TECHNICAL REPORT

TR-115
VDSL2 Functionality Test Plan

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Issue History

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Table of Contents

Executive Summary

The document contains corrections to TR-115 Issue 1.

1 Purpose

The corrections specified in the following sections apply to *TR-115 Issue 1*.

Note: This corrigendum assumes all previous corrigenda on *TR-115 Issue 1* have been previously applied.

2 Correction to Table 18/TR-115

Update **Table 18/TR-115** as follows

Table 18 – Bit swap Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) Set up the loop simulator to: a. 1350 ft 26AWG or b. 450 m PE 0.4mm (3) According to the band-profile to be tested, configure the VTU-O with one of the profile line combinations associated to that band-profile (see section 4.2.3). If for the specific band-profile, profile-line combination is defined with DPBO and/or UPBO enabled, these SHALL be applied. The test SHALL be repeated for both the F-1/0 and I-8/2 settings. (4) All single frequency tone amplitudes that are applied are referenced in terms of power levels (dBm) at the injection point on the loop, calibrated with the VTU-R and VTU-O 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 30dB less than the power level (in dBm), limited by the noise floor of the test equipment used for calibration. (5) Set the noise generator to -140 dBm/Hz AWGN noise at both VTU-O and VTU-R.
Method of Procedure	(1) Connect the VTU-O and VTU-R. Wait for the modems to sync. ~~With -140dBm/Hz AWGN noise added at both the VTU-O and VTU-R ends, initialize the link to stable Showtime.~~ (2) Wait for 1 minute after ~~completion of~~ initialization. (3) Record the bit~~s~~ allocation tables BITSpsus and BITSpsds. (4) Randomly select an integer value, n, the tone number in the range of one of the bands (DS or US) applicable to the chosen band-

profile. Avoid the use of the pilot tone or any unpopulated tones. Ensure that the tone selected has assigned bits as described in the relevant bits per tone map, also after the injection of the RFI in MOP(5). The frequency of the interfering tone SHALL be set to n x 4.3125 kHz.

(5) The interfering tone SHALL be applied at the VTU-R side in the downstream bit swap test and at the VTU-O side in the upstream bit swap test. Its power SHALL be -110 dBm or less.
Wait 60 seconds.~~The power of the interfering tone SHALL be -110 dBm or less.~~

(6) Record and report the value of n used.

(7) Record BITSpsus and BITSpsds, and document them as BITSpsus_Old and BITSpsds_Old respectively.

(8) Calculate and record the Transmitted_Bits_US_Old:

$$\sum_i BITSpsus_i - \left\lceil \frac{NCUSEDus - \frac{NCONEBITus}{2}}{2} \right\rceil - 4$$

and the Transmitted_Bits_DS_Old:

$$\sum_i BITSpsds_i - \left\lceil \frac{NCUSEDds - \frac{NCONEBITds}{2}}{2} \right\rceil - 4$$

where the ⌈ x ⌉ notation represents rounding to the next higher integer, the index 'i' denotes the carrier number, NCUSED represents the number of loaded sub-carriers and NCONEBIT is the number of sub-carriers with 1 bit.

Transmitted_Bits_US_Old and Transmitted_Bits_DS_Old refer to the information bits from the PMS-TC. (See Figure 9-1/G.993.2)
~~Calculate $\sum_i b_i$ of BITSpsus and BITSpsds, and document the results as Total_Bits_US_Old and Total_Bits_DS_Old respectively.~~

(9) Increase the power of the interfering tone to -50 dBm.

~~(10)Observe any bit-swapping operation without retraining of the modems or change in the net data rate. After 2 minutes verify the payload and CRC errors have stopped. (There MAY be some initial~~

	~~errors seen when the signal is first inserted on the line.)~~ ~~(11)~~(10) ~~1~~ 2 minutes after increasing the tone power, record BITSpsus and BITSpsds, and document them as BITSpsus_New and BITSpsds_New respectively. ~~(12)~~(11) Calculate and record values of Transmitted_Bits_US_New and Transmitted_Bits_DS_New by using the formulas in (8). Transmitted_Bits_US_New and Transmitted_Bits_DS_New refer to the information bits from the PMS-TC. (See Figure 9-1/G.993.2) ~~Calculate $\sum_i b_i$ of BITSpsus and BITSpsds, and document the results as Total_Bits_US_New and Total_Bits_DS_New respectively.~~ ~~(13)~~(12) Execute a BER test for 2 minutes. ~~(14)~~(13) 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. ~~(15)~~(14) Record the estimated BER ~~(16)~~(15) Repeat steps 1 to 1~~5~~ for each band applicable to the chosen band-profile.
Expected Result	(1) No retrain SHALL occur during the test. (2) BITSpsus_New recorded in step MOP(10~~1~~) SHALL differ from BITSpsus_Old in step MOP(7), if tone n is in the bands of upstream direction. (3) BITSpsds_New recorded in step MOP(10~~1~~) SHALL differ from BITSpsds_Old in step MOP(7), if tone n is in the bands of downstream direction. (4) ~~Total~~ Transmitted_Bits_US_Old SHALL equal ~~Total~~ Transmitted_Bits_US_New (5) ~~Total~~ Transmitted_Bits_DS_Old SHALL equal ~~Total~~ Transmitted_Bits_DS_New (6) SES (as recorded in step MOP(13~~4~~)) SHALL NOT increase (7) The estimated BER SHALL NOT exceed $1e^{-7}$.

3 Correction to Table 23/TR-115

Update **Table 23/TR-115** as follows

Table 23 – SOS Test In The Downstream

Test Configuration	(1) See Section 4.1 for the test configuration (2) The test SHALL be performed with ONE of the following VDSL2 profile line combinations: a. BA17a_RA_I_150_150 with 450 m of PE 0.4mm (European VDSL2overPOTS) or b. BB17a_RA_I_150_150 with 450 m of PE 0.4mm (European VDSL2overISDN) (3) If, for the specific band-profile, profile-line combinations are defined with DPBO and/or UPBO enabled, these SHALL be applied. (4) Specific settings: SRA settings from Table 22
Method of Procedure	(1) With -140dBm/Hz AWGN noise added at both the VTU-O and VTU-R ends, initialize the link to stable Showtime. Wait for 1 minute after completion of initialization. (2) Choose the following settings. a. DS Minimum SOS Bit Rate (MIN-SOS-BR-ds): 20000kbps. b. DS SOS time Window (SOS-TIME-ds): 64ms c. DS Minimum Percentage of Degraded Tones (SOS-NTONES-ds): 50 d. DS Minimum Number of normalized CRC anomalies (SOS-CRC-ds): 1 e. DS Maximum Number of SOS (MAX-SOS-ds): 15 f. DS SNRM offset for the ROC (SNRMOFFSET-ROC-ds): 6dB g. DS INPMIN for ROC (INPMIN-ROC-ds): 8 symbols NOTE: SOS triggering condition specified by parameter SOS-NTONES is superseded with the number of degraded tones ≥129 (Section13.4.3.2/G.993.2). (3) Disable SOS function. (4) Add the crosstalk noise defined for the band-profile under test in TR-114 to the AWGN noise at VTU-R side only. (5) Force a new initialization. (6) Two minutes through the Showtime record the downstream net data rate as NDR_REINIT_DS (net data rate in the downstream with crosstalk noise achieved if a re-initialization is to occur). (7) Deactivate the line. ~~(7)~~(8) Remove the crosstalk noise. ~~(8)~~(9) Enable SOS function. ~~(9)~~(10) Force a new initialization.

	~~(10)~~(11) Wait for 1 minute after initialization~~Allow to train for 60 seconds to achieve showtime~~. ~~(11)~~(12) Add the crosstalk noise defined for the band-profile under test in TR-114 to the AWGN noise at VTU-R side only. ~~(12)~~(13) Record the net data rate 1 second after the crosstalk is switched on as NDR_SOS_BEG_DS (net data rate in the downstream with crosstalk noise at the end of SOS). ~~(13)~~(14) Record the data rate 3 minutes after the crosstalk is switched on as the NDR_SOS_END_DS (net data rate in the downstream with crosstalk noise at the end of SRA).
Expected Result	(1) No retrain SHALL occur. (2) NDR_SOS_BEG_DS > MIN-SOS-BR-ds NDR_SOS_END_DS> MIN-SOS-BR-ds NDR_SOS_END_DS > 0.8*NDR_REINIT_DS

4 Correction to Table 24/TR-115

Update **Table 24/TR-115** as follows

Table 24 – SOS Test In The Upstream

Test Configuration	(1) See Section 4.1 for the test configuration (2) The test SHALL be performed with ONE of the following VDSL2 profile line combinations: a. BA17a_RA_I_150_150 with 450 m of PE 0.4mm (European VDSL2overPOTS) or b. BB17a_RA_I_150_150 with 450 m of PE 0.4mm (European VDSL2overISDN) (3) If, for the specific band-profile, profile-line combinations are defined with DPBO and/or UPBO enabled, these SHALL be applied. (4) Specific settings: SRA settings from Table 22
Method of Procedure	(1) With -140dBm/Hz AWGN noise added at both the VTU-O and VTU-R ends, initialize the link to stable Showtime. Wait for 1 minute after completion of initialization.. (2) Choose the following settings. a. US Minimum SOS Bit Rate (MIN-SOS-BR-us): 5000kbps. b. US SOS time Window (SOS-TIME-us): 64ms c. US Minimum Percentage of Degraded Tones (SOS-NTONES-us): 50 d. US Minimum Number of normalized CRC anomalies (SOS-CRC-us): 1 e. US Maximum Number of SOS (MAX-SOS-us): 15 f. US SNRM offset for the ROC (SNRMOFFSET-ROC-us): 6dB g. US INPMIN for ROC (INPMIN-ROC-us): 8 symbols NOTE: SOS triggering condition specified by parameter SOS-NTONES is superseded with the number of degraded tones ≥ 129 (Section13.4.3.2/G.993.2). (3) Disable SOS function. (4) Add the crosstalk noise defined for the band-profile under test in TR-114 to the AWGN noise at VTU-R side only. (5) Force a new initialization. (6) Two minutes through the showtime record the downstream net data rate as NDR_REINIT_US (net data rate in the upstream with crosstalk noise achieved if a re-initialization is to occur). ~~(6)~~(7) Deactivate the line ~~(7)~~(8) Remove the crosstalk noise.

	~~(8)~~(9) Enable SOS function. ~~(9)~~(10) Force a new initialization. ~~(10)~~(11) Wait for 1 minute after initialization~~Allow to train for 60 seconds to achieve Showtime~~. ~~(11)~~(12) Add the crosstalk noise defined for the band-profile under test in TR-114 to the AWGN noise at VTU-O side only. ~~(12)~~(13) Record the net data rate 1 second after the crosstalk is switched on as NDR_SOS_BEG_US (net data rate in the upstream with crosstalk noise at the end of SOS). ~~(13)~~(14) Record the data rate 3 minutes after the crosstalk is switched on as the NDR_SOS_END_US (net data rate in the upstream with crosstalk noise at the end of SRA).
Expected Result	(1) No retrain SHALL occur. (2) NDR_SOS_BEG_US > MIN-SOS-BR-us NDR_SOS_END_US > MIN-SOS-BR-us NDR_SOS_END_US > 0.8*NDR_REINIT_US

5 Correction to Table 32/TR-115

Update **Table 32/TR-115** as follows

Table 32 – Downstream Power Back-Off Test

Test Configuration	(1) The VTU modems SHALL be connected as shown in Section 4.1 (2) The test setup SHALL support the PSD mask and aggregate transmit power (ATP) measurements over the entire downstream 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 VTU-O with the general line setting "F-1/0" defined in Section 4.2.2.2. (4) According to the band-profile to be tested, configure the VTU-O with one of the profile line combinations associated with that band-profile (see 4.2.3). If, for the specific band-profile, profile-line combinations are defined with UPBO enabled, apply the related UPBO configuration parameters. ~~Otherwise define one set of UPBO parameters (a, b) for each upstream band~~ If, for the specific band-profile, profile-line combinations are defined with DPBO enabled, apply the related DPBO configuration parameters. Otherwise define one set of DPBO parameters (DPBOEPSD, DPBOESCMA, -B, -C, DPBOMUS, DPBOFMIN, DPBOFMAX). (5) 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) Set spectrum analyzer for the requested frequency range, resolution bandwidth and input attenuation range to prevent it from being overridden. (2) Define DPBOESEL in the range of 10 dB to 60 dB, in 10 dB steps. (3) Force initialization and wait for modems to synchronize. (4) Wait 1 minute following synchronization. (5) Disconnect the line. The VDSL2 link SHOULD stay in L0 ~~stay~~ long enough for the PSD to be measured. If it does not see the Note in Table 28. (6) 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 ohms (the same value as the VTU termination impedance) and a high-impedance differential probe b. over a wideband 50:100 BALUN transformer (assumes 50ohm analyser) If the characteristic of the balun or resistor is not calibrated out, it SHALL have an affect of ≤ 0.5dB on the measurement (7) Take a note of the measured PSD data. (8) Take a note of the measured or calculated ATP. (9) Repeat the test steps 3 through 8 for all DPBOESEL values (20dB, 30dB, 40dB, 50dB and 60dB) defined in step 2
Expected Result	(1) Measured PSD mask SHALL comply with the requirements from Section 7.3.1.2.13/G.997.1 and SHALL not exceed the resultant mask (RESULTMASK).

6 Correction to Table 33/TR-115

Update **Table 33/TR-115** as follows

Table 33 – Upstream Power Back-Off Test

Test Configuration	(1) The VTU modems SHALL be connected as shown in Section 4.1 (2) The test setup SHALL support the PSD mask and aggregate transmit power (ATP) measurements over the entire 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 VTU-O with the general line setting "F-1/0" defined in Section 4.2.2.2. (4) According to the band-profile to be tested, configure the VTU-O with one of the profile line combinations associated with that band-profile (see 4.2.3). If, for the specific band-profile, profile-line combinations are defined with DPBO enabled, apply the related DPBO configuration parameters. ~~Otherwise define one set of DPBO parameters~~ If, for the specific band-profile, profile-line combinations are defined with UPBO enabled, apply the related UPBO configuration parameters. Otherwise define one set of UPBO parameters (a, b) for each upstream band. (5) Line simulator SHALL be set up for the straight homogeneous loop specified for the regional annex, as referenced in Section 4.4 Its length SHALL be set to the length at which the loop is the equivalent of: a. 0dB @ 1MHz; b. 10dB @ 1MHz; c. 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) Set spectrum analyzer for the requested frequency range, resolution bandwidth and input attenuation range to prevent it from being overridden. (2) Force initialization and wait for modems to synchronize. (3) Wait 1 minute following synchronization. (4) Disconnect the line. The VDSL2 link SHOULD stay in L0 ~~stay~~ long enough for the PSD to be measured. If it does not see the Note in Table 28. (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 ohms (the same value as the VTU termination impedance) and a high-impedance differential probe b. over a wideband 50:100 BALUN transformer (assumes 50ohm analyser) If the characteristic of the balun or resistor is not calibrated out, it SHALL have an affect of $\leq$ 0.5dB on the measurement (6) Take a note of the measured PSD data. (7) Take a note of the measured or calculated ATP. (8) Take a note of the estimated electrical length kl_0 (UPBOKLE). (9) Repeat the test steps MOP(2) through MOP(8) for all three loop lengths (between NULL loop and the defined maximum loop) according to the test configuration TC(5). (10) Maintaining the test loop equivalent to 20 dB @ 1MHz. (11) Force the VTU-R to use the electrical length kl_o configured by the CO-MIB (UPBOKL) to compute the UPBO. Set the kl_o value to 15dB and repeat steps 2 through 7.
Expected Result	(1) Measured PSD mask SHALL comply with the requirements from Section 7.2.1.3.2/G.993.2 [2] and SHALL not exceed the reference UPBO mask (UPBOMASK).

7 Correction to Table 38/TR-115

Update **Table 38/TR-115** as follows

Table 38 – MINSNRM Control Test

Test Configuration	(1) See Section 4.1 for the test configuration. (2) As per VDSL2 band-profile to be tested, configure the SUT in one of the profile line combinations associated to that band-profile in the rate adaptive mode (see Section 4.2.3). (3) ~~Additional~~ SNRM test conditions: a. MINSNRM = ~~1dB, 2dB and 3~~5dB and TARSNRM=9dB b. MINSNRM=8dB and TARSNRM=12dB (4) Connect VTU-R and VTU-O through the 300m PE04 or 1kft 26AWG (5) Additional test conditions: OPTIONAL OLR (SRA, SOS) SHALL NOT be used.
Method of Procedure	~~(1)Connect VTU-R and VTU-O through the shortest loop length defined for the chosen profile-line combination in the regional annex of TR-114.~~ ~~(2)~~(1) Inject ~~-140~~-120dBm/Hz AWGN noise added at both the VTU-R and VTU-C ends. This power level is considered the 0dB noise power. ~~(3)~~(2) Let the modems train. Wait for 1 minute after initialization. ~~(4)Record the reported SNR margin. SNRMds and SNRMus~~ ~~(5)~~(3) Increase the noise power level by ~~1~~6dB. ~~Wait for 1 minute.~~ ~~(6)Record the reported SNR margin.~~ ~~(7)~~(4) ~~Repeat step 5 until the reported SNR margin becomes lower than MINSNRM~~ Wait not more than 90 seconds for modem to retrain. ~~(8)~~(5) Repeat the test for ~~each MINSNRM~~ all SNRM test conditions.
Expected Result	(1) For ~~each test~~ all SNRM test conditions ~~Modems~~ modems SHALL retrain. ~~if the reported SNR margin is lower than MINSNRM.~~

8 Correction to Table 45/TR-115

Update **Table 45/TR-115** as follows

Table 45 - SES Ceounter Rreporting Ttest

Test Configuration	(1) See Section 4.1 for the test configuration (2) As per VDSL2 band-profile to be tested, configure the SUT according to Section 4.2 in ~~FX_I_010_001~~ RA_F_150_150 and RA_I_150_150 specific line-setting defined in Table 11 (3) Additional test conditions: OPTIONAL OLR (SRA, SOS) SHALL NOT be used. ~~a.optional OLR (SRA, SOS) SHALL NOT be used.~~
Method of Procedure	(1) Connect VTU-R and VTU-O ~~with 0 length loop and no noise injected~~ through 1350 feet 26AWG or 450 m PE04 . (2) Set the noise generator to -120dBm/Hz AWGN at the VTU-R and at the VTU-O side of the loop. ~~(2)~~(3) Force an initialization and wait for modem to sync. Wait 1 minute following synchronization. ~~(3)~~(4) Note down the initial value of the SES-L, SES-LFE, UAS-L and UAS-LFE performance monitoring counters at the VTU-O and the initial value of the SES-L and UAS-L counters at the VTU-R. ~~(4)~~(5) ~~Force one 330ms "micro-interruption" every 1s for 2 seconds (a total of 2 micro-interruptions)~~ Inject the noise impulse, -110dBm/Hz AWGN, with duration of 590 ± 10 milliseconds at the VTU-R side of the loop. ~~(5)~~(6) Repeat ~~previous event~~MOP(5) 14 times (for a total of 15 impulse events~~14 x 2 micro-interruption~~) with 10s between each event. ~~(6)~~(7) Force performance monitoring counters update and wait 30 seconds for the counters to be read out. ~~(7)~~(8) Note down the value of the counter SES-L and UAS-L at the VTU-R. Note down the value of the counters SES-L and SES-LFE, and UAS-L and UAS-LFE at the VTU-O. ~~(8)~~(9) Calculate the increase of these counters between step 8~~6~~ and step 4~~3~~. (10) Repeat steps 5 to 9, but inject the noise impulse at the VTU-O side of the loop.

Expected Result	(1) No lost of synchronization SHALL occur during the test. (2) No increase of UAS-L and UAS-LFE at the VTU-O SHALL be reported during the test time. (3) If available, no increase of UAS-L at the VTU-R SHALL be reported. (4) The increase of SES-L counter at the VTU-R SHALL be equal to the increase of SES-LFE counter at the VTU-O. (5) The increase of SES-L counter at the VTU-R, as well as the increase of both SES-LFE and SES-L counters at the VTU-O, SHALL be at least equal to ~~30~~ 15 and ~~less than 45~~ ≤ 30.

End of Broadband Forum Technical Report TR-115