# Technical Specifications for the Telecommunications Terminal Equipment and POTS Splitters for Very-high-speed Digital Subscriber Lines

**National Communications Commission**

**July 23 2020**

# Contents

# Technical Specifications for the Telecommunications Terminal Equipment and POTS Splitters for Very-high-speed Digital Subscriber Lines

## 1. Source of law

The Specifications are promulgated pursuant to Paragraph 1, Article 44 of the Telecommunications Management Act.

## 2. Scope of application

The Specifications apply to the VDSL Transceiver Unit - remote terminal (VTU-R) and POTS splitter.

## 3. Contents and references

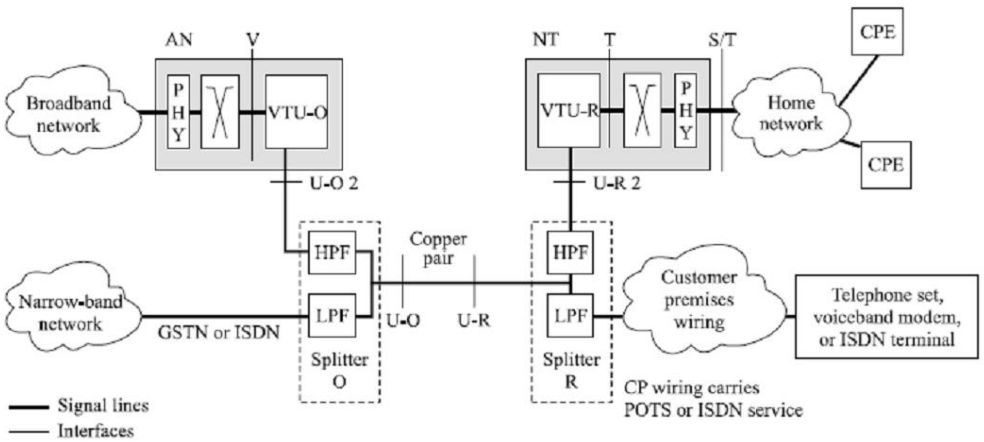
The Specifications are developed based on the test methods and relevant standards for VTU-R and POTS splitter communication interface in ITU-T Rec. G.993.1 and G.993.2 of International Telecommunication Union.

## 4. Acronyms

| | | |
|---|---|---|
| VDSL | 超高速數位用戶迴路 | Very high speed Digital Subscriber Line |
| VTU-O | 機房端 VDSL 設備 | VDSL Transceiver Unit - central office |
| VTU-R | 用戶端 VDSL 電信終端設備 | VDSL Transceiver Unit - remote terminal |
| ERL | 回音回流損失 | Echo Return Loss |
| PSD | 功率頻譜密度 | Power Spectrum Density (dBm/Hz) |
| POTS | 傳統電話服務 | Plain Old Telephone Service |
| SRL | 鳴音回流損失 | Singing Return Loss |
| AWG | 美國線徑規格 | American Wire Gauge |

## 5. VDSL system structure

For the provision of broadband access network service of VDSL, the VTU-O is connected to ISP via broadband network at central office and VDSL is used at the user, while high-speed data service is provided simultaneously over the original telephone line. The following figure provides the scheme of network structure:




Typical reference model applicable for terminal equipment with POTS splitter

## 6. Test items and acceptance criteria

### 6.1 POTS splitter test list

| No. | Test item | Criteria | Test data | Result |
|---|---|---|---|---|
| 1 | DC loop resistance | On the POTS interface, the DC resistance from the tip to the ring shall be equal to or less than 25Ω. | | |
| 2 | DC insulation resistance | With the corresponding U-R interface, the DC insulation resistance on the POTS interface from (1) tip to ground; (2) ring to ground; or (3) tip to ring shall be greater than 5MΩ. | | |
| 3 | Voiceband insertion loss | The 1004Hz voiceband is smaller than 1.0dB (the actual cables or simulated test loop refers to 0, 0.5kft, 2.0kft and 5.0 kft pairs of 26 AWG cable). | | |
| 4 | VDSL band attenuation | 32kHz~300kHz: > 65dB<br>300kHz~12MHz: > 55dB | | |
| 5 | Voiceband attenuation distortion | See Table 1 for the allowable range of voiceband attenuation distortion. | | |
| 6 | Voiceband delay distortion | See Table 2 for the allowable range of voiceband delay distortion. | | |
| 7 | Voiceband return loss | See Table 3 for the allowable range of voiceband return loss. | | |
| 8 | Longitudinal balance of voiceband | The longitudinal balance shall not be smaller than 58dB at the test frequency band between 0.2 and 1kHz, and the longitudinal balance of 53dB or more shall be reached when the test is gradually performed up to 3kHz. | | |
| 9 | Load capacitance of voiceband | (1) For remote splitter not connected to VTU-R, the input capacitance shall be between 20nF and 115nF.<br>(2) For VTU-R with built-in splitter, the input capacitance of POTS interface shall be between 40nF and 150nF.<br>(3) For any line at the tip or ring of loop line port at the remote splitter, the stray capacitance to ground shall be less than 1.0nF. | | |
| 10 | Surge test | The U-R interface of remote splitter shall be subject to the test with Type A and Type B surges:<br>(1) After testing with Type A surge: the equipment tested shall not be short-circuited and the insulation resistance shall be greater than 5MΩ under 100V DC of bias voltage.<br>(2) After testing with Type B surge: the equipment tested shall function properly. | | |

| Description | | | 0.2 – 3.4kHz | | 3.4 – 4kHz | |
|---|---|---|---|---|---|---|
| Simulated test loop or actual cable | ZTc=900Ω | ZTr=600Ω | +1.5 dB | -1.5 dB | +2.0 dB | -2.0 dB |

Table 1 Allowable range of voiceband attenuation distortion

| Description | | | 0.2 - 4 kHz | 0.6 - 3.2 kHz |
|---|---|---|---|---|
| Simulated test loop or actual cable | ZTc=900Ω | ZTr=600Ω | < 250 μs | < 200 μs |

Table 2 Allowable range of voiceband delay distortion

| Zref | Zterm | ERL | SRL-L | SRL-H | Remark |
|---|---|---|---|---|---|
| ZNL-r | 900Ω+2.16μF | > 6 dB | > 5 dB | > 3 dB | |
| ZNL-r | 900Ω+2.16μF | N/A | N/A | > 2 dB | Individual frequencies |

Table 3 Allowable range of voiceband return loss

## 6.2 VTU-R test list

| No. | Test items | Criteria | Test data | Result |
|---|---|---|---|---|
| 1 | Transmitter Pass Band PSD Response Testing | (1) See Table 4 for the limitation for the VTU-R transmitter PSD mask of G.993.1.<br>(2) See Table 5 for the limitation for the over POTS mode VTU-R transmitter PSD mask of G.993.2<br>(3) See Table 6 for the limitation for the all digital mode VTU-R transmitter PSD mask of G.993.2. | | |
| 2 | Total Signal Power Limitation | The total signal power shall be smaller or equal to +14.5dBm. | | |
| 3 | Longitudinal Balance | Frequency range between 200Hz and 12MHz<br>(1) G.993.1 VTU-R shall be greater than or equal to 35 dB.<br>(2) G.993.2 VTU-R shall be greater than or equal to 38 dB. | | |
| 4 | Surge testing | (1) After testing with Type A surge: the remote splitter U-R shall not be short-circuited and the insulation resistance shall be greater than 5MΩ under 100V DC of bias voltage.<br>(2) After testing with Type B surge: the remote splitter U-R tested shall function properly.<br>(3) The AC power cable shall function properly after the surge test. | | |
| 5 | Electric safety | Compliance with CNS 14336-1 | | |
| 6 | EMC | Compliance with CNS 13438 | | |

| Frequency (kHz) | PSD (dBm/Hz) | |
|---|---|---|
| | M1 | M2 |
| 0-4 | -101 | |
| 25 | -38 | |
| 138 | -38 | |
| 307 | -90 | |
| 482 | -100 | |
| 3575 | -105 | |
| 3750 | -80 | |
| 3751 | -60 | -53 |
| 5199 | -60 | -53 |
| 5200 | -80 | |
| 5375 | -107 | |
| 8325 | -107 | |
| 8500 | -80 | |
| 8501 | -60 | -54 |
| 11999 | -60 | -54 |
| 12000 | -80 | |
| 12175 | -107 | |
| 30000 | -110 | |

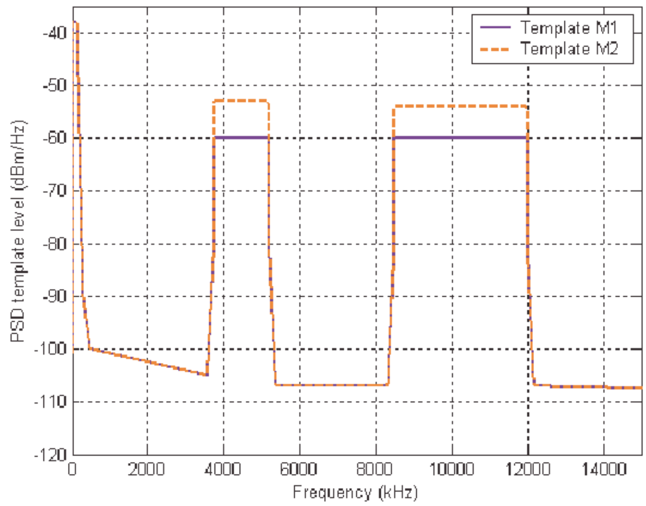
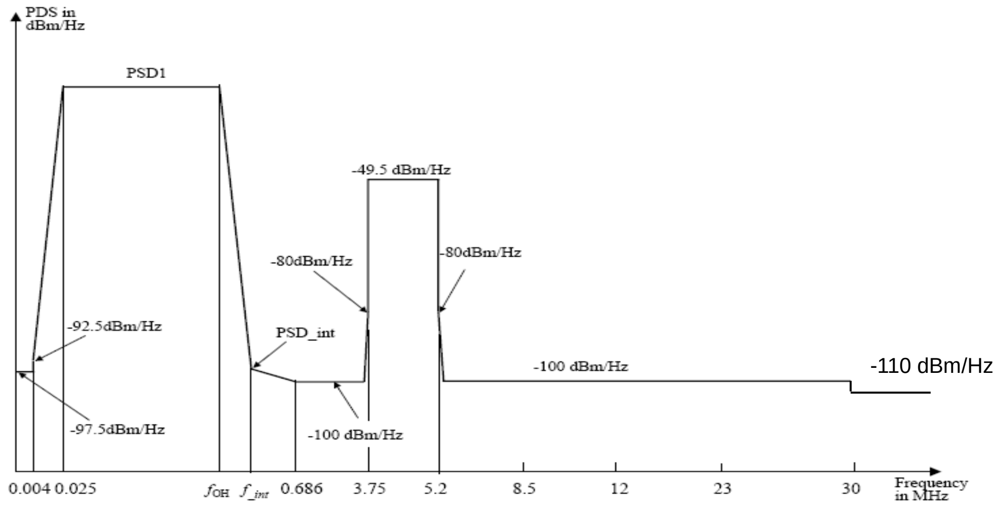
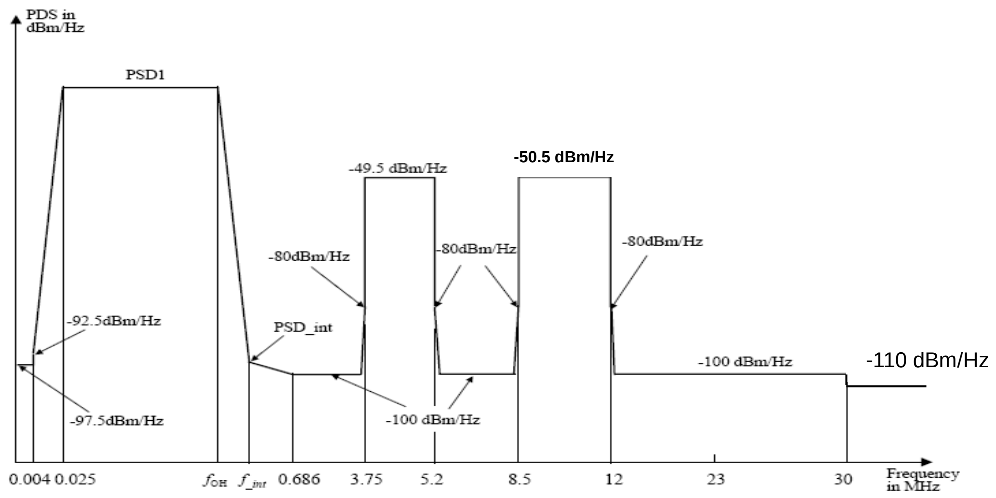


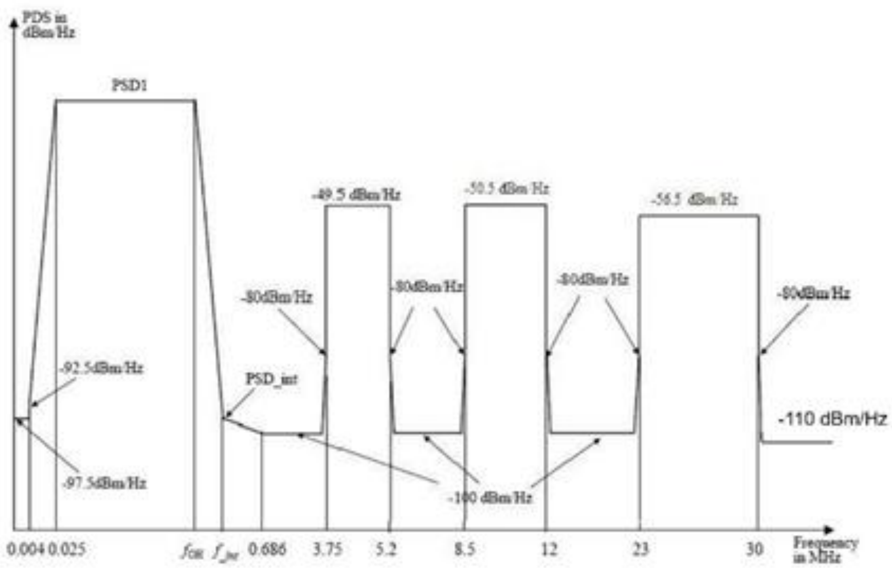

Table 4 Limitation for transmitter PSD mask of G.993.1 VTU-R




(1) PSD mask for profiles 8a, 8b, 8c and 8d




(2) PSD mask for profiles 12a, 12b and 17a

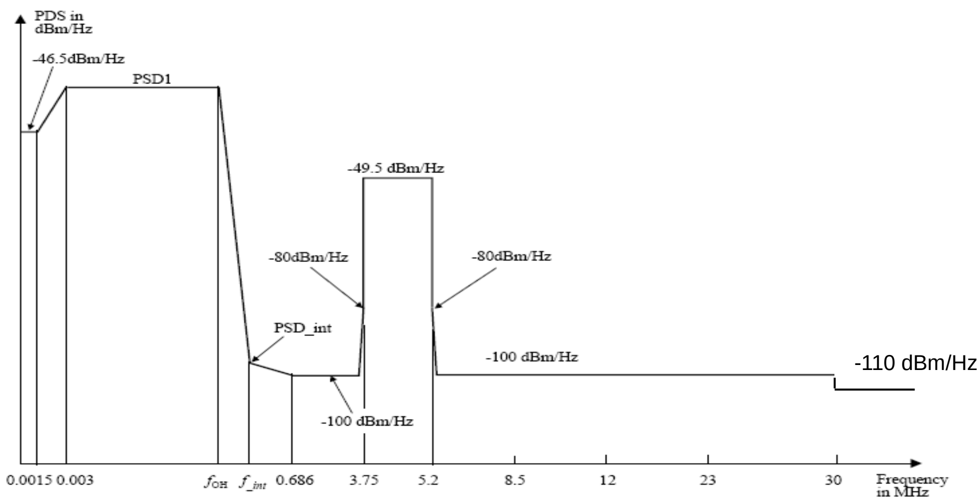



(3) PSD mask for profile 30a

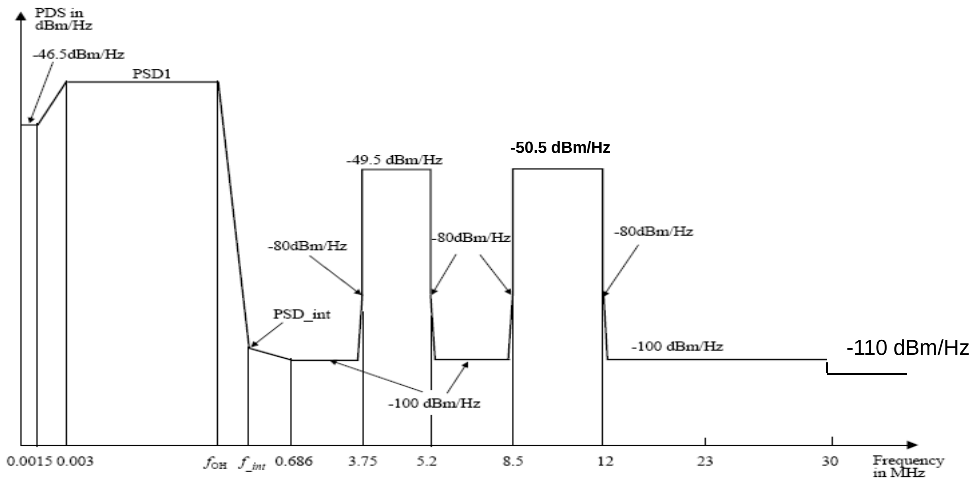
| Frequency (kHz) | PSD level limitation for profiles 8a, 8b, 8c and 8d (dBm/Hz) | PSD level limitation for profiles 12a, 12b and 17a (dBm/Hz) | PSD level limitation for profile 30a (dBm/Hz) |
|---|---|---|---|
| 0 | −97.5 | −97.5 | −97.5 |
| 4 | −97.5 | −97.5 | −97.5 |
| 4 | −92.5 | −92.5 | −92.5 |
| 25.875 | *PSD1* | *PSD1* | *PSD1* |
| $F_{0H}$ | *PSD1* | *PSD1* | *PSD1* |
| *F_int* | *PSD_int* | *PSD_int* | *PSD_int* |
| 686 | −100 | −100 | −100 |
| 1104 | −100 | −100 | −100 |
| 3750−175 | −100 | −100 | −100 |
| 3750 | −80 | −80 | −80 |
| 3750 | −53+3.5 | −53+3.5 | −53+3.5 |
| 5200 | −53+3.5 | −53+3.5 | −53+3.5 |
| 5200 | −80 | −80 | −80 |
| 5200+175 | −100 | −100 | −100 |
| 8500−175 | −100 | −100 | −100 |
| 8500 | −100 | −80 | −80 |
| 8500 | −100 | −54+3.5 | −54+3.5 |
| 12000 | −100 | −54+3.5 | −54+3.5 |
| 12000 | −100 | −80 | −80 |
| 12000+175 | −100 | −100 | −100 |
| 23000−175 | −100 | −100 | −100 |
| 23000 | −100 | −100 | −80 |
| 23000 | −100 | −100 | −60+3.5 |
| 30000 | −100 | −100 | −60+3.5 |
| 30000 | −110 | −110 | −80 |
| 30175 | −110 | −110 | −110 |
| ≥30175 | −110 | −110 | −110 |

| Mask no. | Indication no. | *PSD1* (dBm/Hz) | $f_{0H}$ (kHz) | *f_int* (kHz) | *PSD_int* (dBm/Hz) |
|---|---|---|---|---|---|
| 1 | EU-32 | −34.5 | 138.00 | 242.92 | −93.2 |
| 2 | EU-36 | −35.0 | 155.25 | 274.00 | −94.0 |
| 3 | EU-40 | −35.5 | 172.50 | 305.16 | −94.7 |
| 4 | EU-44 | −35.9 | 189.75 | 336.40 | −95.4 |
| 5 | EU-48 | −36.3 | 207.00 | 367.69 | −95.9 |
| 6 | EU-52 | −36.6 | 224.25 | 399.04 | −96.5 |
| 7 | EU-56 | −36.9 | 241.50 | 430.45 | −97.0 |
| 8 | EU-60 | −37.2 | 258.75 | 461.90 | −97.4 |
| 9 | EU-64 | −37.5 | 276.00 | 493.41 | −97.9 |

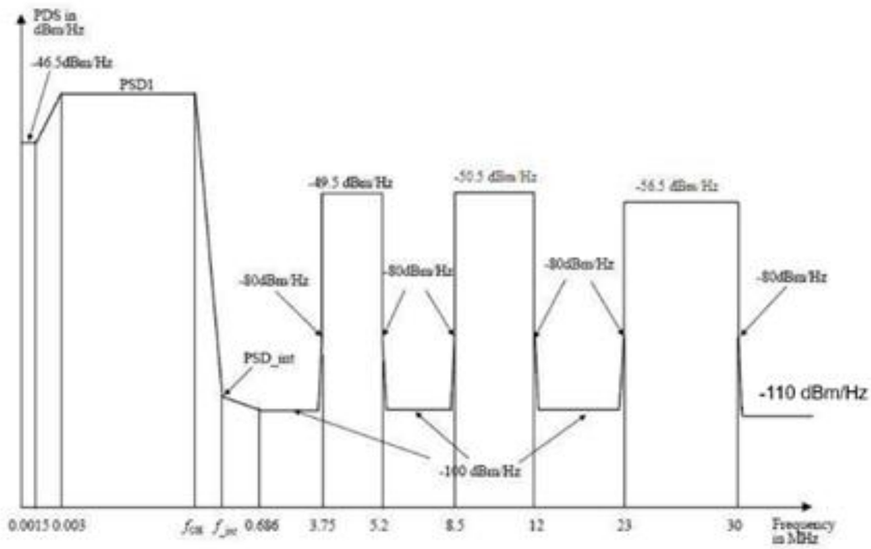
Table 5 VTU-R PSD mask limitation of G.993.2 in POTS mode




(1) PSD mask for profiles 8a, 8b, 8c and 8d




(2) PSD mask for profiles 12a, 12b and 17a




(3) PSD mask for profile 30a

| Frequency (kHz) | PSD level limitation for profiles 8a, 8b, 8c and 8d (dBm/Hz) | PSD level limitation for profiles 12a, 12b and 17a (dBm/Hz) | PSD level limitation for profile 30a (dBm/Hz) |
|---|---|---|---|
| 0 | −46.5 | −46.5 | −46.5 |
| 1.5 | −46.5 | −46.5 | −46.5 |
| 3 | *PSD1* | *PSD1* | *PSD1* |
| $f_{0H}$ | *PSD1* | *PSD1* | *PSD1* |
| $f_{int}$ | *PSDint* | *PSDint* | *PSDint* |
| 686 | −100 | −100 | −100 |
| 1104 | −100 | −100 | −100 |
| 3750−175 | −100 | −100 | −100 |
| 3750 | −80 | −80 | −80 |
| 3750 | −53+3.5 | −53+3.5 | −53+3.5 |
| 5200 | −53+3.5 | −53+3.5 | −53+3.5 |
| 5200 | −80 | −80 | −80 |
| 5200+175 | −100 | −100 | −100 |
| 8500−175 | −100 | −100 | −100 |
| 8500 | −100 | −80 | −80 |
| 8500 | −100 | −54+3.5 | −54+3.5 |
| 12000 | −100 | −54+3.5 | −54+3.5 |
| 12000 | −100 | −80 | −80 |
| 12000+175 | −100 | −100 | −100 |
| 23000−175 | −100 | −100 | −100 |
| 23000 | −100 | −100 | −80 |
| 23000 | −100 | −100 | −60+3.5 |
| 30000 | −100 | −100 | −60+3.5 |
| 30000 | −110 | −110 | −80 |
| 30175 | −110 | −110 | −110 |
| ≥30175 | −110 | −110 | −110 |

| Mask no. | Indication no. | *PSD1* (dBm/Hz) | $f_{0H}$ (kHz) | *f_int* (kHz) | *PSD_int* (dBm/Hz) |
|---|---|---|---|---|---|
| 1 | ADLU-32 | −34.5 | 138.00 | 242.92 | −93.2 |
| 2 | ADLU-36 | −35.0 | 155.25 | 274.00 | −94.0 |
| 3 | ADLU-40 | −35.5 | 172.50 | 305.16 | −94.7 |
| 4 | ADLU-44 | −35.9 | 189.75 | 336.40 | −95.4 |
| 5 | ADLU-48 | −36.3 | 207.00 | 367.69 | −95.9 |
| 6 | ADLU-52 | −36.6 | 224.25 | 399.04 | −96.5 |
| 7 | ADLU-56 | −36.9 | 241.50 | 430.45 | −97.0 |
| 8 | ADLU-60 | −37.2 | 258.75 | 461.90 | −97.4 |
| 9 | ADLU-64 | −37.5 | 276.00 | 493.41 | −97.9 |

Table 6 VTU-R PSD mask limits of G.993.2 in all digital mode

6.3 The test items specified in 6.1 and 6.2 apply to VTU-R with POTS splitter.

## 7. POTS splitter communication interface tests

### 7.1 DC loop resistance

7.1.1 Purpose: ensure that the DC loop resistance of VDSL splitter at the remote terminal complies with the criteria specified in 6.1 POTS Splitter test list.

7.1.2 Wiring:

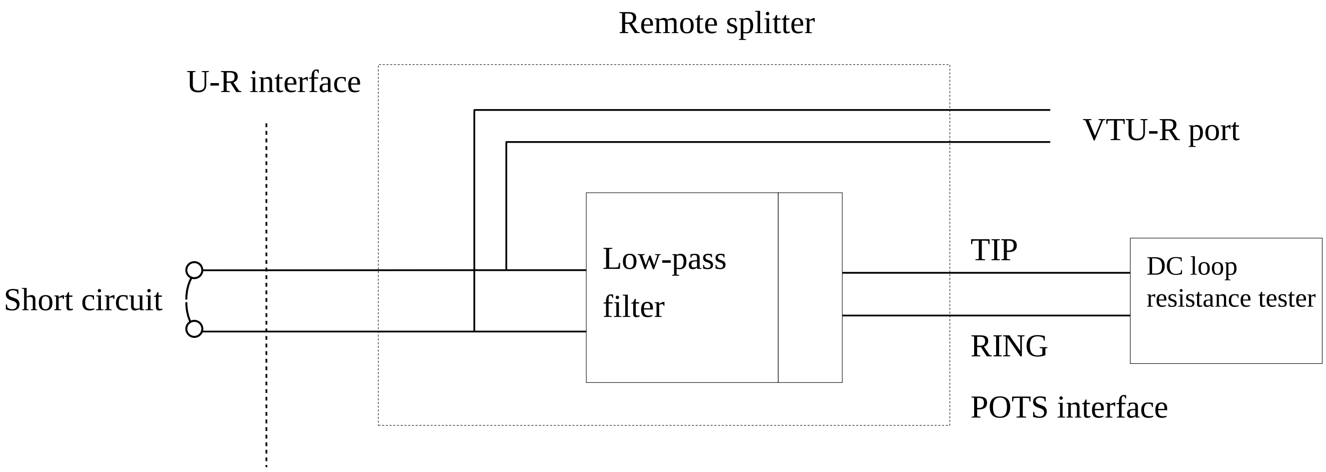



Figure 1 DC resistance test between tip and ring on POTS interface

7.1.3 Test steps:

(1) Connect the DC loop resistance tester and remote splitter in the way shown in Figure 1.

(2) Short-circuit the U-R interface. Set the loop current from the DC loop resistance tester output to 10mA.

(3) Measure the DC voltage between tip and ring of the remote splitter using a voltmeter.

(4) Determine the DC resistance value under telephone line bias voltage (-48VDC) by dividing the measured voltage with the loop current. Keep a record of the result.

(5) Repeat the test steps above with the loop current set at 20mA, 60 mA and 100mA.

(6) Determine the DC loop resistance value between tip and ring on the Remote splitter.

7.2 DC insulation resistance

7.2.1 Purpose: ensure that the DC insulation resistance of VDSL splitter at the remote terminal complies with the criteria specified in 6.1 POTS Splitter test list.

7.2.2 Wiring:

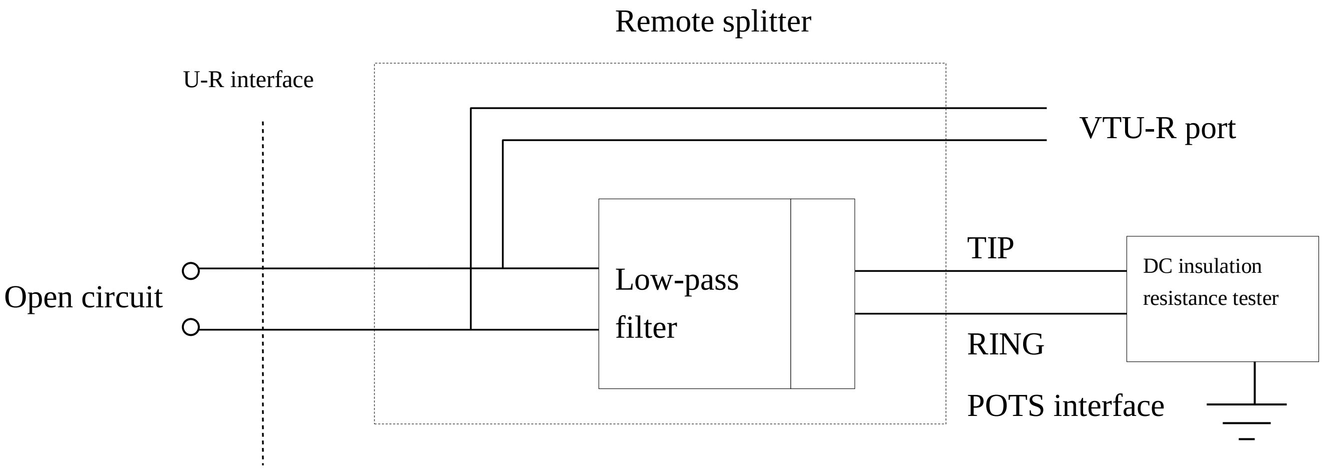



Figure 2 DC insulation resistance test between tip or ring and ground and between tip to ring on POTS interface

7.2.3 Test steps:

(1) Connect the DC insulation resistance tester and remote splitter in the way shown in Figure 2.

(2) Make the U-R interface open circuit. Set the voltage output of the DC insulation resistance tester output to DC100V.

(3) Measure the DC insulation resistance between ring and ground on the POTS interface using the DC insulation resistance tester. Keep a record of the result.

(4) Measure the DC insulation resistance between tip and ground on the POTS interface using the DC insulation resistance tester. Keep a record of the result.

(5) Measure the DC insulation resistance between ring and tip on the POTS interface using the DC insulation resistance tester. Keep a record of the result.

7.3 Insertion Loss in the Voice Band

7.3.1 Purpose: ensure that the insertion loss in the voice band (1004Hz) complies with the criteria specified in 6.1 POTS Splitter test list when the VDSL splitter at the remote terminal is connected to a simulated test loop or actual cable.

7.3.2 Wiring:

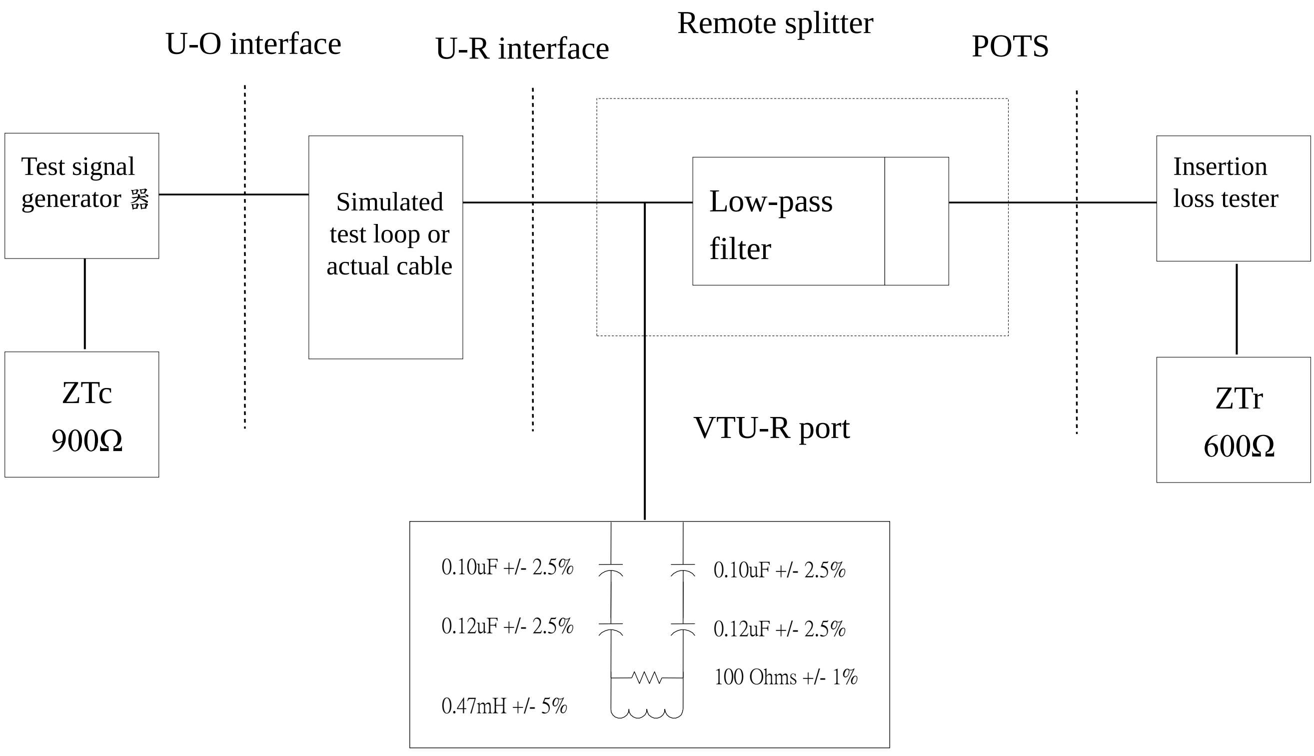



Figure 3 Wiring for the voiceband insertion loss test

Note----ZHP-r: high-pass impedance at remote terminal; see Figure 3 for parts specifications.
Actual cable or simulated test loop: refers to 0, 0.5kft, 2.0kft and 5.0 kft pairs of 26 AWG.

7.3.3 Test steps:

(1) Connect the insertion loss tester, high-pass impedance (ZHP-r) circuit, remote splitter and actual cable or simulated test loop, as shown in Figure 3.

(2) Select the 26AWG 0ft Cable or simulated test loop. Measure the insertion loss under the 1004Hz test signal before the system is connected to the splitter and high-pass impedance (ZHP-r) circuit. Keep a record of the result.

(3) Insert the remote splitter and high-pass impedance (ZHP-r) circuit in the system wiring. Measure the insertion loss under the 1004Hz test signal. Keep a record of the result.

(4) Select the 26AWG 0.5ft, 2kft and 5kft cables or simulated test loop. Repeated the steps above and keep a record of the result.

(5) Determine the insertion loss after interfacing with the remote splitter. Keep a record of the result.

## 7.4 Attenuation

7.4.1 Purpose: ensure that the signal attenuation of VDSL splitter at the remote terminal at the frequency bands between 30kHz and 1104kHz, and between 1.104MHz and 12MHz complies with the criteria specified in 6.1 POTS Splitter test list.

7.4.2 Wiring:

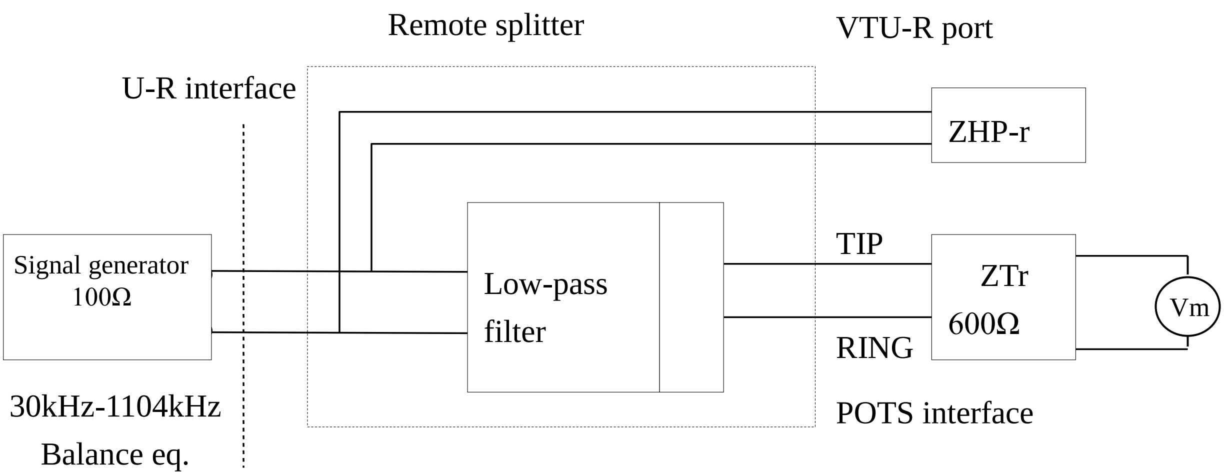
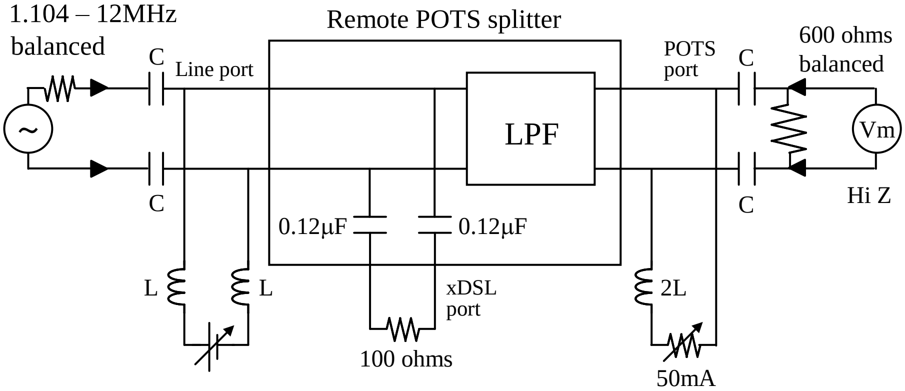



Figure 4 Wiring for signal attenuation test between 30kHz and 1104kHz




Where: R = 600 ohms, J = 50mA
R = open, J = 0 mA

Figure 5 Wiring for signal attenuation test between 1.104MHz and 12MHz

7.4.3 Test steps:

(1) Connect the 30kHz-1104kHz band signal generator, Vm frequency selective level tester, high-pass impedance (ZHP-r) circuit and remote splitter, as shown in Figure 4.

(2) Measure the attenuation in the 30kHz-1104kHz band. Keep a record of the result.

(3) Set up the remote splitter as shown in Figure 5. Set the loop current at 50mA.

(4) Measure the attenuation in the 1.104MHz - 12MHz band. Keep a record of the result.

7.5 Attenuation Distortion in the Voice Band

7.5.1 Purpose: ensure that the attenuation distortion in the voice band complies with the allowable range in Table 1 when the VDSL splitter at the remote terminal is connected to simulated test loop.

7.5.2 Wiring:

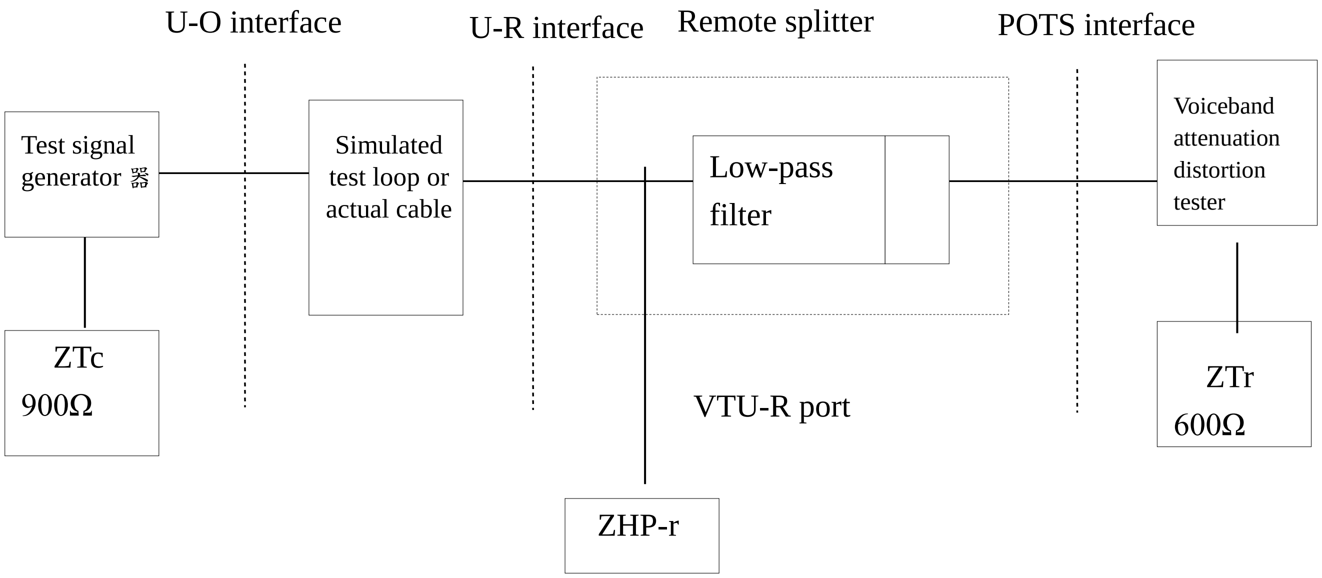



Figure 6 Wiring for voiceband attenuation distortion test

7.5.3 Test steps:

(1) Connect the voiceband attenuation distortion tester, test signal generator, high-pass impedance (ZHP-r) circuit, remote splitter and actual cable or simulated test loop, as shown in Figure 6.

(2) Select 26AWG 0ft cable or simulated test loop. Measure the insertion loss under the 200Hz to 3400Hz test signal before the system is connected to the splitter and high-pass impedance (ZHP-r) circuit. Keep a record of the result.

(3) Insert the splitter and high-pass impedance (ZHP-r) circuit in the system wiring. Measure the attenuation distortion under the 200Hz to 3400Hz test signal. Print the result out and keep a record.

(4) Measure the attenuation distortion under the 1004Hz test signal with system connected to the splitter and high-pass impedance (ZHP-r) circuit. Compare the measurement with the results from the previous attenuation distortion test and keep a record.

(5) Repeat the previous test steps and measure the attenuation distortion under the 3400Hz to 4000Hz test signal. Compare the measurement with the attenuation distortion under the 1004Hz test signal and keep a record.

(6) Select 26AWG 0.5kft, 2.0kft and 5kft simulated test loops or actual cables. Repeat the test steps above. Keep a record of the result.

7.6 Delay Distortion in the Voice band

7.6.1 Purpose: ensure that the delay distortion in the voice band complies with the allowable range in Table 2 when the VDSL splitter at the remote terminal is connected to simulated test loop.

7.6.2 Wiring:

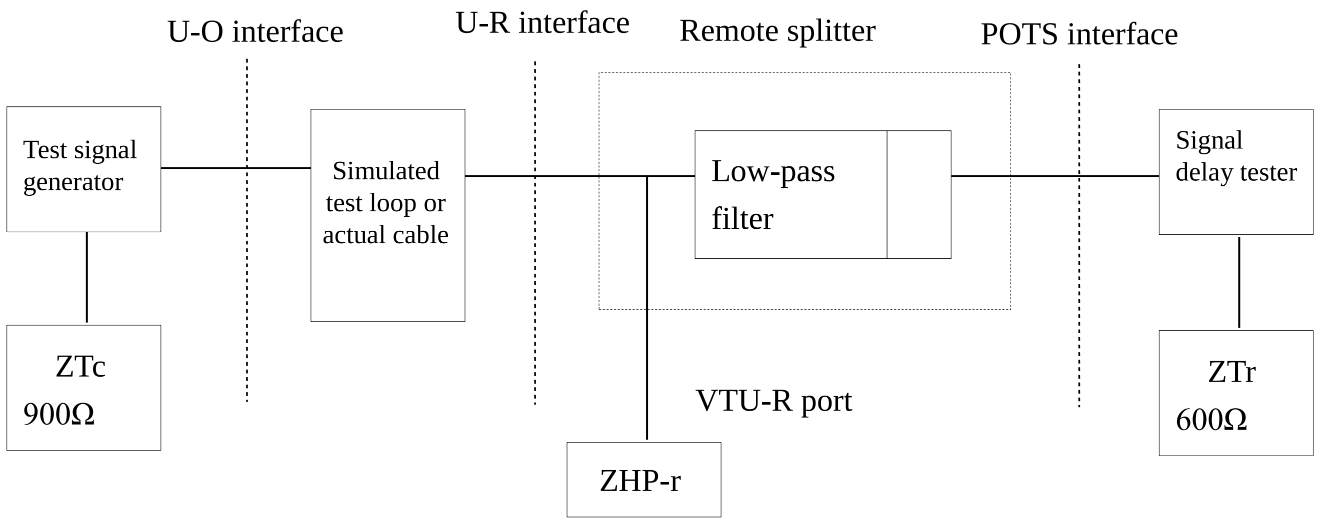



Figure 7 Wiring for voiceband delay distortion test

7.6.3 Test steps:

(1) Connect the signal delay tester, test signal generator, high-pass impedance (ZHP-r) circuit, remote splitter and simulated test loop, as shown in Figure 7.

(2) Select 26AWG 0ft Cable simulated test loop or actual cable. Measure the signal delay under the 600Hz to 3200Hz test signal before the system is connected to the splitter and high-pass impedance (ZHP-r) circuit. Keep a record of the result.

(3) Insert the splitter and high-pass impedance (ZHP-r) circuit in the system wiring. Measure the signal delay under the 600Hz to 3200Hz test signal. Compare with the results from the previous signal delay test and keep a record.

(4) Select 26AWG 0ft Cable simulated test loop or actual cable. Measure the signal delay under the 200Hz to 4000Hz test signal before the system is connected to the splitter and

high-pass impedance (ZHP-r) circuit. Keep a record of the result.

(5) Insert the splitter and high-pass impedance (ZHP-r) circuit in the system wiring. Measure the signal delay under the 200Hz to 4000Hz test signal. Compare with the results from the previous signal delay test and keep a record.

(6) Select 26AWG 0.5ft, 2kft and 5kft simulated test loops or actual cables. Repeat the test steps above. Keep a record of the result.

7.7 Return Loss in the Voice band

7.7.1 Purpose: ensure that the return loss in the voice band complies with the allowable range in Table 3 when the VDSL splitter at the remote terminal is connected to simulated test loop.

7.7.2 Wiring:

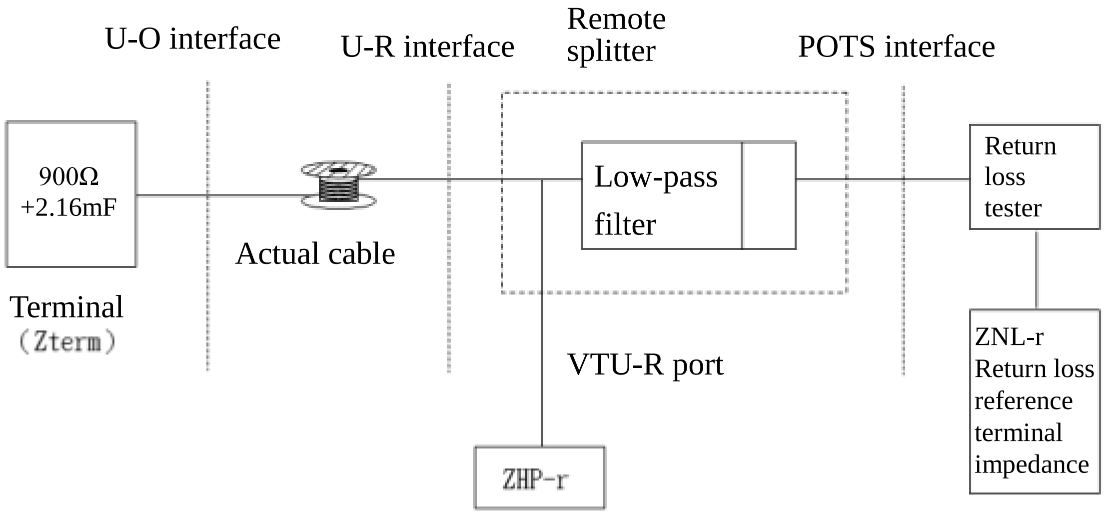



Figure 8 Wiring for return loss test

Note 1: the return loss reference terminal impedance, ZNL-r, is equivalent to a no-load loop model when looking from the remote terminal. It is the combination of 348Ω resistor and 100nF capacitor in parallel that are then connected to a 1330Ω resistor in parallel.

Note 2: the high-pass impedance, ZHP-r, is equivalent to the VTU-R circuit impedance when looking from the telephone loop through the remote splitter; see Figure 4 for details.

Note 3: actual cable: 1kft pairs of 26AWG Cable.

7.7.3 Test steps:

(1) Connect the return loss tester, high-pass impedance (ZHP-r) circuit, remote splitter, equivalent impedances such as return loss reference terminal impedance (ZNL-r) at the remote terminal and telephone exchange at the central office, and a reel of actual cable, as shown in Figure 8.

(2) Measure the return loss. Keep a record of the result.

(3) Select the individual frequencies between 2200Hz and 3400Hz. Repeat the test steps above. Keep a record of the result.

7.8 Longitudinal Balance Testing in the Voice band

7.8.1 Purpose: ensure that the longitudinal balance of VDSL splitter at the remote terminal in the voice band complies with the criteria specified in 6.1 POTS Splitter test list.

7.8.2 Wiring:

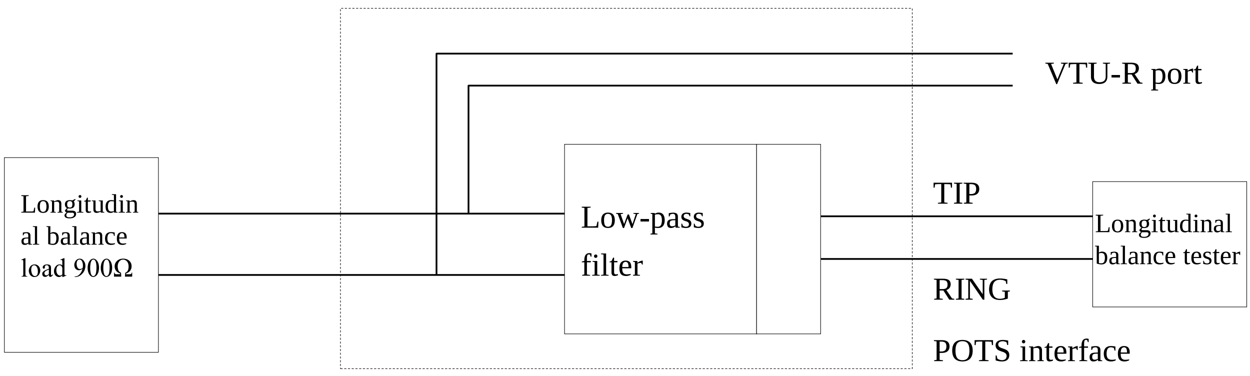



Figure 9 Wiring for longitudinal balance test

Note: the longitudinal balance of auxiliary test circuit shall be >77dB. The peak-to-peak voltage of test signal shall not exceed 3V. A loop bias current of 25mA shall be added during the test.

7.8.3 Test steps:

(1) Connect the voiceband longitudinal balance tester, longitudinal balance test load and remote splitter as shown in Figure. Set the loop current at 25mA.

(2) Measure the longitudinal balance in the voice band. Keep a record of the result.

7.9 Transparent Capacitor

7.9.1 Purpose: ensure that the VDSL splitter at the remote terminal is capable of routine tests in a general metal wire test system while maintaining the accuracy and independence of telephone network maintenance test; the transparent capacitor shall comply with the criteria specified in 6.1 POTS Splitter test list.

7.9.2 Wiring:

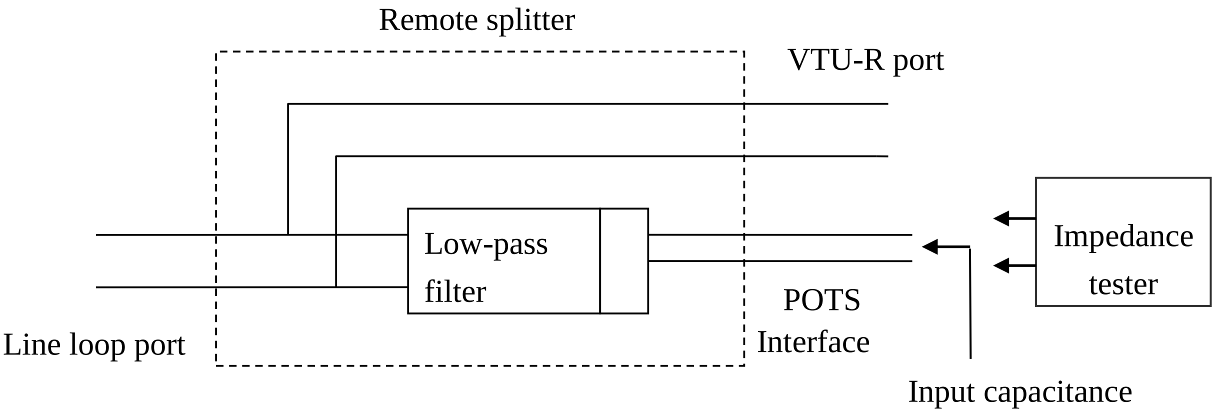



Figure 10 Wiring for transparent capacitor test on subscriber loop

7.9.3 Test steps:

(1) Set up the remote splitter as shown in Figure 10.

(2) Measure the input capacitance of remote splitter in the 20~30Hz frequency band at the POTS interface. Keep a record of the result.

(3) Measure the stray capacitance of either tip or ring to ground in the Remote splitter. Keep a record of the result.

7.10 Surge Testing

7.10.1 Purpose: ensure that both ends of remote splitter U-R interface function properly after the surge test.

7.10.2 Wiring:

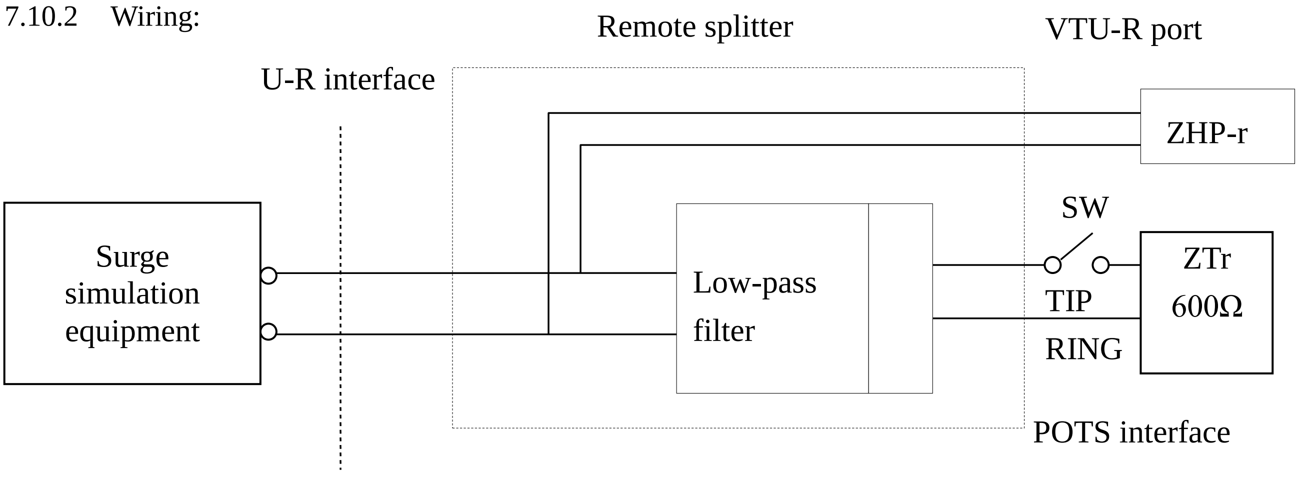



Figure 11 Wiring for surge test

7.10.3 Test steps:

(1) Set up the remote splitter as shown in Figure 11.

(2) Surge waveforms:

Type A:

Open-circuit voltage: front time ($T_f$)≦10us, impact time ($T_d$)≧560us and peak voltage at 800V or more;

Short-circuit current: front time ($T_f$)≦10us, impact time ($T_d$)≧560us and peak current energy at 100A or more.

Type B:

Open-circuit voltage: front time ($T_f$) 9us±30%, impact time ($T_d$) 720us±20% and peak voltage at 1000V or more;

Short-circuit current: front time ($T_f$) 5us±30%, impact time ($T_d$) 320us±20% and peak current energy at 25A or more.

(3) SW OFF, the surge waveforms above are applied to both ends of remote splitter U-R interface; the surges are applied once in forward direction and once in reverse direction.

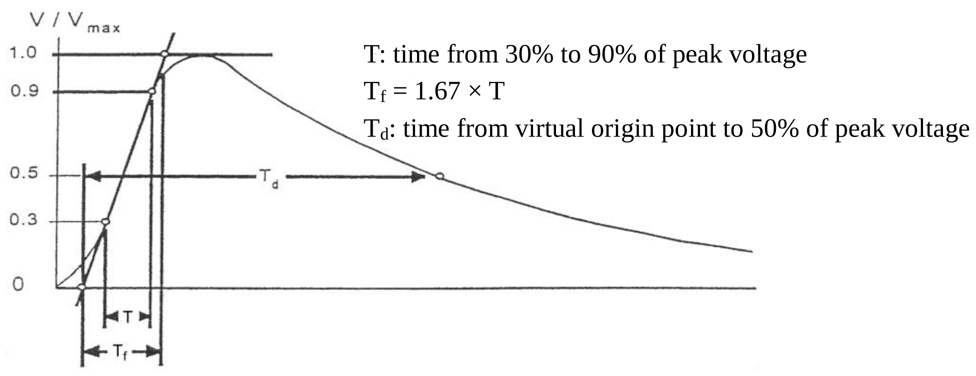
(4) SW ON, the surge waveforms above are applied to both ends of remote splitter U-R interface; the surges are applied once in forward direction and once in reverse direction.

(5) Check that the remote splitter complies with the criteria for the surge test.

Note 1: The surge voltage waveform is shown as follows:

Front time ($T_f$)=1.67 × T (time from 30% to 90% of peak voltage);

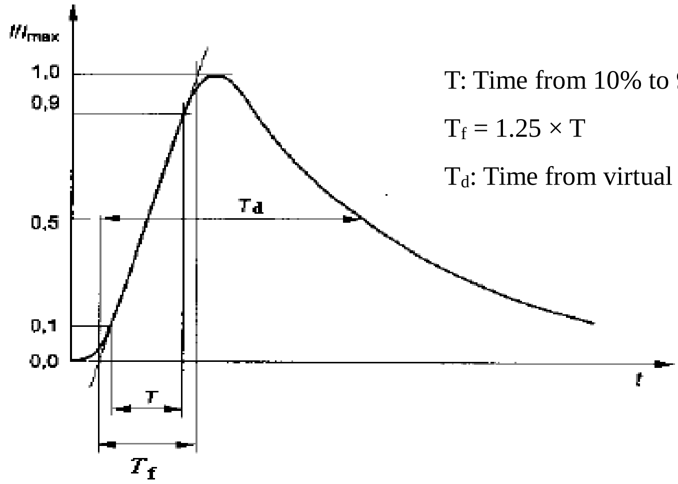
Impact time ($T_d$): time from virtual origin point to 50% of peak voltage.




Note 2: the surge current waveform is shown as follows:

Front time ($T_f$)=1.25 × T (time from 10% to 90% of peak current);

Impact time ($T_d$): time from virtual origin point to 50% of peak current.




T: Time from 10% to 90% of peak current

$T_f = 1.25 \times T$

$T_d$: Time from virtual origin point to 50% of peak current

Note 3: the surge tests are 60 seconds apart.

## 8. VTU-R communication interface test

### 8.1 Transmitter Pass Band PSD Response Testing

8.1.1 Purpose: ensure that the maximum transmitter pass band PSD of each VTU-R band complies with the criteria in 6.2 VTU-R test list.

8.1.2 Wiring:

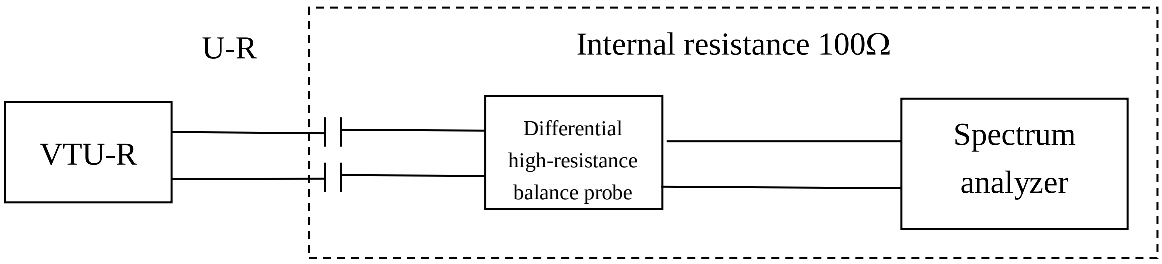



Figure 12 Setup for VTU-R transmitter pass band PSD response test

8.1.3 Test steps:

(1) Connect the test loop as shown in Figure 12.

(2) Connect the power so that the VTU-R to be tested is at the maximum transmission stability.

(3) Measure the VTU-R transmitter PSD using differential high-resistance balance probe and spectrum analyzer. Keep a record of the transmitter PSD measurement. Print out or save the result.

### 8.2 Total Signal Power Limitation

8.2.1 Purpose: ensure that the maximum total signal power limitation of VTU-R complies with the criteria in 6.2 VTU-R test list.

8.2.2 Wiring:

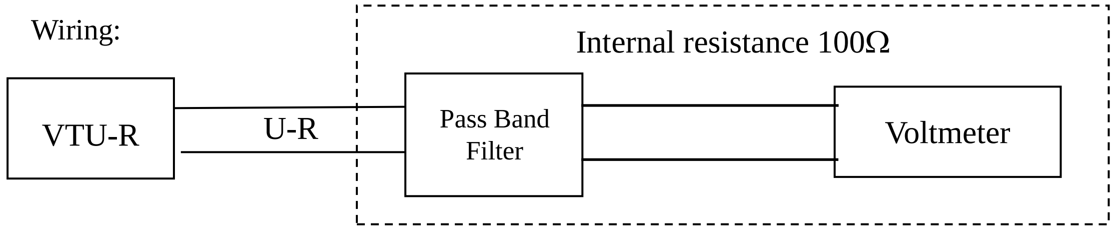



Figure 13 Setup for VTU-R total signal power limitation test

8.2.3 Test steps:

(1) Connect the test loop as shown in Figure 13.

(2) Connect the power so that the VTU-R to be tested is at the maximum transmission stability.

(3) Measure the Vrms of transmission signal using a voltmeter. Keep a record of the result.

(4) Determine the total signal power = 20 log (Vrms/316mV). Keep a record of the result.

## 8.3 Longitudinal Balance

8.3.1 Purpose: ensure that the longitudinal balance of VTU-R complies with the criteria in 6.2 VTU-R test list.

8.3.2 Wiring:

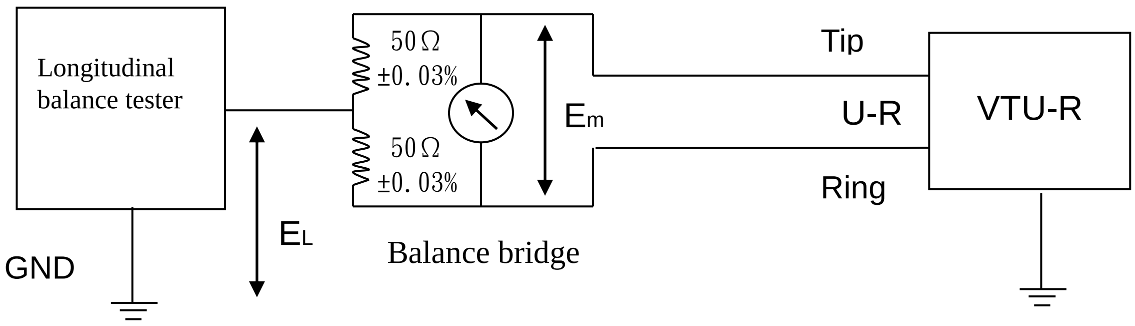



Figure 14 Setup for longitudinal balance test

8.3.3 Test steps:

(1) Connect the test loop as shown in Figure 14.

(2) Operate the longitudinal balance tester to perform a calibration procedure.

(3) Operate the longitudinal balance tester to perform the longitudinal balance test.

(4) Determine the longitudinal balance = 20log |EL/Em| dB. Keep a record and save the measurements.

## 8.4 Surge Testing

8.4.1 Purpose: ensure that both ends of VTU-R U-R interface and AC power cable function properly after the surge test.

8.4.2 Wiring:

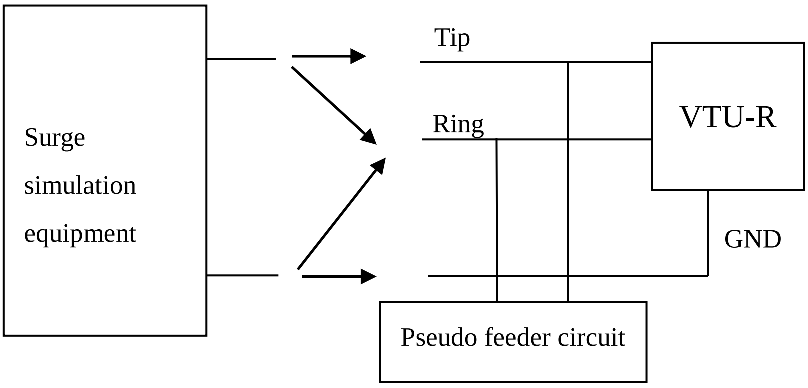



Figure 16 Wiring for surge test on U-R interface

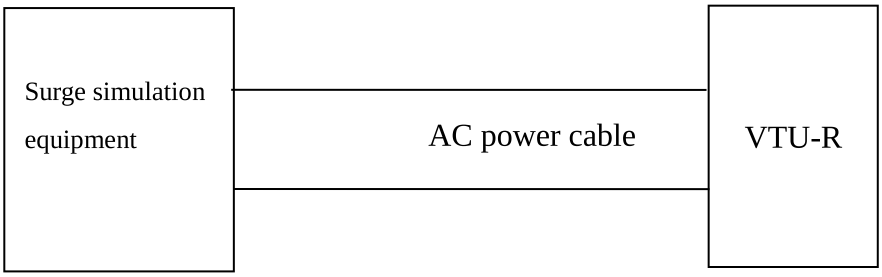



Figure 17 AC power cable surge test setup

8.4.3 Test steps:

a. Test steps for lateral surge between telephone lines:

(1) Set up the VTU-R as shown in Figure 16.

(2) Surge waveforms:

Type A:

Open-circuit voltage: front time ($T_f$)≦10us, impact time ($T_d$)≧560us and peak voltage at 800V or more;

Short-circuit current: front time ($T_f$)≦10us, impact time ($T_d$)≧560us and peak current energy at 100A or more.

Type B:

Open-circuit voltage: front time ($T_f$) 9us±30%, impact time ($T_d$) 720us±20% and peak voltage at 1000V or more;

Short-circuit current: front time ($T_f$) 5us±30%, impact time ($T_d$) 320us±20% and peak current energy at 25A or more.

(3) Apply the surge waveforms specified above at tip and ring of the VTU-R interface; the surges are applied once in forward direction and once in reverse direction.

(4) Check that the VTU-R complies with the criteria of surge test.

b. Test steps for longitudinal surge:

(1) Set up the VTU-R as shown in Figure 16.

(2) Surge waveforms:

Type A:

Open-circuit voltage: front time ($T_f$)≦10us, impact time ($T_d$)≧160us and peak voltage at 1500V or more;

Short-circuit current: front time ($T_f$)≦10us, impact time ($T_d$)≧160us and peak current energy at 200A or more.

Type B:

Open-circuit voltage: front time ($T_f$) 9us±30%, impact time (Td) 720us±20% and peak voltage at 1500V or more;

Short-circuit current: front time ($T_f$) 5us±30%, impact time (Td) 320us±20% and peal current energy at 37.5A or more.

(3) Apply the surge waveforms specified above between tip / ring of the VTU-R interface and metal ground or casing of VTU-R; the surges are applied once in forward direction and once in reverse direction.

(4) Check that the VTU-R complies with the criteria of surge test.

c. AC power cable surge test:

(1) Set up the VTU-R as shown in Figure 17.

(2) Waveform: front time ($T_f$)≦2us, impact time ($T_d$)≧10us and peak voltage at 2500V; the surge wave generator shall be capable of peak current energy at 1000A or more.

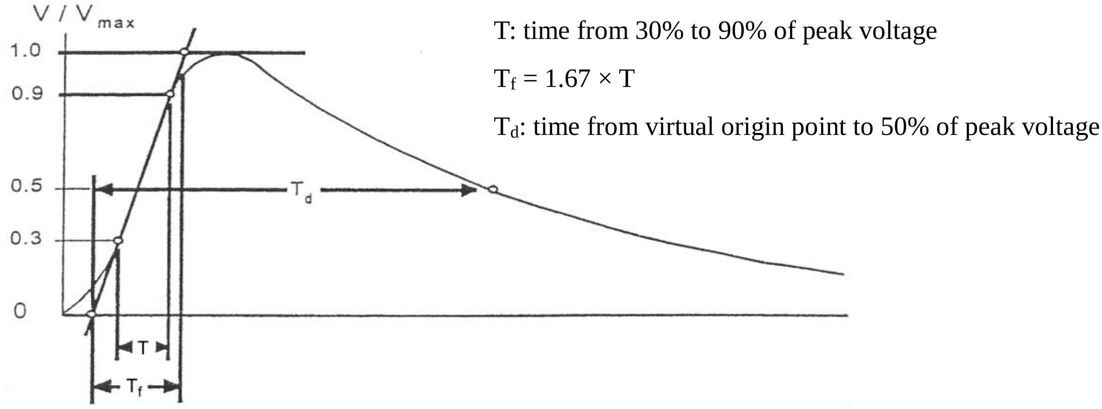
(3) While the VTU-R is fed by AC power supply, apply the waveform specified above at both ends of VTU-R power cable; the surge is applied three times in forward direction and three times in reverse direction.

(4) Check that the VTU-R power interface complies with the criteria of surge test.

Note 1: the surge voltage waveform is shown as follows:

Front time ($T_f$)=1.67 × T (time from 30% to 90% of peak voltage);

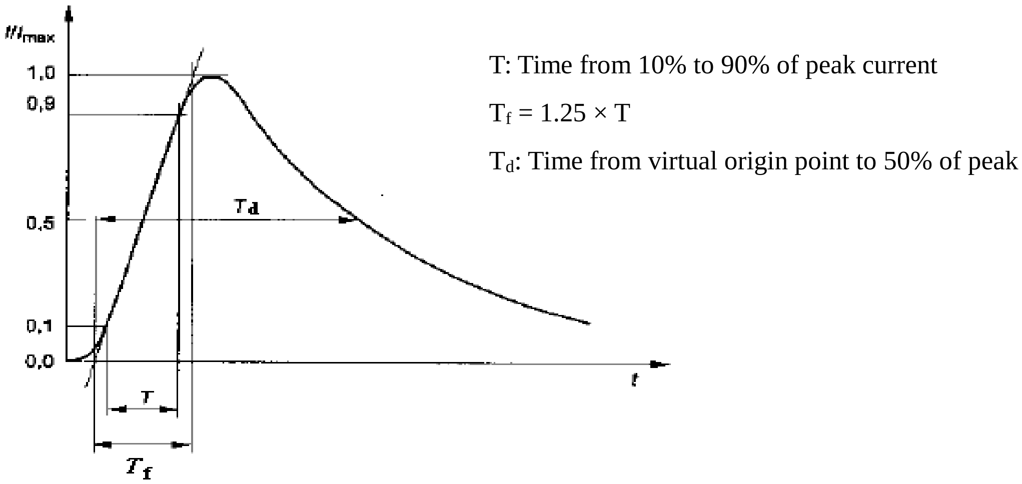
Impact time ($T_d$): time from virtual origin point to 50% of peak voltage.




Note 2: The surge current waveform is shown as follows:

Front time ($T_f$)=1.25 × T (time from 10% to 90% of peak current);

Impact time ($T_d$): time from virtual origin point to 50% of peak current.




Note 3: The surge tests are 60 seconds apart.