

**ASYMMETRIC DIGITAL SUBSCRIBER
LINE (ADSL) MODEM (REMOTE TERMINAL)**

**GENERIC REQUIREMENTS
NO. GR/ANE-05/01.SEPT.99**

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No. TBTUF/ADSL-RT/44-TEC.2000

Dated 4.7.2000

Subject: Amendment in the GR No. G/ANE-05/01.SEP 99 for ADSL Modem (Remote Terminal).

The following amendment for addition of new clauses in the GR No. G/ANE-05/01.SEP 99 for ADSL Modem (Remote Terminal) is issued with immediate effect.

Amendment No.1

Clause 2.6

The ADSL Modem at the remote end shall support the routing functionality along with the ATM protocols. The router shall be an integrated part of the Modem supporting the following routing protocols:

- Multi-user sharing via Ethernet LAN,
- TCPIIP with RIP Ver 2 and static routing support.
- DHCP Relay Agent (RFC 1542)
- DHCP Server (RFC 2131, 2132)
- DNS Relay
- DHCP Client (RFC-2132)
- Network Address Translation (NAT) and NAT server support
- Network Numbering (RFC 1631)

Clause 2.7

The ADSL Modem at the remote end shall support the Bandwidth Optimization features as follows.

- Data Compression upto 4: 1 (STAC LZS) RFC 1972
- Van Jacobson Header compression (RFC 1144).

= End of amendment =

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**TELECOMMUNICATION ENGINEERING CENTRE
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**GENERIC REQUIREMENTS FOR
ASYMMETRIC DIGITAL SUBSCRIBER LINE (ADSL) MODEM
(REMOTE TERMINAL)**

1.0 Introduction

- 1.1 This document gives the generic requirements of Asymmetric Digital Subscriber Line (ADSL) Modem. The equipment shall use the existing copper pair to function on the high speed data as per standard laid down in the ITU- T Rec. G.992.1. The ADSL Modem technology shall be capable of providing various services to the customers in association with ADSL system for central office. The ADSL block diagram is as shown in Figure 1.
- 1.2 The ADSL Modem (ATU-R) shall function as the Remote Terminal (RT) and shall be installed at the customer premise. The ATU-R (ADSL Transceiver Unit at remote end) shall interface the customer's premise equipment (CPE) on one side and the subscribers loop on the other side. A POTS Splitter shall be deployed to provide PSTN or ISDN services.
- 1.3 The distance between the ATU-R (RT) and COT shall be upto 3.5 Kms without any regeneration on 0.5 mm copper pair
- 1.4 The ADSL Modem shall function on a downstream rate from 1.5 Mb/s to over 6.1 Mb/s and an upstream rate shall range from 16 Kb/s to 640 Kb/s.
- 1.5 The ADSL Modem shall be configurable and managed from the Central Office Terminal of an ADSL link network as defined in the GR for ADSL Central Office Terminal No. G/ANE-04/01.SEPT 99.
- 1.6 The ADSL Modem has various applications. It shall function in conjunction with an ADSL COT equipment and shall be able to provide different services of the service providers to the customers along with a PSTN or ISDN service. The equipment shall support services like Switched Digital Video Broadcast, Interactive Video, Home Office, Teleshopping, Telemedicine, Internet access and various other applications.
- 1.6.1 The ATU-R equipment at the RT shall function in the switching mode in respect to the mode of working of the ADSL COT equipment as defined in the TEC GR of ADSL system for central office terminal (COT).

ADSL System Reference Model

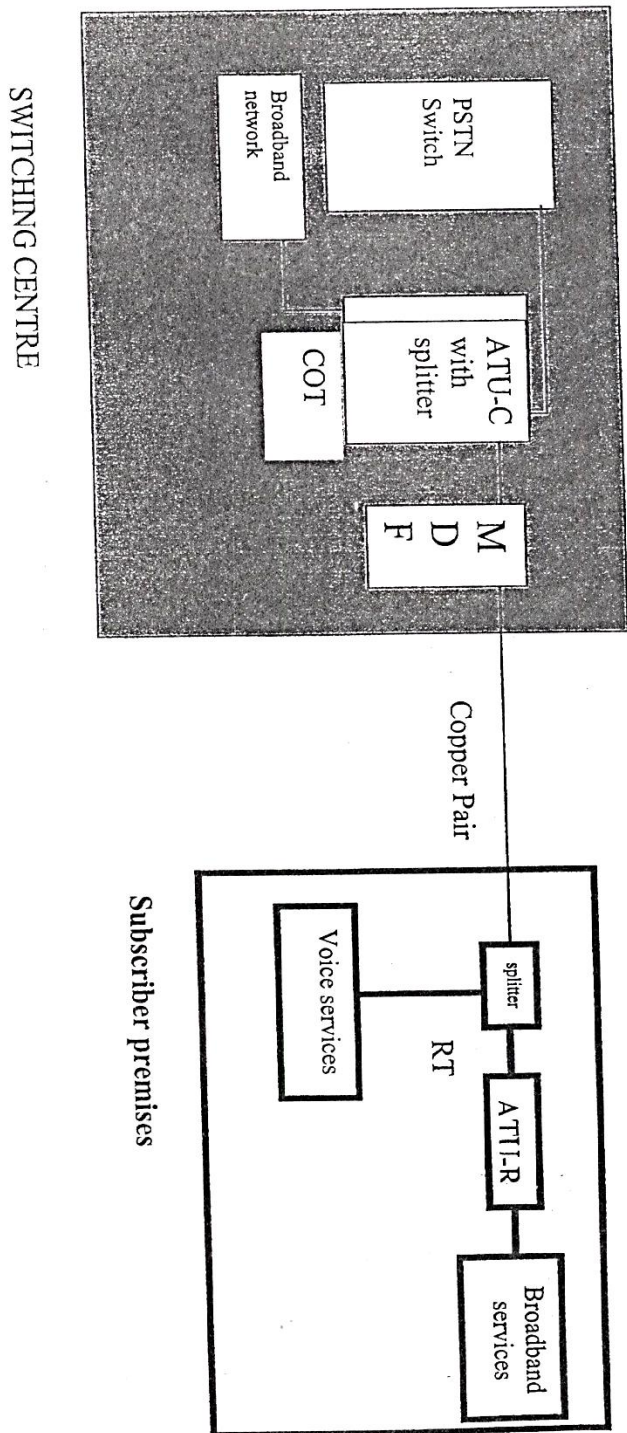


FIGURE 1

2.0 Functional Requirements

2.1 ATU-R transmitter for STM transport:

The ATU-R transmitter of an ADSL system transporting STM data shall support the simplex bearer channel AS0 downstream and the duplex bearer channel LS0 downstream as well as upstream. Provisioning for support of AS1, AS2, AS3, LS1 and LS2 shall be made. Bearer channel AS0 shall support the transport of data at all integer multiples of 32 Kb/s from 32 Kb/s to 6144 Kb/s. Bearer channel LS0 shall support 16 Kb/s and all integer multiples of 32 Kb/s from 32 Kb/s to 640 Kb/s. When AS1, AS2, AS3, LS1 and LS2 are provided, they shall support the range of integer multiples of 32 Kb/s as shown in the table below.

Table 6.1 of ITU-T Rec. G.992.1
Required 32 Kb/s multiples for transport of STM

Bearer Channel	Lowest Required Integer Multiple	Largest Required Integer Multiple	Corresponding Highest Required Data Rate Kb/s
AS0	1	192	6144
AS1	1	144	4608
AS2	1	96	3072
AS3	1	48	1536
LS0	1	20	640
LS1	1	20	640
LS2	1	20	640

2.2 ATU-R transmitter for AIM transport

An ADSL system transporting AIM data shall support bearer channel LS0 upstream and shall also support all integer multiples of 32 Kb/s from 32 Kb/s to 6144 Kb/s downstream and up to 640 Kb/s upstream. ATM data shall be mapped to sub-channel AS0 in the downstream direction and to sub-channel LS0 in the upstream direction.

When AS1 and AS2 are provided, they shall support the range of integer multiples of 32 Kb/s as shown in table 6.1 of ITU-T Rec. G.992.1.

2.3 Transport Capacity

ADSL system shall transport up to seven bearer channels on seven sub-channels simultaneously: -

- Up to four independent downstream simplex bearers.
- Up to three duplex bearers.

The three duplex bearers may alternatively be configured as independent unidirectional simplex bearers, and the rates of the bearers in the two directions can be asymmetric.

All bearer channel data rates shall be programmable in any combination of multiples of 32 Kb/s.

2.4 ADSL system overheads

The total bit rate transmitted by the ADSL system when operating in full overhead framing mode shall include capacity for :

- the data rate transmitted in the ADSL bearer channels;
- ADSL system overheads, which include:
 - a. an ADSL embedded operations channel, eoc,
 - b. an ADSL overhead control channel, aoc,
 - c. CRC check bytes,
 - d. fixed indicator bits for OAM,
 - e. FEC redundancy bytes.
 - f. capacity for synchronisation control byte and capacity for bearer channel synchronisation.

2.5 POTS Splitters:

a) The function of POTS splitter is two folds –

- i) For ADSL signals, it shall provide protection from the high frequency transients and impedance effects that occur during POTS operation - ringing, ring trip and off-hook transients and impedance changes.
- ii) For POTS voice band service, the LPF provides protection from ADSL signals which may impact through non-linear or other effects, remote devices and central office operation. This filtering shall be performed on the end-to-end voice-band connection (i.e., between POTS and PSTN interfaces).

b) The POTS splitter shall be implemented as a passive element and shall guarantee the telephone working even during the power failure.

- c) The POTS splitter shall be transparent for all signals within the voice band supporting DC feed, ringing DTMF, voice, facsimile, 16 KHz metering and also Decadic dialling.
- d) It is also envisaged that the voice frequency path shall remain active when the telephone is on hook for the purpose of Calling Line Identification.
- e) Lightening and surge protection measures specified in ITU-T Rec. K.21 shall be provided.

3.0 Engineering requirements

- 3.1 The equipment shall be fully solid state and adopt state of the art technology.
- 3.2 The equipment shall be compact and composite in construction and light weight. The actual dimensions and weight of the equipment shall be furnished by the manufacturer.
- 3.3 All connectors shall be reliable and of standard type to ensure failure free operation over long periods and under specified environmental conditions.
- 3.4 All connectors and the cable used shall be of low loss type and suitably shielded.
- 3.5 The equipment shall have natural cooling arrangement which shall not involve any forced cooling such as by using fans etc. either inside or outside the equipment.

4.0 Operational Requirements

- 4.1 The equipment shall be designed for continuous operation.
- 4.2 ATU-R equipment shall have functional and operational compatibility with the ADSL Central Office Terminal as defined in the TEC GR for the ADSL COT for all operations including management function.
- 4.3 The equipment shall be able to perform satisfactorily without any degradation at altitude up to 3000 meters above mean sea level. A test certificate from the manufacturer shall be acceptable.
- 4.4 The equipment shall be able to work without any degradation in saline atmosphere near coastal areas and shall be protected against corrosion.
- 4.5 Visual indication to show power ON/OFF status shall be provided.
- 4.6 Visual indications wherever provided shall be green colour for healthy and red colour for unhealthy conditions.

- 4.7 The system hardware as well as software shall not pose any problem due to changes in date and time caused by events such as changeover of millennium/century, leap year etc. in the normal functioning of the system.

5.0 Quality Requirements

- 5.1 The manufacturer shall furnish the MTBF/MTTR values. The calculations shall be based on the guidelines in either DOT QA document No. QM-115 (January 1997) "Reliability Methods and Predictions" or any other international standard.

- 5.2 a) The equipment shall be manufactured in accordance with international quality standards ISO 9002 for which the manufacturer should be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer would be required to be submitted.

b) Alternatively option of compliance for sub clause (a) which may be permitted on a case by case basis till January 1, 2000 :-

The equipment shall be manufactured as per guidelines to the manufacturer issued vide QA Circle Document Nos. QM-205 and QM-206.

- 5.3 The equipment shall conform to the requirements for Environment specified in DOT QA document QM- 333 (Issue-I: September 1990) "Specification for environmental testing of electronic equipments for transmission and switching use". The applicable tests shall be for environmental category B2 including vibration.

6.0 Maintenance requirements

Maintenance philosophy is to replace faulty units/subsystems after quick on-line analysis through monitoring sockets, alarm indications. The actual repair will be undertaken at centralized repair centres. The corrective measures at site shall involve replacement of faulty units/sub-systems.

- 6.1 The equipment shall have easy access for servicing and maintenance.
- 6.2 As and when bugs found/determined in the software the manufacturer shall provide patches/firmware replacement if involved free of cost for three years. Modified documentation wherever applicable shall also be supplied free of cost.
- 6.3 Ratings and types of fuses used shall be indicated by the supplier.
- 6.4 The manufacturer/supplier shall furnish the list of recommended spares for three years maintenance.
- 6.5 The supplier shall have maintenance/repair facility in India.

- 6.6 Supplier shall guarantee the spares so long as the equipment is in service, at least for 10 years from the date of supply. The purchaser would like to stock spares as and when the supplier decides to close down the production of the offered equipment. In such an event, supplier shall give a two years notice to the purchaser so as to stock the spares.

7.0 Power Supply

The Remote Terminal equipment i.e., the ATU-R shall be powered from AC mains supply with nominal voltage of 230 V with a frequency of 50 Hz $\pm$ 2 Hz and shall be able to withstand and work satisfactorily with the voltage variation from 160 V to 260 VAC.

8.0 Accessories

- 8.1 The supplier shall provide one complete set of:
- (a) All the necessary interface, connectors, connecting cables and accessories required for satisfactory and convenient operation of the equipment. Types of connectors, adopters to be used and the accessories of the approved quality shall be clearly indicated in the operating manuals which should be in conformity with the detailed list in the GR.
 - (b) Software and the arrangement to load the software at site.
- 8.2 Special tools, extender boards, extender cables and accessories essential for installation, operation and maintenance of the equipment shall be clearly indicated and supplied along with the equipment.
- 8.3 Special tools, extender boards, extender cables and accessories essential for repair of the equipment shall be clearly indicated and supplied in case the same are ordered.

9.0 Documentation

Technical literature in English with complete layout, detailed block schematic and circuit diagram of various assemblies with test voltages/waveforms at different test points of the units shall be provided. All aspects of installation, operation, maintenance and repair shall be covered in the manuals. The manuals shall include the following: -

- i) Installation, Operation and Maintenance Manual
 - a) Safety measures to be observed in handling the equipment;
 - b) Precautions for installation, operation and maintenance;

- c) Test jigs and fixtures required and procedures for routine maintenance, preventive maintenance, troubleshooting and sub-assembly replacement.
 - d) Illustration of internal and external mechanical parts.
- ii) Repair Manual (to be supplied when ordered)
 - a) List of replaceable parts used including their sources and the approving authority.
 - b) Detailed ordering information for all the replaceable shall be listed in the manual to facilitate reordering of spares as and when required;
 - c) Procedure for troubleshooting and sub-assembly replacement shall be provided. Test fixtures and accessories required for repair shall also be indicated. Systematic trouble shooting charts (fault tree) shall be given for the probable faults with their remedial actions.

10.0 Equipment Safety requirements

- 10.1 Protection against short circuit/open circuit shall be provided.
- 10.2 All switches/controls on front panel shall have suitable safeguards against accidental operations.
- 10.3 The equipment shall be adequately safeguarded to prevent entry of dust, insects and lizards. Applicability of IEC 529 standard is under study and the same is proposed for future implementation.

11.0 Technical Requirements

11.1 Technical Requirements of ADSL Modem (ATU-R)

11.1.1 ATU-R input and output & interfaces for STM transport

The functional data interfaces at the ADSL Modem for STM transport are shown in the figure 8.1 of ITU-T Rec. G.992.1. Output interfaces for the high speed downstream simplex bearer channels are designed AS0 through AS3; input/output interfaces for the duplex bearer channels are designated LS0 through LS2. There may also be a functional interface to transport operations, administration and maintenance (GAM) indicators from the SMs (service modules) to the ATU-R; this interface may physically be combined with the LS0 upstream interface.

11.1.2 ADSL Modem input and output V interfaces for ATM transport :

The ATU-R input and output V interfaces are identical to the ATU-C equipment of the ADSL COT input and output interfaces, as specified in the GR of the ADSL COT equipment.

11.1.3 Framing structure for ATM transport :

An ATU-R configured for either STM or ATM transport shall support the full overhead framing structures 0 which envisages the enabling of the synchronisation control mechanism.

11.1.4 Network timing reference:

On getting an indication from the ADSL COT equipment to transmit the change of phase offset, the ATU-R shall deliver an 8 KHz signal.

11.1.5 Superframe structure:

The superframe structure of the ATU-R is identical to that of ATU-C transmitter of the ADSL COT equipment as specified in clause 14.5. The ATU-R shall support the indicator bits as per table 7.2 of ITU-T Rec. G.992.1. The indicator bits ib20-23 shall not transport NTR in the upstream direction and shall be set to 1.

11.1.6 Frame structure:

Each data frame shall be encoded into a DMT symbol as specified for ADSL COT equipment in the relevant GR and each frame is composed of a fast data buffer and an interleaved data buffer.

11.1.7 Synchronisation:

The input data stream shall be synchronised to the synchronisation control byte and the LEX bytes. Forward error correction coding shall be applied to the synchronisation control bytes. The eqpt. shall comply the synchronisation of fast data buffers and interleaved data buffers as detailed in clause 8.4.2.1 and 8.4.2.2 of ITU-T Rec. G. 992.1 on ADSL.

11.1.8 Modulation -

The frequency spacing, Δf , between sub carries shall be 4.3125 KHz with a tolerance of ± 50 ppm.

11.1.9 Data Sub Carriers:

Maximum allowable data sub - carriers shall be 31 at frequencies $n\Delta f$ ($n=1$ to 31) to be used. The lower limit of n shall be determined by the ADSL POTS splitting filters ; the upper limit is set by the transmit and receive band-limiting filters.

11.1.10 Transmitter Dynamic range:

The transmitter includes all analog transmitter functions: the D/A converter, the antialiasing filter, the hybrid circuitry, and the POTS or ISDN splitter. The transmitted signal shall conform to the frequency requirements as indicated in 8.11.1 of ITU-T Rec.G.992.1 for frequency spacing

11.1.11 Maximum clipping rate:

The maximum output signal of the transmitter shall be such that the signal shall be clipped no more than 0.00001 % of the time.

11.1.12 Noise/Distortion floor:

The maximum value of MTPR of the transmitter shall be 38 dB for any Sub-carrier, where MTPR is the multi-tone power ratio of the rms value of the full-amplitude tone in that sub-carrier to the rms sum of all the non-tone signals in the 4.3125 KHz frequency band.

11.1.13 Transmitter Spectral response:

The ATU-R transmitter spectral mask shall be as per figure A-3 of ITU-T Rec. G.992.1 as given in Annex 1.

11.1.14 Pilot:

The pilot frequency shall be 69 KHz.

11.1.15 Connectors:

The ATU-R line side connector shall be of RJ 11 type.

11.2 Technical requirements for POTS Splitters

The voice terminal shall support the parameters in the sub-clause 11.2.1 to 11.2.8.

11.2.1 Impedance:

The impedance for voice band terminal shall be 600 ohms.

11.2.2 Return Loss:

The return loss of Teleport and Lineport against 600 ohms shall be as follow:

300 Hz - 500 Hz > 14 db

500 Hz - 2000 Hz > 18 db

2000 Hz - 3400 Hz > 14 db

11.2.3 Insertion Loss:

The Teleport to Lineport insertion loss shall be < 0.3 db at 1 KHz for 600 ohms.

11.2.4 Isolation:

Isolation resistance, branch - earth = α ohms;100 VDC,

Isolation resistance, branch - branch = α ohms ; 100 VDC.

11.2.5 Signal Power:

Maximum peak signal power in 200 - 4000 Hz shall be < 3 dbm, Loop current shall be < 63 mA.

11.2.6 Ringing:

Ringing frequency shall be 25 Hz,

Ringing voltage shall be 75 V rms (nominal).

11.2.7 Unbalance about earth:

15Hz- 50Hz > 40 db terminated with 600 ohms,

50 Hz - 600 Hz > 46 db terminated with 600 ohms

600 Hz - 3400 Hz , > 52 db terminated with 600 ohms.

11.2.8 The connectors at the POTS-Splitter towards ATU-R as well as the telephone instrument side shall be RJ 11.

12.0 Performance Requirements

The performance of the equipment shall be as per ITU-T Rec. G.996.1.

The equipment shall be tested for error performance as follows:-

- In laboratory : BER performance over a simulated hop of 3.5 kms shall be tested for no errors for 48 hours .
- In field : BER performance for 48 hours shall be established for conforming to ITU-T

13.0 Interface between the ATU-R and the customer's equipment

The interface requirements of the ATU-R to interface the customer's equipment shall be either of the following and shall be as per the DOT's order :

- (a) ATMF 25,
- (b) Ethernet 10 baseT.
- (c) USB (Universal Serial Bus)

14.0 Eoc Operations and Maintenance

The ADSL equipment shall have dedicated eoc channels for operations and maintenance capabilities for the ATU-R. The working of this channel and the bit allocations are detailed in Clause 9.0 of ITU-T Rec. G.992.1.

15.0 ADSL Overhead Control (aoc) channel

The aoc data shall be carried as overhead bytes in the ADSL framing structure. The actual multiplexing of these overhead bytes into ADSL framing structure shall depend on the framing structure used (i.e., full overhead or reduced overhead) and on the allocation of any bearer channel to the fast or interleaved data buffer. The aoc protocol and the on-line adaptation shall be as per ITU-T Rec. G.992.1.

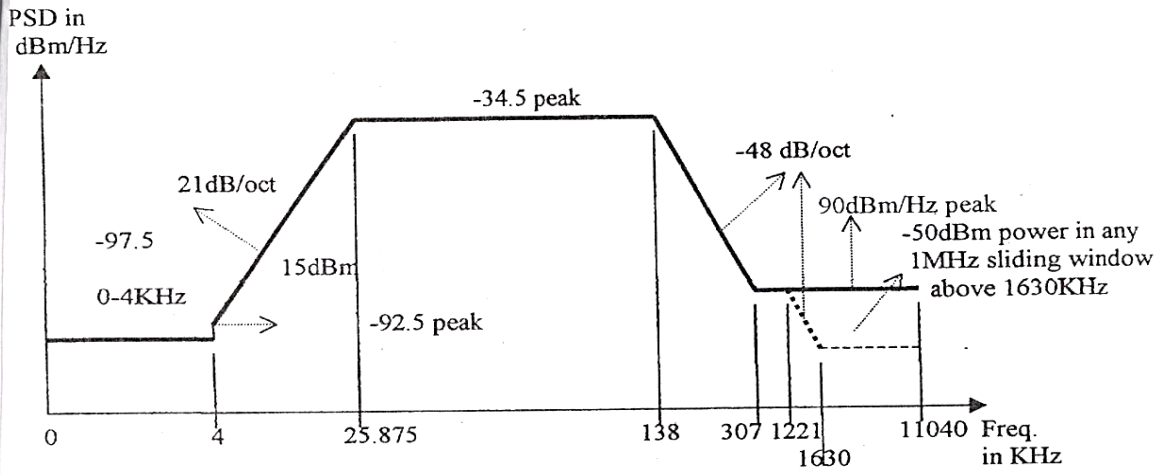
16.0 Alarms:

The ADSL Modem shall have the provision of indicating two conditions - healthy condition and the defect/fault condition.

17.0 ADSL Modem Management

The software of the ADSL Modem shall be easy to install and all the network specific provisioning settings can be pre-configured in the software by the manufacturer. It shall also be able to be managed from the Central Office Terminal of an ADSL system as detailed in the relevant TEC GR for the ADSL COT equipment.

Annex I



FREQUENCY BAND (KHz)	EQUATION FOR LINE (dBm/ Hz)
0 < f < 4	-97.5, with max power in the in 0 – 4 KHz band of + 15 dBm
4 < f < 25.875	$-92.5 + 21.5 \times \log_2 (f/4)$
25.875 < f < 138	-34.5
138 < f < 1221	$-34.5 - 48 \times \log_2 (f/138)$
307 < f < 1221	-90
1221 < f < 1630	- 90 peak, with max power in the [f, f + 1 MHz] window of $(-90 - 48 \times \log_2 (f/1221) + 60)$ dBm
1630 < f < 11040	- 90 peak, with max power in the [f, f + 1 MHz] window of 50 dBm

NOTES:-

1. All PSD measurement are in 100 ohms; the POTS band total power measurement is in 600 ohms.
2. The breakpoint frequencies and PSD values are exact, the indicated slopes are approximate.
3. Above 25.875 KHz, the peak PSD shall be measured with a 10KHz resolution bandwidth.
4. The power in a 1 MHz sliding window is measured in a 1 MHz bandwidth, starting at the measurement frequency.
5. The step in the PSD mask at 4KHz is to protect V.90 performance.
6. All PSD and power measurement shall be made at the U-C interface.

ATU-R transmitter PSD mask
Figure A-3 of ITU- T Rec. G.992.1

ABBREVIATIONS

AEX	:	A(s) Extension Byte
Aoc	:	ADSL Overhead Control
ASX	:	Any of the simplex bearer channels AS0 to AS3
A TM	:	Asynchronous Transfer Mode
ATMF	:	Asynchronous Transfer Mode Forum
ATU-C	:	ADSL Transceiver Unit at Central Office End
ATU-R	:	ADSL Transceiver Unit at Remote Terminal End
BER	:	Bit Error Ratio
BNC	:	Bayonet N-type Connector
COT	:	Central Office End
CRC	:	Cyclic Redundancy Check
D/A	:	Digital to Analog
DMT	:	Discrete Multi-tone
DC	:	Direct Current
DSLAM	:	Digital Subscriber Line Access Multiplexer
DTMF	:	Dual-tone Multi Frequency
DVC	:	Desktop Video Conferencing
EMC	:	Electromagnetic Compatibility
eoc	:	Embedded Control Channel
FEC	:	Forward Error Correction
GR	:	Generic Requirements
ISDN	:	Integrated Service Digital Network
IEC	:	International Electro-technical Commission
ITU	:	International Telecom Union
KHz	:	Kilo Hertz
KV	:	Kilo Volts
LCT	:	Local Craft Terminal
LEX	:	L(s) extension byte
LPF	:	Low Pass Filter
LSX	:	Any of the Duplex bearer channels LS0 to LS2
MDF	:	Main Distribution Frame
MTPR	:	Multitone Power Ratio
NEXT	:	Near End Cross Talk
NMS	:	Network management System
NTR	:	Network Timing Reference
OAM	:	Operation, Administration and Maintenance
PIJF	:	Polythene Insulated Jelly Fined
Ppm	:	Pulse Per Million
PSTN	:	Public Switched Telephone Network
POTS	:	Plain Old Telephone Service
QA	:	Quality Assurance
RF	:	Radio Frequency
rms	:	Root Mean square
RT	:	Remote Terminal

SM	:	Service Module
SMU	:	Service Module Unit
SNMP	:	Simple Network Management Protocol
STM	:	Synchronous Transport Module
TEC	:	Telecommunication Engineering Centre
TMN	:	Telecom Network management
T-R	:	Interface between ATU-R and Switching Layer (ATM or STM)
V-C	:	Logical Interface between ATU-C and a Digital Network Element
VP	:	Virtual Path
VTOA	:	Voice and telephony over ATM

List of Reference Documents

1. ITU-T Rec G.992.1- Recommendation for ADSL transceiver
2. DOT QA No. QM 333-Environmental testing procedures.
3. DOT QA Nos QM-205 and QM-206- on quality requirements.
4. IS 8437(1993)-Guide on the effects of current passing through the human body.
5. IS 13252(1992)- Safety of information technology equipment.
6. IEC 1000-4-2- Testing and measurement techniques of electrostatic discharge immunity test.
7. IEC 1000-4-4- Testing and measurement techniques of electrical fast transient/burst immunity.
8. ENV 50141(1993)- Basic immunity standard.
9. ITU-T Rec G.996.1- Recommendation for ADSL testing.
10. ITU-T Rec. G.821- Error performance of an international digital connection.
11. ITU-T Rec. G.826- Error performance parameters at or above primary rate.
12. ITU-T Rec. K.20 – Resistibility to subscriber’s terminals to overvoltages and overcurrents.