



**Technical Specifications for the
Telecommunications Terminal Equipment
and POTS Splitters for Asymmetric Digital
Subscriber Lines**

National Communications Commission

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Technical Specifications for the Telecommunications Terminal Equipment and POTS Splitters for Asymmetric 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 Asymmetric Digital Subscriber Line (ADSL) Transceiver Unit - remote terminal (ATU-R) and POTS splitter.

3. Contents and reference

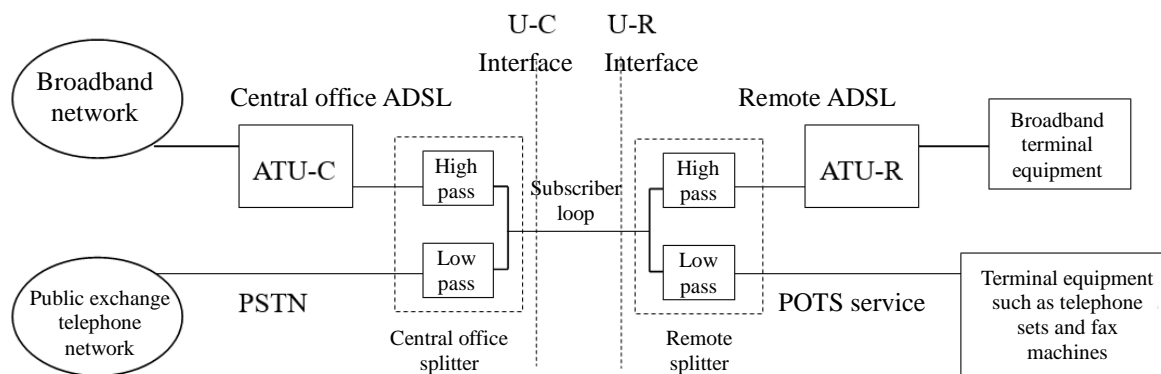
The Specifications are developed based on the test methods and relevant standards for ATU-R and POTS splitter communication interface in ITU-T Rec. G.993.1, G.993.2, G.992.5 and G.996.1 of International Telecommunication Union.

4. Acronyms

ADSL	非對稱數位用戶迴路	Asymmetric Digital Subscriber Line
ATU-C	機房端 ADSL 設備	ADSL Transceiver Unit - central office
ATU-R	用戶端 ADSL 電信終端設備	ADSL 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

5. ADSL system architecture

For the provision of broadband access network service of ADSL, the ATU-C is connected to ISP via broadband network at central office and ADSL 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 (per ITU-T Rec. G.992.1):





6. Test items and acceptance criteria

6.1 POTS Splitter test list

No.	Test item	Acceptance 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	Simulated test loop or actual cable (1004Hz voiceband): < 1.0dB		
4	ADSL band attenuation	ADSL band 32kHz~300kHz: > 65dB ADSL/ADSL2 band 300kHz~1140kHz: > 55dB ADSL2+ band 300kHz~2208kHz: > 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 ATU-R, the input capacitance shall be between 20nF and 115nF. (2) For ATU-R with built-in splitter, the input capacitance of POTS interface shall be between 40nF and 150nF. (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: (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. (2) After testing with Type B surge: the equipment tested shall function properly.		

Description		0.2 – 3.4kHz		3.4 – 4.0kHz	
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		0.6-3.2 kHz	0.2-4.0 kHz
Simulated test loop or actual cable	ZTc=900Ω ZTr=600Ω	< 200 μs	<250 μs

Table 2 Allowable range of voiceband delay distortion

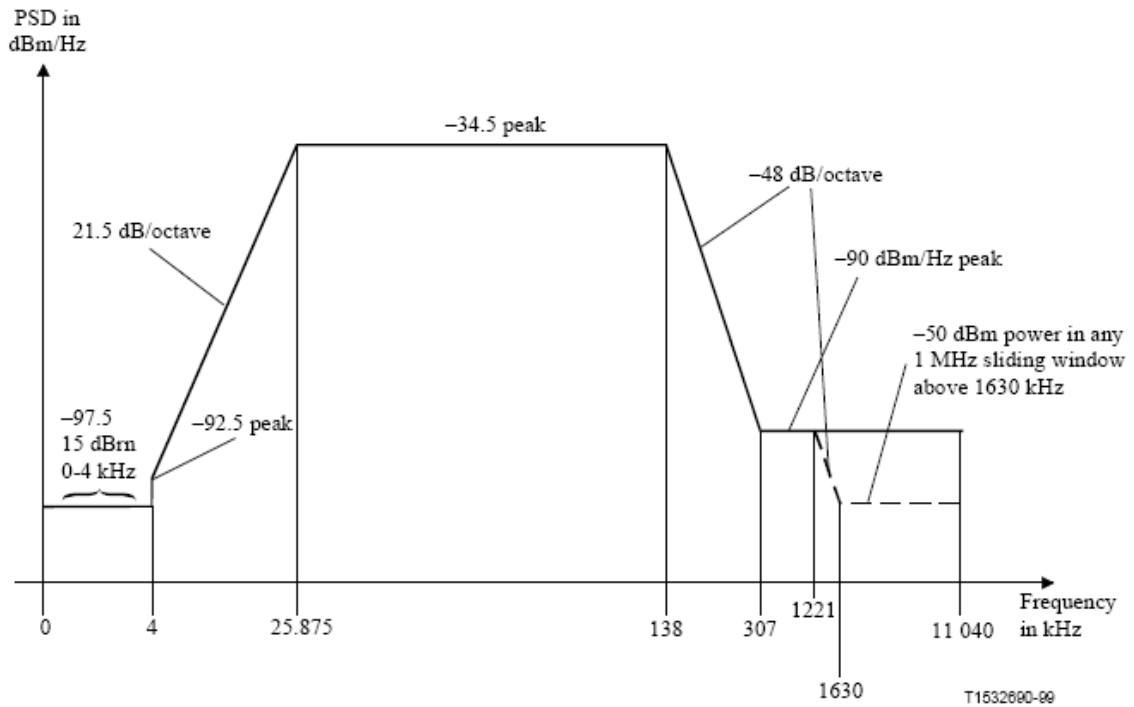


Zref	Zterm	ERL	SRL-L	SRL-H	Remark
ZNL-r	900Ω+2.16μF	> 6 dB	> 5 dB	> 3 dB	
ZNL-r	900Ω+2.16μF	N/A	N/A	> 2 dB	Individual frequencies

Table 3 Allowable range of voiceband return loss

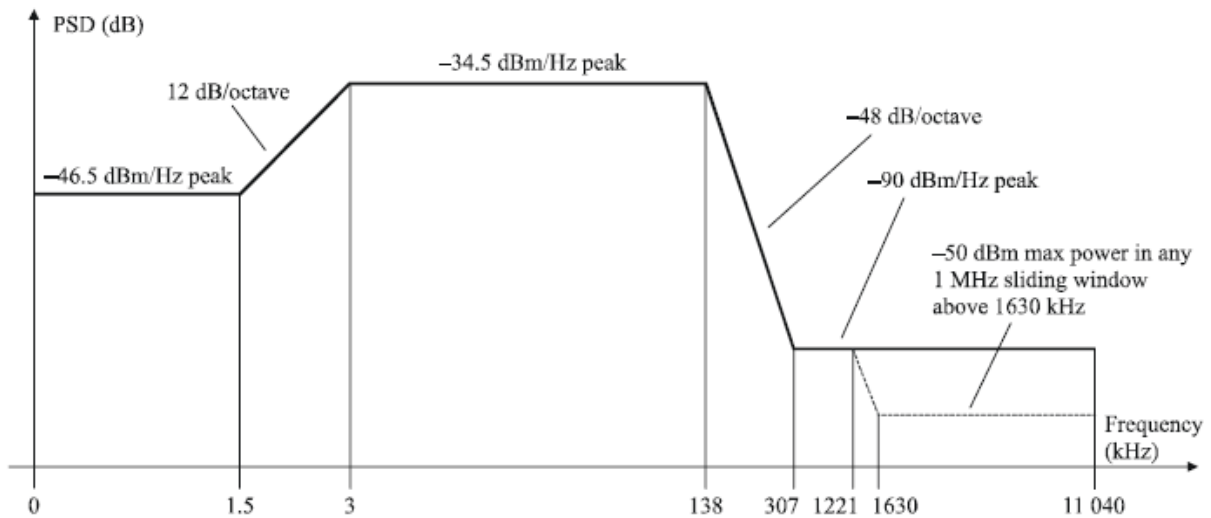
6.2 ATU-R test list

No.	Test items	Criteria	Test data	Result
1	Transmitter Pass Band PSD Response Testing	<ul style="list-style-type: none"> ● G.992.1 ATU-R transmitter PSD mask and G.992.3 Over POTS Mode ATU-R transmitter PSD mask, as shown in Table 4; (for ADSL/ADSL2) ● G.992.3 All Digital Mode ATU-R transmitter PSD mask, as shown in Table 5; (for ADSL2) ● G.992.5 ATU-R Over POTS Mode transmitter PSD mask, as shown in Table 6; (for ADSL2+) ● G.992.5 All Digital Mode ATU-R transmitter PSD mask, as shown in Table 7; (for ADSL2+) ● G.992.3, G.992.5 ATU-R Over POTS Mode with Extended Upstream Bandwidth transmitter PSD mask, as shown in Table 8; (for ADSL2/ADSL2+) 		
2	Total Signal Power Limitation	<ul style="list-style-type: none"> ● G.992.1 Total Signal Power shall be < 13dBm (for ADSL) ● G.992.3 over POTS mode Total Signal Power shall be < 13dBm; All Digital Mode Total Signal Power shall be < 13.8dBm (for ADSL2). ● G.992.5 over POTS mode Total Signal Power shall be < 13dBm; All Digital Mode Total Signal Power shall be < 13.8dBm (for ADSL2+). 		
3	ADSL Band Longitudinal Balance	> 40dB		
4	Input Impedance	For the U-R interface, the impedance shall be between 1.1 kΩ and 2.0 kΩ, and capacitance between 20 and 34 nF.		
5	Surge Testing	The U-R interface and AC power cable shall be subject to the test with Type A and Type B surges: (1) After testing with Type A surge: the equipment shall not be short-circuited and the DC insulation resistance shall be greater than 5MΩ. (2) After testing with Type B surge: the equipment tested shall function properly.		
6	Electric safety	Compliance with CNS 14336-1		
7	Electromagnetic compatibility	Compliance with CNS 13438		



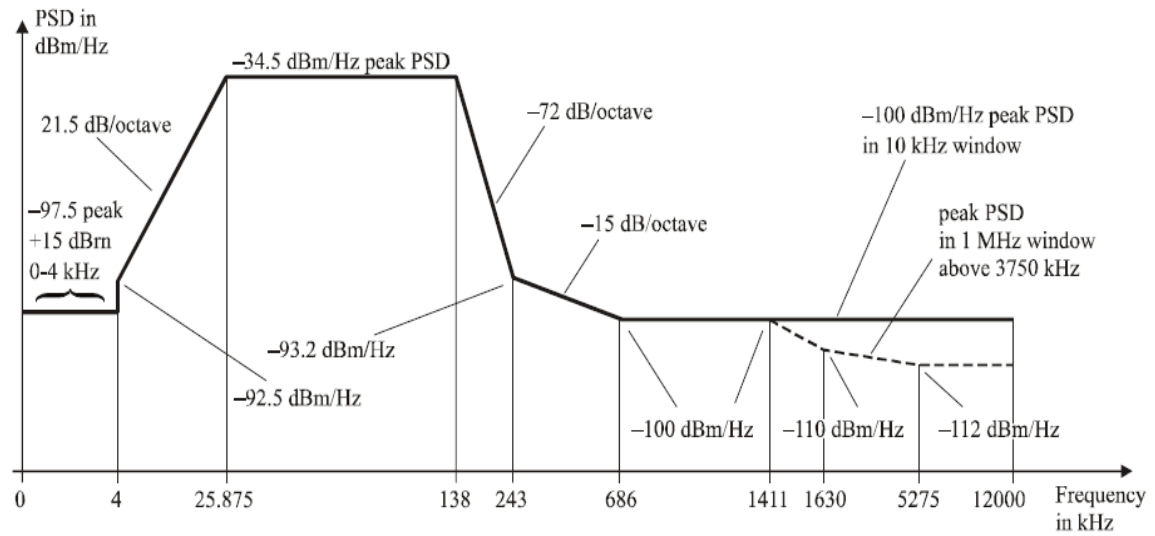
Frequency band, f (kHz)	Limitation curve function (dBm/Hz)
0<f<4	-97.5, maximum power +15dBm in the 0-4kHz band
4<f<25.875	-92.5 + 21.5 x log ₂ (f/4)
25.875<f<138	-34.5
138<f<307	-34.5 - 48 x log ₂ (f/138)
307<f<1221	-90
1221<f<1630	-90 peak, maximum power [-90 - 48 x log ₂ (f/1221)+60] dBm in the [f, f+1MHz] band window
1630<f<11040	-90 peak, maximum power -50 dBm in the [f, f+1MHz] band window

Table 4 G.992.1/ G.992.3 Over POTS Mode ATU-R transmitter PSD Mask



Frequency band, f(kHz)	Limitation curve function (dBm/Hz)
$0 < f \leq 1.5$	-46.5
$1.5 < f \leq 3$	$-34.5 + 12 \times \log_2(f/3)$
$3 < f \leq 138$	-34.5
$138 < f \leq 307$	$-34.5 - 48 \times \log_2(f/138)$
$307 < f \leq 1221$	-90
$1221 < f \leq 1630$	-90 peak, maximum power $[-90 - 48 \times \log_2(f/1221) + 60]$ dBm in the $[f, f+1\text{MHz}]$ band window.
$1630 < f \leq 11040$	peak -90, maximum power -50 dBm at the $[f, f+1\text{MHz}]$ band window

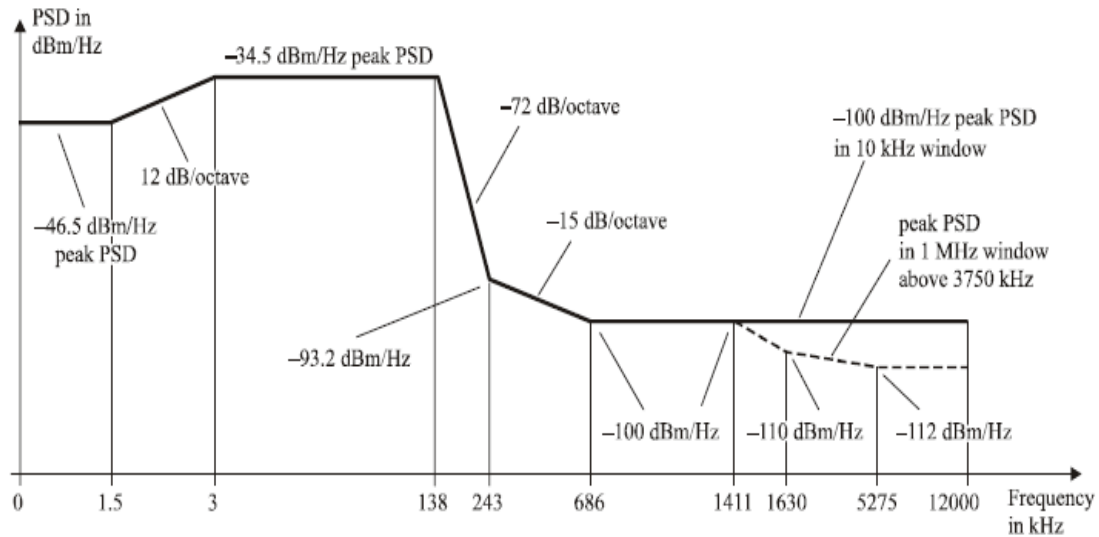
Table 5 G.992.3 All Digital Mode ATU-R transmitter PSD mask



Frequency (kHz)	PSD level (dBm/Hz)	MBW
0	-97.5	100 Hz
4	-97.5	100 Hz
4	-92.5	100 Hz
10	interpolated	10 kHz
25.875	-34.5	10 kHz
138	-34.5	10 kHz
243	-93.2	10 kHz
686	-100	10 kHz
5275	-100	10 kHz
12000	-100	10 kHz

Frequency (kHz)	PSD level (dBm/Hz)	MBW
686 $f \le 1411$	-100	1 MHz
1411 $f \le 1630$	-100 peak, maximum power [-100 - 48 x log ₂ (f/1411)+60] dBm in the [f,f+1MHz] band window	1 MHz
1630 $f \le 5275$	-100 peak, maximum power [-110 - 1.18 x log ₂ (f/1630)+60] dBm in the [f,f+1MHz] band window	1 MHz
5275 $f \le 12000$	-100 peak, maximum power -52dBm in the [f,f+1MHz] band window	1 MHz

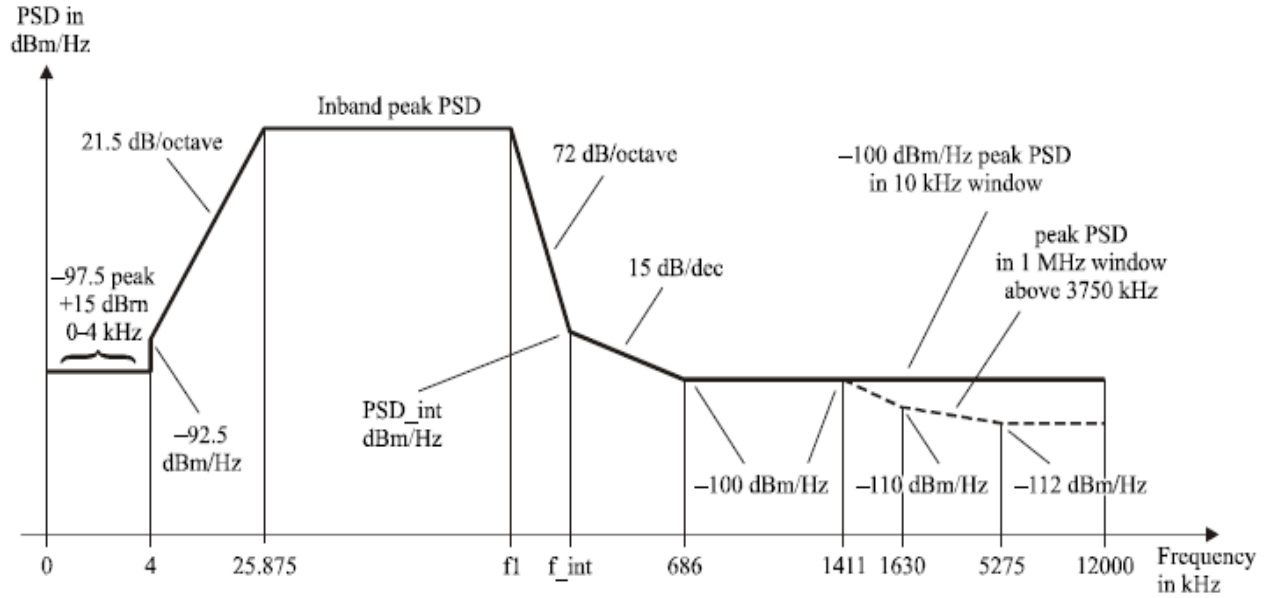
Table 6 G.992.5 Over POTS Mode ATU-R transmitter PSD mask



Frequency (kHz)	PSD level (dBm/Hz)	MBW
0	-46.5	100 Hz
1.5	-46.5	100 Hz
3	-34.5	100 Hz
10	-34.5	10 kHz
138	-34.5	10 kHz
243	-93.2	10 kHz
686	-100	10 kHz
5275	-100	10 kHz
12000	-100	10 kHz

Frequency (kHz)	PSD level (dBm/Hz)	MBW
686 < f ≤ 1411	-100	1 MHz
1411 < f ≤ 1630	-100 peak, maximum power [-100 - 48 x log ₂ (f/1411)+60] dBm in the [f,f+1MHz] band window	1 MHz
1630 < f ≤ 5275	-100 peak, maximum power [-110 - 1.18 x log ₂ (f/1630)+60] dBm in the [f,f+1MHz] band window	1 MHz
5275 < f ≤ 12000	-100 peak, maximum power -52dBm in the [f,f+1MHz] band window	1 MHz

Table 7 G.992.5 All Digital Mode ATU-R transmitter PSD mask



Frequency (kHz)	PSD level (dBm/Hz)	MBW
0	-97.5	100 Hz
4	-97.5	100 Hz
4	-92.5	100 Hz
10	interpolated	10 kHz
25.875	Inband_peak_PSD	10 kHz
f_l	Inband_peak_PSD	10 kHz
f_{int}	PSD_int	10 kHz
686	-100	10 kHz
5275	-100	10 kHz
12000	-100	10 kHz

Additionally, the PSD mask shall be satisfying the following requirements:

Frequency (kHz)	PSD level (dBm/Hz)	MBW
$686 < f \leq 1411$	-100	1 MHz
$1411 < f \leq 1630$	-100 peak, maximum power $[-100 - 48 \times \log_2(f/1411) + 60]$ dBm in the $[f, f+1\text{MHz}]$ band window	1 MHz
$1630 < f \leq 5275$	-100 peak, maximum power $[-110 - 1.18 \times \log_2(f/1630) + 60]$ dBm in the $[f, f+1\text{MHz}]$ band window	1 MHz
$5275 < f \leq 12000$	-100 peak, maximum power -52dBm in the $[f, f+1\text{MHz}]$ band window	1 MHz



Table M.3/G.992.5 – Inband_peak PSD, PSD_int and the frequencies f_1 and f_{int}

Upstream mask-number	Designator	Template nominal PSD (dBm/Hz)	Template maximum aggregate transmit power (dBm)	Inband peak PSD (dBm/Hz)	Frequency f_1 (kHz)	Intercept frequency f_{int} (kHz)	Intercept PSD level PSD_{int} (dBm/Hz)
1	EU-32	-38.0	12.5	-34.5	138.00	242.92	-93.2
2	EU-36	-38.5	12.62	-35.0	155.25	274.00	-94.0
3	EU-40	-39.0	12.66	-35.5	172.50	305.16	-94.7
4	EU-44	-39.4	12.75	-35.9	189.75	336.40	-95.4
5	EU-48	-39.8	12.78	-36.3	207.00	367.69	-95.9
6	EU-52	-40.1	12.87	-36.6	224.25	399.04	-96.5
7	EU-56	-40.4	12.94	-36.9	241.50	430.45	-97.0
8	EU-60	-40.7	12.97	-37.2	258.75	461.90	-97.4
9	EU-64	-41.0	12.98	-37.5	276.00	493.41	-97.9

Table 8 G.992.3 G.992.5 over POTS with extended upstream bandwidth ATU-R transmitter PSD mask

6.3 For ATU-R with POTS splitter, the test items in §6.1 and §6.2 apply.

7. POTS splitter communication interface tests

7.1 DC Loop Resistance

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

7.1.2 Wiring:

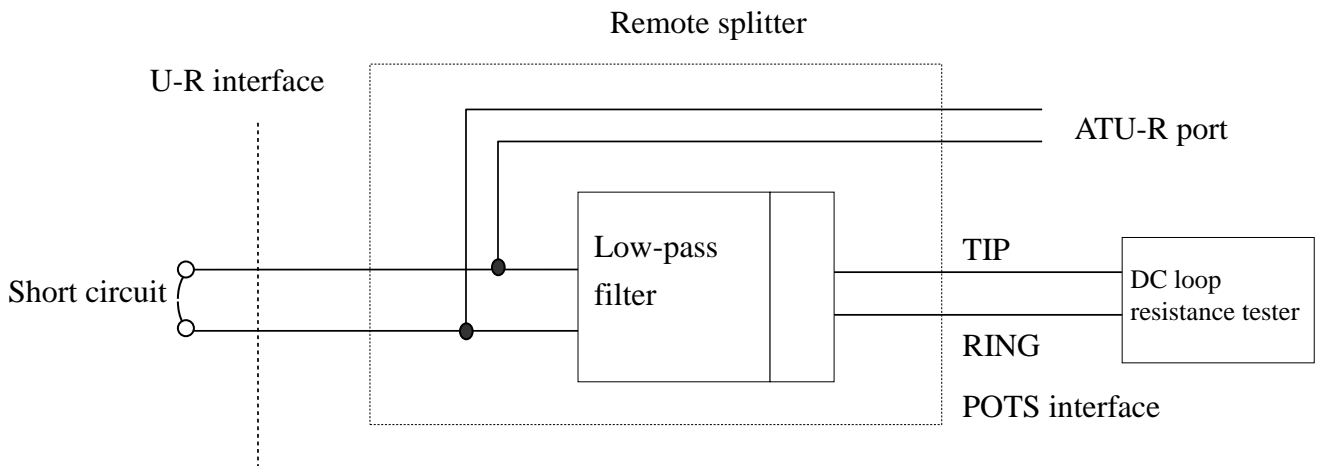


Figure 1 DC resistance test from tip to ring on POTS interface

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 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 Insulation Resistance

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

7.2.2 Wiring:

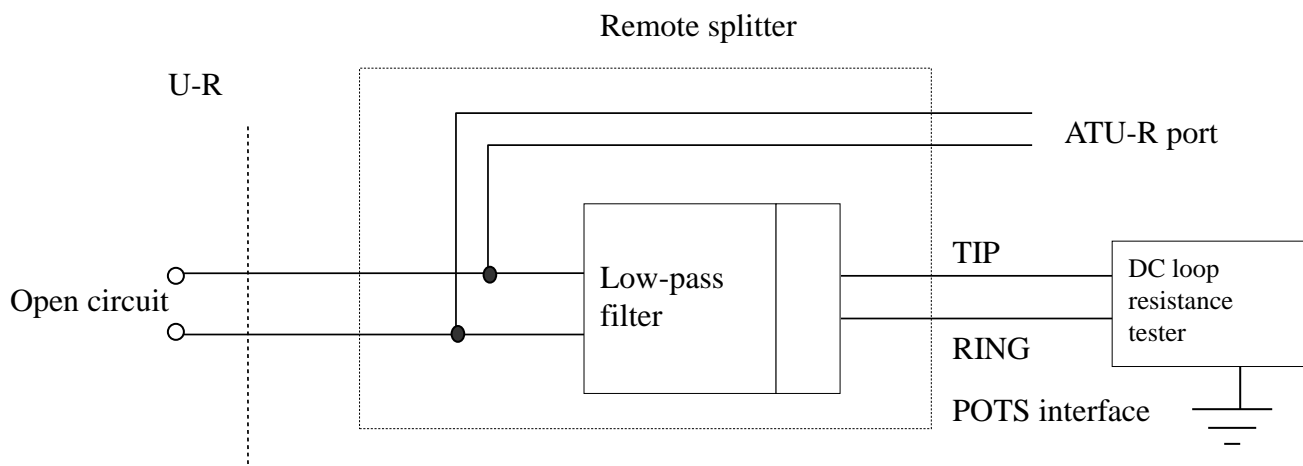


Figure 2 DC insulation test between tip or ring and ground, or between tip and ring on POTS interface

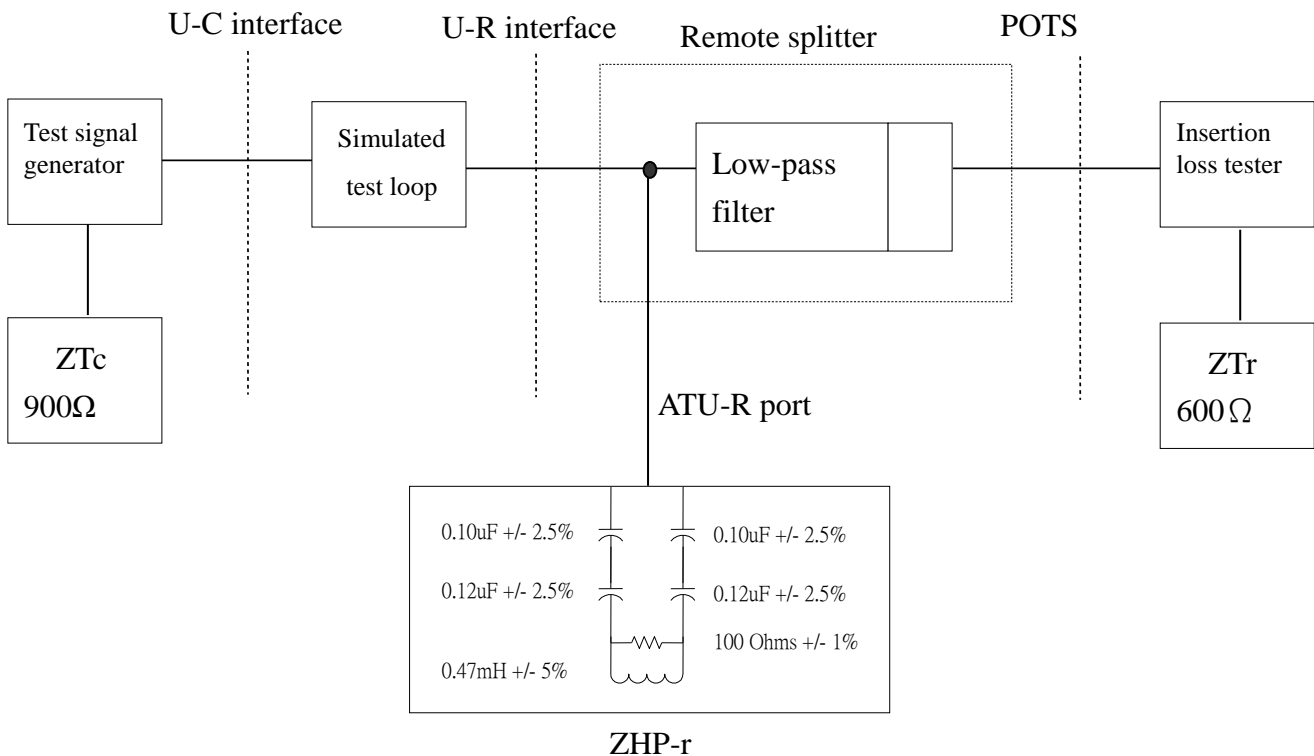
7.2.3 Test steps:

- (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 ADSL splitter at the remote terminal is connected to a simulated test loop or actual cable.
The simulated test loop is defined as 0, 0.5kft, 2.0kft and 5.0 kft pairs of 26 AWG Cable.

7.3.2 Wiring:



Note: ZHP-r: high-pass impedance at remote terminal; see the figure for parts specifications.

Figure 4 Wiring for the voiceband insertion loss test

7.3.3 Test steps:

- (1) Connect the insertion loss tester and simulated test loop, as shown in Figure 4.
- (2) Select the 26AWG 0ft Cable 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, as shown in Figure 4. Measure the insertion loss under the 1004Hz test signal. Keep a record of the result.
- (4) Select the short-loop 26AWG 5kft 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 in the ADSL Band

7.4.1 Purpose: ensure that the attenuation in the ADSL band of ADSL splitter at the remote terminal complies with the criteria specified in §6.1 POTS Splitter test list.

7.4.2 Wiring:

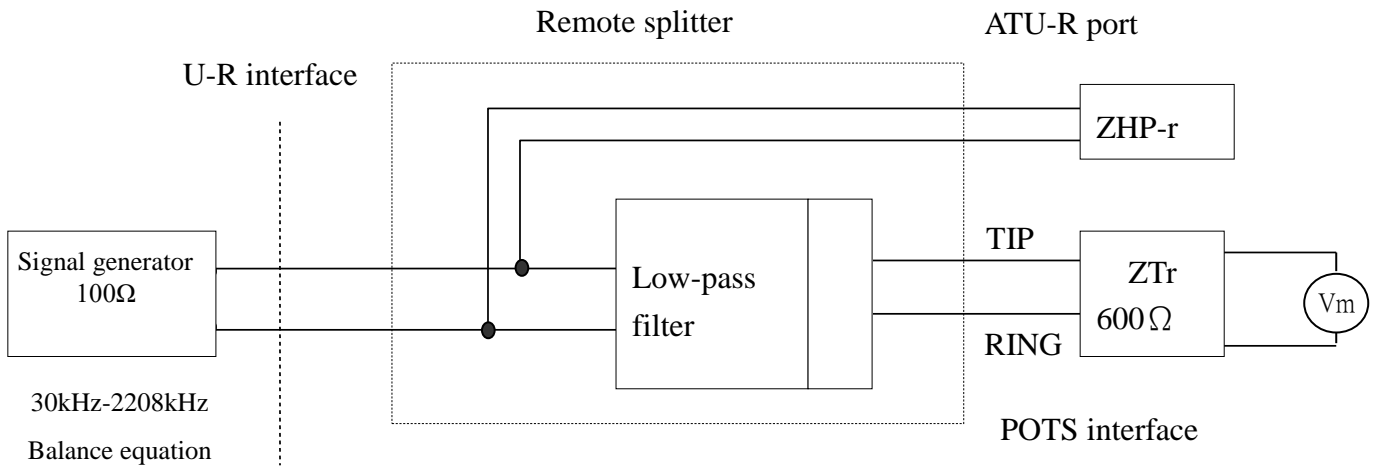


Figure 5 Wiring for the ADSL band attenuation test

7.4.3 Test steps:

- (1) Connect the ADSL band signal generator, Vm frequency selective level tester, high-pass impedance (ZHP-r) circuit and remote splitter, as shown in Figure 5.
- (2) Measure the ADSL band attenuation. 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 when the ADSL splitter at remote terminal is connected to the simulated test loop.

7.5.2 Wiring:

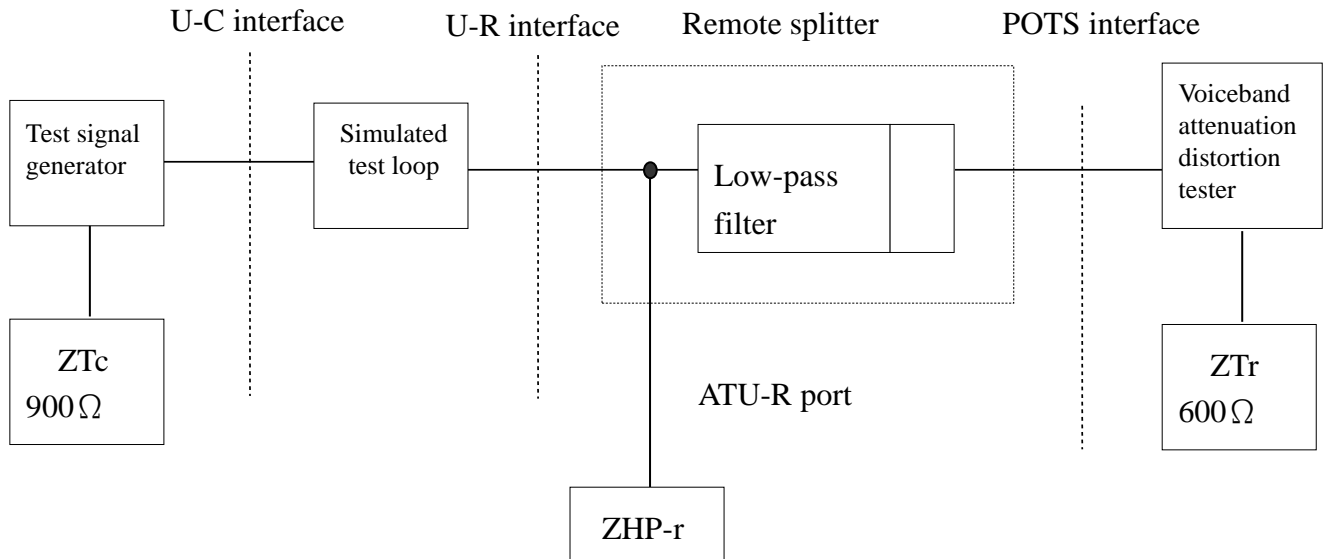


Figure 6 Wiring for voiceband attenuation distortion test

7.5.3 Test steps:

- (1) Connect the voiceband attenuation distortion tester, test signal generator and simulated test loop, as shown in Figure 6.
- (2) Select 26AWG 0ft cable 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 sort-loop 26AWG 0.5kft, 2.0kft and 5kft test loops. 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 ADSL splitter at the remote terminal is connected to simulated test loop.

7.6.2 Wiring:

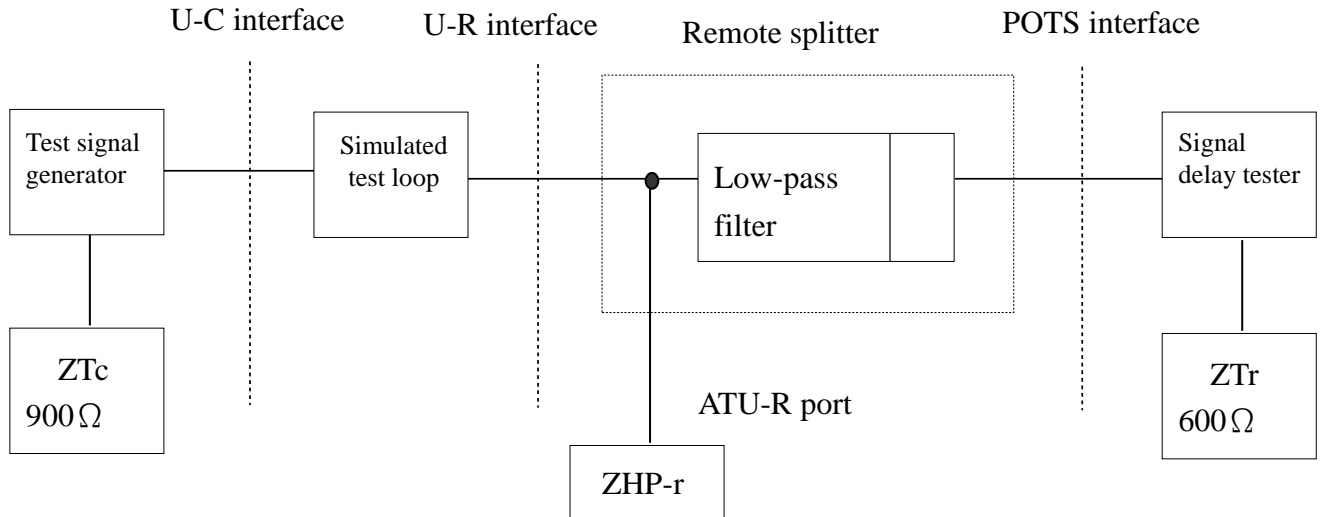


Figure 7 Wiring for voiceband delay distortion test

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. 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. 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 cable simulated test loops. 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 ADSL splitter at the remote terminal is connected to simulated test loop.

7.7.2 Wiring:

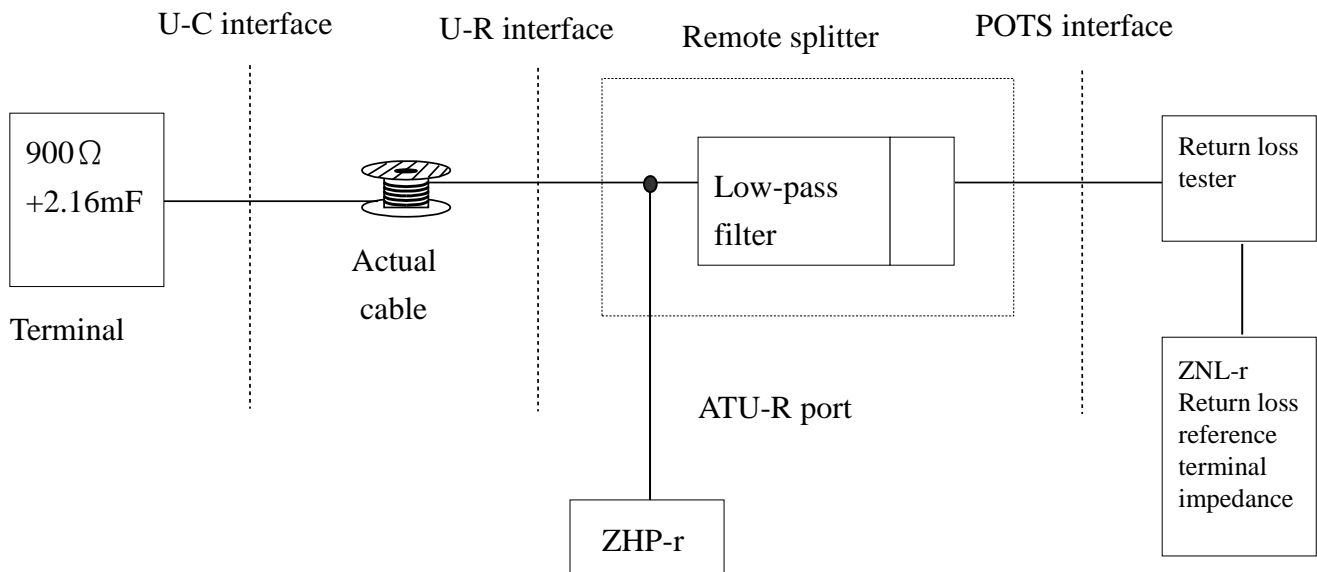


Figure 8 Wiring for return loss test

- 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 ATU-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 ADSL 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:

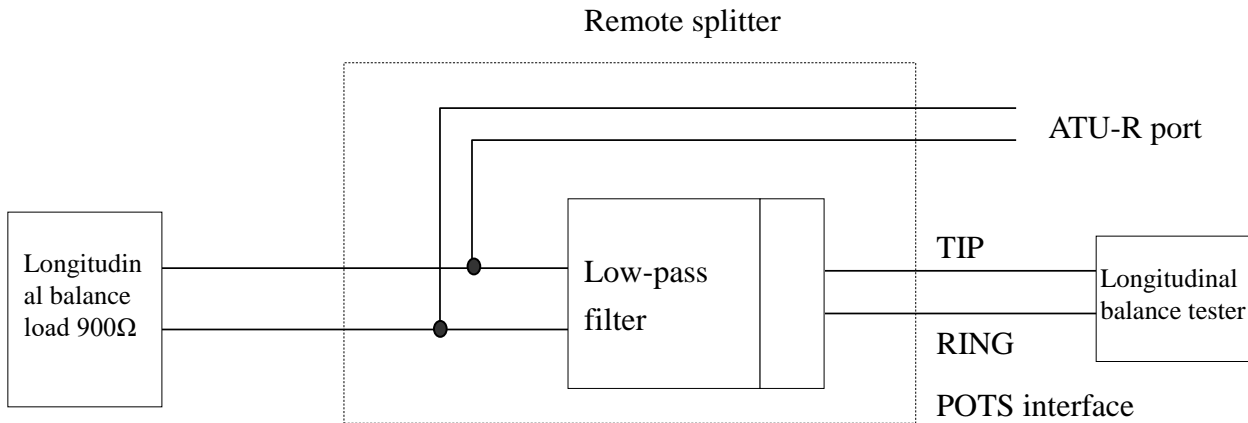


Figure 9 Wiring for longitudinal balance test

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 ADSL 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:

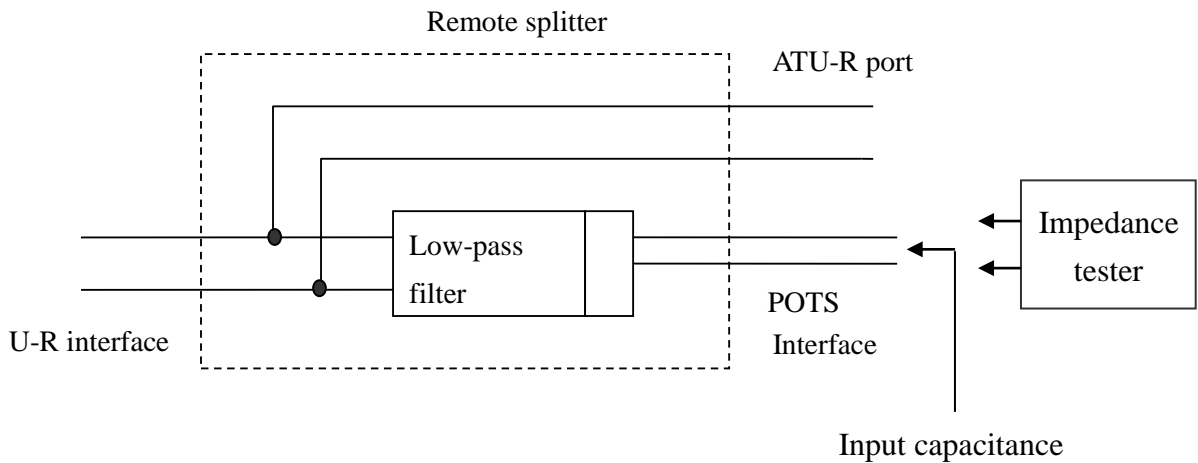


Figure 10 Wiring for transparent capacitor test on subscriber loop

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 the U-R interface of remote splitter is provided with surge protection.

7.10.2 Wiring:

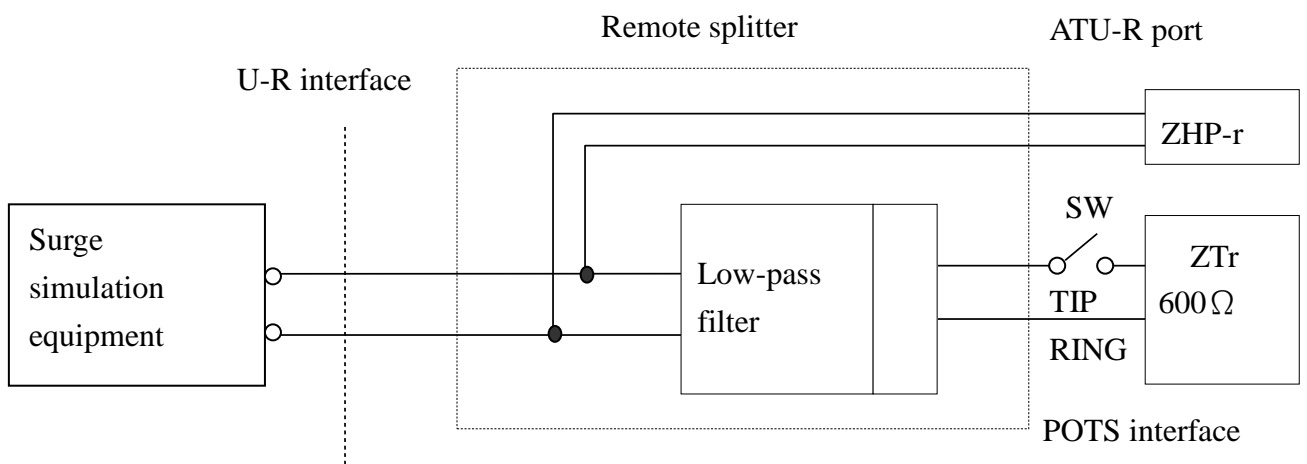


Figure 11 Wiring for surge test



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) $\leq 10\mu\text{s}$, impact time (T_d) $\geq 560\mu\text{s}$ and peak voltage at 800V or more;

Short-circuit current: front time (T_f) $\leq 10\mu\text{s}$, impact time (T_d) $\geq 560\mu\text{s}$ and peak current energy at 100A or more.

Type B:

Open-circuit voltage: front time (T_f) $\leq 9\mu\text{s}$, impact time (T_d) $\geq 720\mu\text{s}$ and peak voltage at 1000V or more;

Short-circuit current: front time (T_f) $\leq 5\mu\text{s}$, impact time (T_d) $\geq 320\mu\text{s}$ and peak current energy at 25A or more.

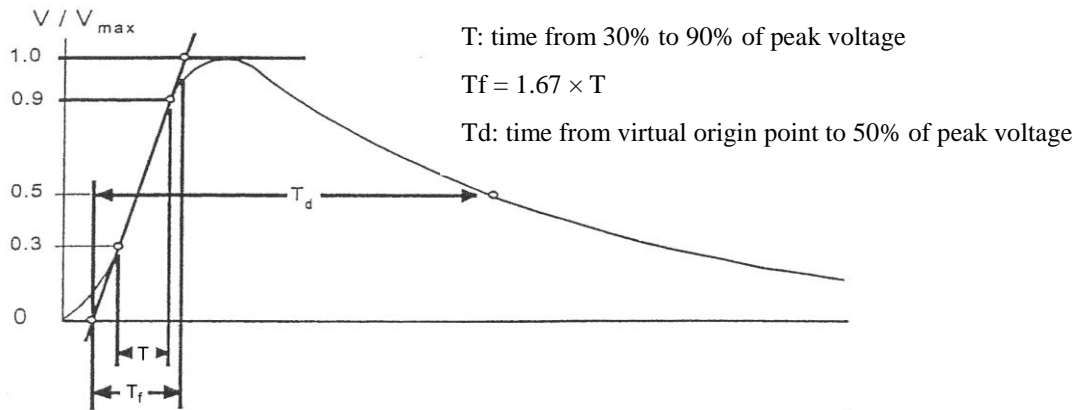
- (3) SW OFF, the surge waveforms above are applied to both ends of remote splitter U-R interface; the surges are applied once in forward direction and once in reverse direction.
- (4) SW ON, the surge waveforms above are applied to both ends of remote splitter U-R interface; the surges are applied once in forward direction and once in reverse direction.
- (5) Check that the remote splitter complies with the criteria for the surge test.



Note: The surge voltage waveform is shown as follows:

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

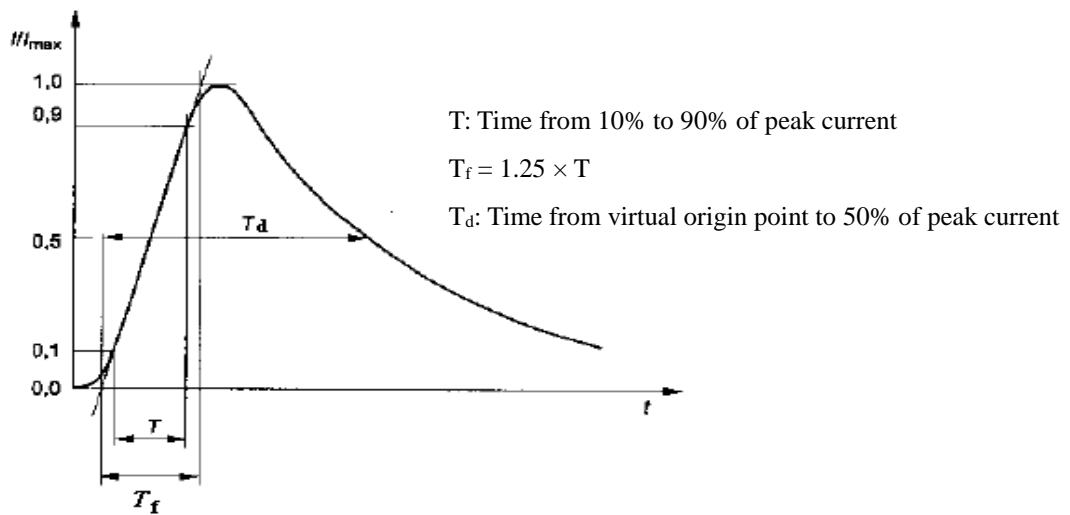
Impact time (T_d): time from virtual origin point to 50% of peak voltage.



Note: the surge current waveform is shown as follows:

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

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



8. ATU-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 ATU-R band complies with the criteria in §6.2 ATU-R test list when ATU-R is connected to ATU-C.

8.1.2 Wiring:

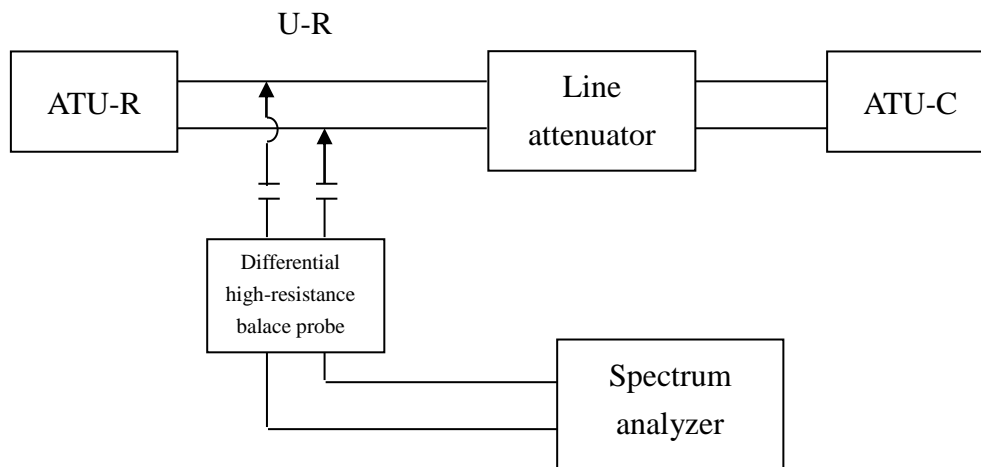


Figure 12 Setup for ATU-R transmitter pass band PSD response test

Note--PSD : Transmitter Power Spectrum Density (dBm/Hz)

Pass Band : 25.875kHz~138kHz or 3kHz~138kHz Band

Low Frequency Stop Band : 0~25.875kHz or 0~3kHz Band

High Frequency Stop Band : 138k~11.04MHz Band (for ADSL/ADSL2)

138k~12MHz Band (for ADSL2+)

8.1.3 Test steps:

- (1) Connect the test loop as shown in Figure 12.
- (2) Connect the power so that the ATU-R to be tested is at the maximum transmission stability.
- (3) Measure the ATU-R transmitter PSD (in the pass band range) using differential high-resistance balance probe and spectrum analyzer. Keep a record and save the result in a file.
- (4) Measure the low frequency stop band using differential high-resistance balance probe and spectrum analyzer.
- (5) Increase the attenuation to disconnect ATU-R from ATU-C and then decrease the

attenuation so that it enters the handshake state that attempts to make connection; once in a steady state of connection, measure the transmitter PSD of ATU-R's high frequency stop band. Print out or save the results.

8.2 Total Signal Power Limitation

8.2.1 Purpose: ensure that the total signal power limitation of ATU-R complies with the criteria in §6.2 ATU-R test list when ATU-R is connected to ATU-C.

8.2.2 Wiring:

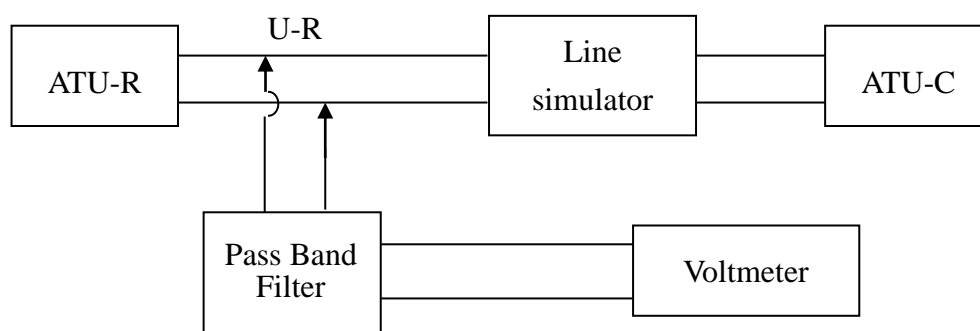


Figure 13 ATU-R total signal power limitation test setup

8.2.3 Test steps:

- (1) Connect the test loop as shown in Figure 13.
- (2) Connect the power so that the ATU-R to be tested is at the maximum transmission stability.
- (3) Attenuate the central office down-stream signal using the line simulator.
- (4) Measure the V_{rms} of transmission signal using a voltmeter. Keep a record of the result.
- (5) Determine the total signal power = $20 \log (V_{rms}/316mV)$. Keep a record of the result.

8.3 ADSL Band Longitudinal Balance

8.3.1 Purpose: ensure that the ADSL band longitudinal balance of ATU-R complies with the criteria in §6.2 ATU-R test list.



8.3.2 Wiring:

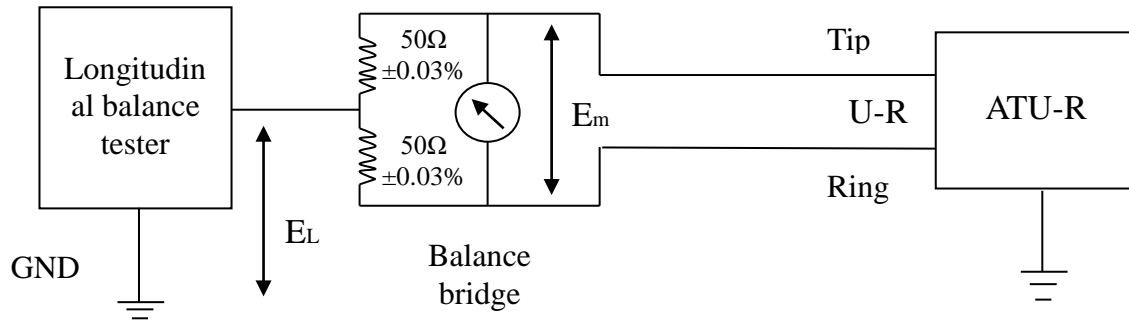


Figure 14 ADSL band longitudinal balance test setup

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 = $20\log |EL/Em|$ dB. Keep a record and save the measurements.

8.4 Input Impedance

8.4.1 Purpose: ensure that the input impedance of ATU-R complies with the criteria in §6.2 ATU-R test list.

8.4.2 Wiring:

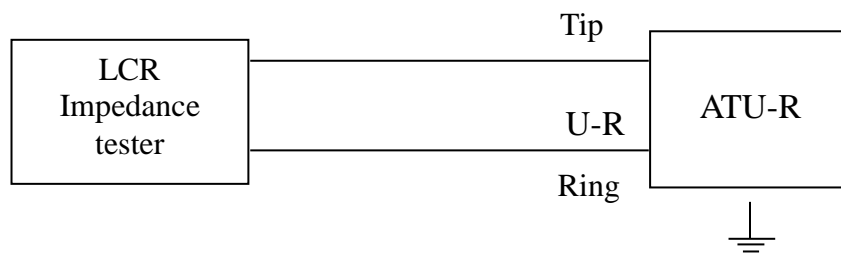


Figure 15 ATU-R input impedance test setup

8.4.3 Test steps:

- (1) Connect the test loop as shown in Figure 15.
- (2) Set the voltage and frequency of LCR impedance tester measurement signal (3V, 4 kHz).
- (3) Select the impedance items to be measured and perform the test.
- (4) Switch to the capacitance items to be measured and perform the test.
- (5) Keep a record and save the measurement results.

8.5 Surge Test

8.5.1 Purpose: ensure that ATU-R is provided with surge protection.

8.5.2 Surge test wiring:

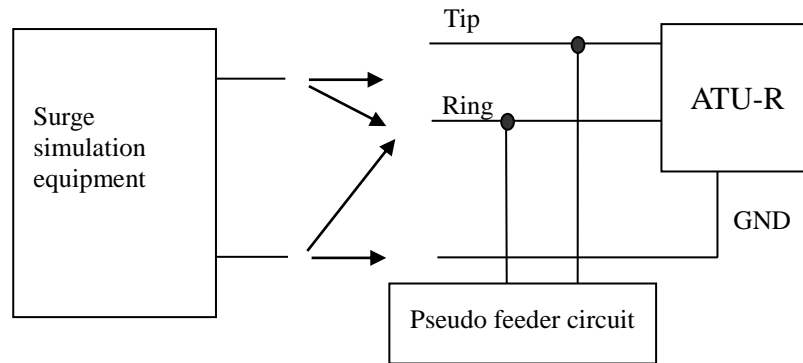


Figure 16 Telephone line surge test setup

Test equipment:

Surge simulation equipment, central office DSLAM simulation equipment

a. Test steps for lateral surge between telephone lines:

- (1) Set up the ATU-R at the remote terminal as shown in Figure 16.
- (2) Surge waveforms:

Type A:

Open-circuit voltage: front time (T_f) $\leq 10\mu\text{s}$, impact time (T_d) $\geq 560\mu\text{s}$ and peak voltage at 800V or more;

Short-circuit current: front time (T_f) $\leq 10\mu\text{s}$, impact time (T_d) $\geq 560\mu\text{s}$ and peak current energy at 100A or more.

Type B:

Open-circuit voltage: front time (T_f) $\leq 9\mu\text{s}$, impact time (T_d) $\geq 720\mu\text{s}$ and peak voltage at 1000V or more;

Short-circuit current: front time (T_f) $\leq 5\mu\text{s}$, impact time (T_d) $\geq 320\mu\text{s}$ and peak current energy at 25A or more.

- (3) Apply the surge waveforms specified above at tip and ring of the ATU-R interface; the surges are applied once in forward direction and once in reverse direction.
- (4) Check that the ATU-R complies with the criteria of surge test.



b. Longitudinal surge test steps:

(1) Set up the ATU-R at the remote terminal as shown in Figure 16.

(2) Surge waveforms:

Type A:

Open-circuit voltage: front time (T_f) $\leq 10\mu s$, impact time (T_d) $\geq 160\mu s$ and peak voltage at 1500V or more;

Short-circuit current: front time (T_f) $\leq 10\mu s$, impact time (T_d) $\geq 160\mu s$ and peak current energy at 200A or more.

Type B:

Open-circuit voltage: front time (T_f) $\leq 9\mu s$, impact time (T_d) $\geq 720\mu s$ and peak voltage at 1500V or more;

Short-circuit current: front time (T_f) $\leq 5\mu s$, impact time (T_d) $\geq 320\mu s$ and peak current energy at 37.5A or more.

(3) Apply the surge waveforms specified above between tip / ring of the ATU-R interface and metal ground or casing of ATU-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 ATU-R at the remote terminal as shown in Figure 17.

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

(3) While the ATU-R is fed by AC power supply, apply the waveform specified above at both ends of ATU-R power cable; the surge is applied three times in forward direction and three times in reverse direction with an interval of 60 seconds between applications.

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

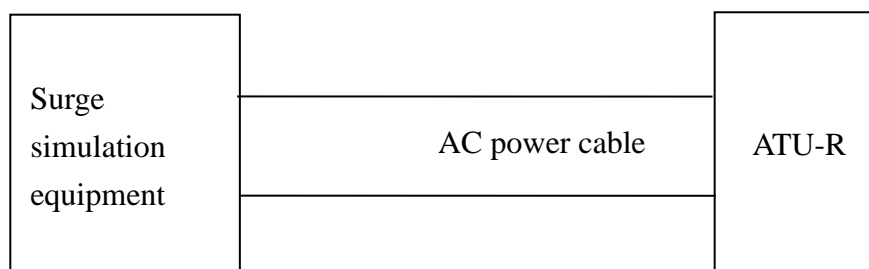


Figure 17 AC power cable surge test setup



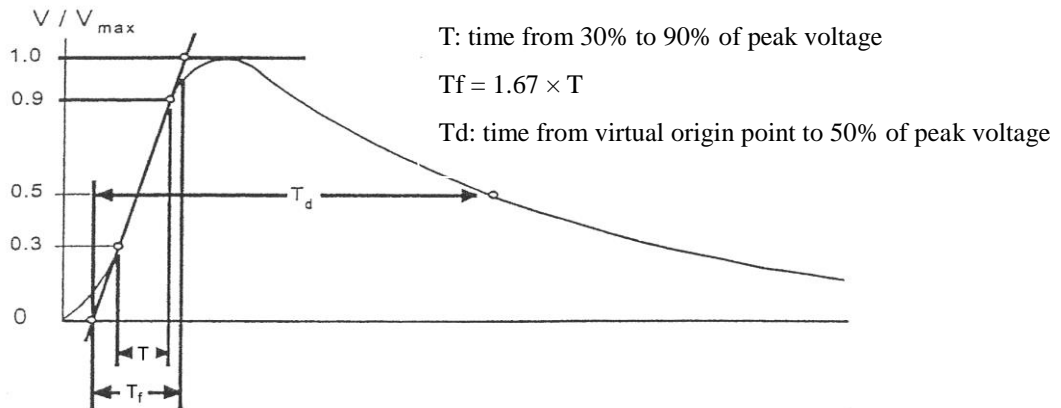
Test equipment:

Surge simulation equipment, central office DSLAM simulation equipment

Note: The surge voltage waveform is shown as follows:

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

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



Note: the surge current waveform is shown as follows:

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

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

