17/2/41_150_150	BA17ade_LR	RA_R-17/2/41_150_150
2	BA17ade_LR_RA_I-8/2_150_150	BA17ade_LR	RA_I-8/2_150_150

For the loops 150m upto 4050m in Table L.6 the profile number 1 from Table L.5 SHALL be used. For the loop 5100m in Table L.6 the profile number 2 from Table L.5 SHALL be used.

18 individual tests – 16 tests SHALL be passed

Table L.6 – Performance tests with BA17ade_LR

Loop Length (m, PE04 loop)	BA17ade_LR							
	Downstream				Upstream			
	Actual net data rate (kbps)			Noise Margin, Reported (dB)	Actual net data rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
150	109200				41400			
600	54200				18800			
1200	22600				1000			
1800	13300				700			
2400	9900				800			
3000	6400				800			
3600	3900				600			
4050	2700				500			
5100	900				400			

L.4 Rate adaptive performance tests for Long reach VDSL2 with DPBO and UPBO

The tests with retransmission-enabled profiles are designed to be passed by implementations with a MAXDELAYOCTET-split parameter (MDOSPLIT) set to80%.

The basic BA17ade Band Profile SHALL be applied with the following modifications to the "Common Line Settings" specified in Table L.7 and Table L.8 to define the two shaped-PSD Band Profiles BA17ade_LR*x*_D&UPBO.

Table L.7 – Common Line Settings for BA17ade_LR36_D&UPBO Band Profile

Parameter	Setting	Description
All parameters but those specified below	Value as specified in Table 7 [1]	
DPBOEPSD	ADSL2plus Annex A	PSD mask that is assumed to be permitted at the exchange
DPBOESEL	36 dB	E-side electrical length
DPBOESCMA	0.1719	Model of the frequency dependent loss of E-side cable: scalars DPBOESCMA (NOTE)

DPBOESCMB	0.644453	Model of the frequency dependent loss of E-side cable: scalars DPBOESCMB (NOTE)
DPBOESCMC	0.18359	Model of the frequency dependent loss of E-side cable: scalars DPBOESCMC (NOTE)
DPBOMUS	- 101.5 dBm/Hz	Minimum usable receive signal PSD mask
DPBOFMIN	138 kHz	Minimum frequency from which on the DPBO SHALL be applied
DPBOFMAX	2208 kHz	Maximum frequency up to which the DPBO SHALL be applied
UPBOKLF	0	Force CO-MIB electrical loop length (means that kl_0 is estimated during training)
UPBOKL	estimated during training	Upstream electrical loop length (kl_0)
UPBOA US0	40	A and B values US band 0 (these values imply no UPBO)
UPBOB US0	0	
UPBOA US1	60	A value US band 1
UPBOB US1	21	B value US band 1
UPBOA US2	60	A value US band 2
UPBOB US2	8	B value US band 2
NOTE: the values of DPBOESCMA, B and C are referred to a PE04 loop. Values that are configured according to G.997.1 SHALL be rounded to the nearest scalar value.		

Table L.8 – Common Line Settings for BA17ade_LR72_D&UPBO Band Profile

Parameter	Setting	Description
All parameters but those specified below	Value as specified in Table 7 [1]	
DPBOEPSD	ADSL2plus Annex A	PSD mask that is assumed to be permitted at the exchange
DPBOESEL	72 dB	E-side electrical length
DPBOESCMA	0.1719	Model of the frequency dependent loss of E-side cable: scalars DPBOESCMA (NOTE)
DPBOESCMB	0.644453	Model of the frequency dependent loss of E-side cable: scalars DPBOESCMB (NOTE)
DPBOESCMC	0.18359	Model of the frequency dependent loss of E-side cable: scalars DPBOESCMC (NOTE)
DPBOMUS	- 101.5 dBm/Hz	Minimum usable receive signal PSD mask
DPBOFMIN	138 kHz	Minimum frequency from which on the DPBO SHALL be applied
DPBOFMAX	2208 kHz	Maximum frequency up to which the DPBO SHALL be applied

UPBOKLF	0	Force CO-MIB electrical loop length (means that kl_0 is estimated during training)
UPBOKL	estimated during training	Upstream electrical loop length (kl_0)
UPBOA US0	40	A and B values US band 0 (these values imply no UPBO)
UPBOB US0	0	
UPBOA US1	60	A value US band 1
UPBOB US1	21	B value US band 1
UPBOA US2	60	A value US band 2
UPBOB US2	8	B value US band 2
NOTE: the values of DPBOESCMA, B and C are referred to a PE04 loop. Values that are configured according to G.997.1 SHALL be rounded to the nearest scalar value.		

Table L.9 provides the profile-line combinations that SHALL be configured on the equipment under test:

Table L.9 – Profile-line combinations for BA17ade_LR*x*_D&UPBO

Profile number	Profile-line combination	Band-profile	Specific line-setting
1	BA17ade_LR36_D&UPBO_RA_R-17/2/41_150_150	BA17ade_LR36_D&UPBO	RA_R-17/2/41_150_150
2	BA17ade_LR36_D&UPBO_RA_ I-8/2_150_150	BA17ade_LR36_D&UPBO	RA_I-8/2_150_150
3	BA17ade_LR72_D&UPBO_RA_R-17/2/41_150_150	BA17ade_LR72_D&UPBO	RA_R-17/2/41_150_150
4	BA17ade_LR72_D&UPBO_RA_I-8/2_150_150	BA17ade_LR72_D&UPBO	RA_I-8/2_150_150

For the loops 150m upto 4050m in Table L.12 the profile number 1 from Table L.9 SHALL be used. For the loop 5100m in Table L.12 the profile number 2 from Table L.9 SHALL be used.

For the loops 150m upto 4050m in Table L.13 the profile number 3 from Table L.9 SHALL be used. For the loop 5100m in Table L.13 the profile number 4 from Table L.9 SHALL be used.

The noise model n_BA17ade_LR*x*_D&UPBO defined in Table L.10 SHALL be used, which is coherent with the noise models framework specified in section 6.3.3.4.

Table L.10 – Noise model n_BA17ade_LRx_D&UPBO

Noise model	Associated band-profile	Self noise disturbers	Alien noise disturbers
n_BA17ade_LR36_D&UPBO	BA17ade_LR36_D&UPBO	19	None
n_BA17ade_LR72_D&UPBO	BA17ade_LR72_D&UPBO	19	None

For this Band Profile the value of kl_0 (UPBOKL) is estimated by the SUTs during training. The PSD of a single self-disturber SHALL be deterministically defined by the settings of Table L.7 and Table L.8 above using kl_0 values for calculation of the single self-disturber PSD listed in Table L.11.

Table L.11 – kl_0 for calculation of the single self-disturber PSD for BA17ade_LR*x*_D&UPBO

Loop Length (m, PE04 loop)	kl_0 (UPBOKL) (dB @ 1MHz)
150	3.7
600	14.8
1200	29.7
1800	44.5

NOTE: Section 7.2.1.3.2.2/G993.2 states: "If the estimated value of kl0 is smaller than 1.8, the modem shall be allowed to perform power back-off as if kl0 were equal to 1.8. The estimate of the electrical length should be sufficiently accurate to avoid spectrum management problems and additional performance loss." Therefore noise calculations SHALL assume kl0 value of 1.8dB which will simulate UPBO shaped disturbers at 50m line length in a more realistic way.

36 individual tests – 32 tests SHALL be passed

Table L.12 – Performance tests with BA17ade_LR36_D&UPBO

Loop Length (m, PE04 loop)	BA17ade_LR36_D&UPBO							
	Downstream				Upstream			
	Actual net data rate (kbps)			Noise Margin, Reported (dB)	Actual net data rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
150	100900				31100			
600	54100				15900			
1200	12100				2100			
1800	3900				800			
2400	8200				800			
3000	6100				700			
3600	3900				600			
4050	2700				400			
5100	900				400			

Table L.13 – Performance tests with BA17ade_LR72_D&UPBO

Loop Length (m, PE04 loop)	BA17ade_LR72_D&UPBO							
	Downstream				Upstream			
	Actual net data rate (kbps)			Noise Margin, Reported (dB)	Actual net data rate (kbps)			Noise Margin, Reported (dB)
	Expected	Measured	Pass/Fail		Expected	Measured	Pass/Fail	
150	102700				32300			
600	51200				15100			
1200	17800				1600			
1800	7300				800			
2400	9800				800			
3000	6400				700			
3600	4000				600			
4050	2700				500			
5100	900				400			

6 Summary of Profile and Line Combinations for Annex L

Amend the text of Appendix III Summary of Profile and Line Combinations to reflect Annex L (revision marks relative to the TR-114 Issue 3 text).

Table 185: Summary of profile-line combinations used in TR-114

VDSL2 Band-profile	Specific line-setting	Profile-line combination
Annex L		
BA17ade_LR	RA_R-17/2/41_150_150	BA17ade_LR_ _RA_R-17/2/41_150_150
BA17ade_LR	RA_I-8/2_150_150	BA17ade_LR_RA_I-8/2_150_150
BA17ade_LR36_D&UPBO	RA_R-17/2/41_150_150	BA17ade_LR36_D&UPBO_RA_R-17/2/41_150_150
BA17ade_LR36_D&UPBO	RA_I-8/2_150_150	BA17ade_LR36_D&UPBO_RA_ I-8/2_150_150
BA17ade_LR72_D&UPBO	RA_R-17/2/41_150_150	BA17ade_LR72_D&UPBO_RA_R-17/2/41_150_150
BA17ade_LR72_D&UPBO	RA_I-8/2_150_150	BA17ade_LR72_D&UPBO_RA_I-8/2_150_150

7 Crosstalk impairment for Annex L tests

Add new Appendix on Crosstalk impairment for Annex L performance tests.

Appendix IX Crosstalk impairment for Annex L performance tests (informative)

BA17ade_LR36_PE04_1200_DUPBO.xlsx file contains the crosstalk impairment for BA17ade_LR36_D&UPBO performance tests, defined in Section L.4, on *1200*m PE04 loop.

End of Broadband Forum Technical Report TR-114