TA3000 SHDSL T1/E1 LTU Specification

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Responsible Manager:	_____	Signature:	_____
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Revision History

Issue No.	*Date*	*Author(s)*	*Description*

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1. Scope

This specification details the technical design requirements for a TA3000 SHDSL T1/E1 Line Termination Unit (LTU) to be developed and manufactured by Adtran, Inc., Huntsville, Alabama U.S.A.

2. Applicable References

- Adtran SHDSL Proprietary EOC Protocol specification
- AS/ACIF S043.2 2001 Requirements for Customer Equipment for connection to a metallic local loop interface of a Telecommunications Network - Part 2: Broadband.
- ANSI T1.403.CORE.199x, Network to Customer Installation DS1 Metallic Interface.
- ITU-T Recommendation G.703 (10/98), Physical/electrical characteristics of hierarchical digital interfaces.
- ITU-T Recommendation G.704 (10/98), Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 Kbps hierarchical levels.
- ITU-T Recommendation G.706 (4/91), Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in Recommendation G.704.
- ITU-T Recommendation G.732, Characteristics of primary PCM multiplex equipment operating at 2048 Kbps.
- ITU-T Recommendation G.736 (3/93), Characteristics of a synchronous digital multiplex equipment operating at 2048 Kbps.
- ITU-T Recommendation G.775 (10/98), Loss Of Signal (LOS), Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) defect detection and clearance criteria for PDH signals.
- ITU-T Recommendation G.784 (1/94), Synchronous digital hierarchy (SDH) management.
- ITU-T Recommendation G.797 (3/96), Characteristics of a flexible multiplexer in a plesiochronous digital hierarchy environment.
- ITU-T Recommendation G.821 (8/96) Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network.
- ITU-T Recommendation G.823 (03/93) Digital Networks. The Control of Jitter and Wander within Digital Networks which are based on the 2048 Kbps Hierarchy.
- ITU-T Recommendation G.826 (2/99), Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate.
- ITU-T Recommendation G.991.2 (02/2001), Single-Pair High Speed Digital Subscriber Line (SHDSL) Transceivers.
- ITU-T Recommendation G.991.2: Amendment 1 Text (until officially published, use temporary document FC-020, Clearwater, Florida, USA, 10-14 December 2001)
- ITU-T Recommendation G.994.1 (02/2001), Handshake procedures for digital subscriber line (DSL) transceivers.
- ITU Recommendation K.20 (1996), Resistibility of telecommunication switching equipment to over-voltages and over-currents.
- ITU Recommendation K.21 (1996), Resistibility of subscriber's terminal to over-voltages and over-currents
- ITU Recommendation O.150 (05/96) General Requirements for instrumentation for performance measurements on digital transmission equipment
- ITU Recommendation O.151 (05/96) Error performance measuring equipment operating at the primary rate and above
- ITU-T Recommendation X.21 (09/92) Data Communications Network: Interfaces. Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment for Synchronous Operation on Public Data Networks.

3. Definitions

Aligned Mode (SHDSL)	The customer payload is aligned to the SHDSL payload.
AIS	Alarm Indication Signal
AMI	Alternate Mark Inversion Coding. A line code where 1's are represented by marks that alternate in polarity.
BER	Bit Error Rate
BERT	Bit Error Rate Tester
B8ZS	Bipolar with 8-zero Substitution
CAS	Channel Associated Signalling
CCS	Common Channel Signalling
CRC-4	Cyclic Redundancy Check using 4 bits.
CRC-6	Cyclic Redundancy Check using 6 bits.
Cust	Customer Interface (e.g. G.703) or Direction
CVC	Code Violation Count
DTR	Data Terminal Ready
E-bit	CRC block error bit as defined by ITU-T G.704 CRC-multiframing
E1	Refers to a 2Mbit/s link that conforms to G.703 for its electrical characteristics, and uses G.704 framing.
E1 Frame	A single group of 256 bits, representing 32 timeslots (8 bits wide).
ES	Errored Second
ESF	Extended Superframe Format
ETSI	European Telecommunication Standards Institute
EOC	Embedded Operations Channel
FAS	Frame Alignment Signal
FDL	Facility Data Link
G.703 Port	An E1 customer port compliant to ITU-T G.703
G.703 Service(s)	A G.703 (E1) signal organized to provide one or more Nx64Kbps data services to individual customers.
HDB3	High-Density Bipolar 3
ITU-T	International Telecommunication Unit – Transmission. (Telecommunication Standardisation Sector of ITU)
LED	Light Emitting Diode
LOF	Loss of Frame alignment
LOMF	Loss Of Multiframe alignment
LOS	Loss of Signal
LOSWS	Loss of Sync Word Second
LTU	Line Terminating Unit. Also known as STU-C.

MSB	Most Significant Bit.
NEBE	Near-End Block Error
Net	SHDSL Network Interface or Direction
NFAS	Non Frame Alignment Signal
NMS	Network Management System
NTU	Network Terminating Unit. Also known as STU-R.
Nx64K port	Generic term for a serial DTE interface (e.g. V.35 or X.21)
Outage Seconds	A seconds count of 10 or more consecutive Error Seconds
Pair	Refers to a twisted pair of copper
PCM	Pulse Code Modulation
PN127	PN127 is an inband remote looping protocol
PRBS	Pseudo-Random Bit Sequence
PREP	The Preparatory signal used to initiate a V.54 or PN127 remote loop
PSE	Protection Switching Equipment
RAI	Remote Alarm Indication
REM	Remote Alarm indication received via a G.704 signal
RL	Remote Loop
ROM	Read Only Memory
Rx	Receive
SHDSL	Single-pair High-Bit-Rate Digital Subscriber Line
Service	A combination of one or more timeslots that are used to provide a single end-to-end data connection
SES	Severely Errored Second
SF	Superframe Format
Simultaneous Service	Two or more services that come out physically different ports
Slip	A slip occurs when a buffer over/under runs. Some data will be lost.
STU-C	SHDSL Transceiver Unit - Central office. Also known as ‘LT’ mode.
STU-R	SHDSL Transceiver Unit - Remote end. Also known as ‘NT’ mode.
T1	Refers to a 1.544Mbps data link that conforms to T1.403
TERM	The Termination signal used to disable a V.54 or PN127 remote loop
Tx	Transmit
UAS	Unavailable Second
XBER	Excessive Bit Error Rate, approximately $1x10^{-3}$

4. Product Overview

The TA3000 SHDSL T1/E1 LTU shall provide an interface between the SHDSL network and the central office data network. The TA3000 SHDSL T1/E1 LTU shall perform in the following configuration.

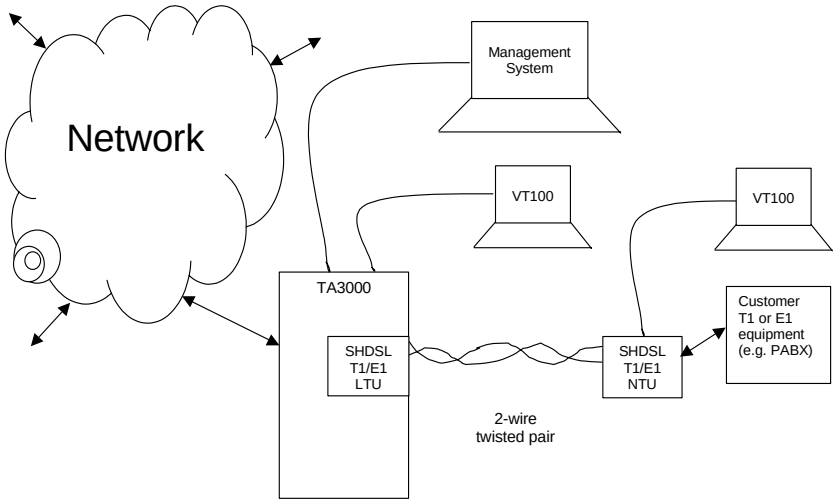

Figure 1 – Typical System Application

LTU configuration, testing, and performance monitoring shall be managed either by the VT100 local management screen menus or by SNMP commands initiated from the Element Management System (EMS).

5. Physical Description

The LTU shall be designed for a TA3000 form factor shelf. The front panel shall provide LED status indicators for data port, test and alarm conditions.

5.1. Front Panel

Figure 2 – TA3000 SHDSL T1/E1 LTU Front Panel

5.1.1. LED Indicators

The front panel shall have 5 tri-color LED status indicators. LED functionality shall be in accordance to Table 1.

Table 1 – LED Indicator Status

LED	*Off*	*Green*	*Yellow*	*Red*
PWR	The unit is powered off.	The unit is powered on.	The unit is either Out of Service or is in the process of a firmware upgrade.	N/A
SHDSL	The unit is powered off.	Port is trained with good signal quality.	Port is trained with poor signal quality.	Port is not trained.
T1/E1	Port is active with alarms.	Port is active with no alarms.	N/A	N/A
TEST	No test in progress.	Local Loopback is active or a BERT is running with pattern sync and no errors.	BERT is running with errors.	BERT is running with no pattern sync.
ALM	No alarms active.	N/A	Remote alarm(s) active.	Local alarm(s) active.

6. Power Supply

The TA3000 SHDSL T1/E1 LTU shall support the following power scheme: local –48VDC power. No adjustments, strapping or configuration changes shall be necessary to power the units.

The LTU power supply shall include "dying gasp" circuitry that meets the power status bit requirements as specified in ITU-T G.991.2 and for ISDN PRA V3 operation mode.

Span powering operation shall adhere to ITU-T G.991.2 Section B.5.3.

6.1. Reset Circuitry

To ensure that the equipment does not lock-up in an unworkable state, a "watchdog timer" and internal voltage monitor shall be provided. The watchdog shall reset the unit if it is not pulsed in 2 seconds max. (500 ms min.; 1200 ms typ; 2000ms max.). The internal voltage monitor shall hold the LTU circuitry in reset if the internal voltage(s) drop below a level suitable for reliable operation.

7. Management

In addition to the limited monitoring functionality of the LED indicators described above, the TA3000 SHDSL T1/E1 LTU shall provide the following management capabilities:

- locally managed via the SCU VT100 management port,
- locally managed via the remote EMS using SNMP proxy,
- management of the remote NTU by a remote VT100 virtual terminal session via the SCU VT100 management port,
- management of the remote NTU via the SHDSL EOC and SNMP proxy by the remote EMS.

Management functionality shall be the same, whether by VT100 or by SNMP. There shall be no internal dip-switches or other physical intervention required to configure the TA3000 SHDSL T1/E1 LTU.

7.1. Local VT100 Management

The TA3000 SHDSL T1/E1 LTU shall provide local VT100 menu screens available via the TA3000 SCU VT100 management port. These screens shall be provided for displaying unit identification information, for option configuration, for displaying both current status and performance history, and for testing the unit and circuit.

7.2. Remote VT100 Virtual Terminal Management

The TA3000 SHDSL T1/E1 LTU shall support a virtual terminal session over the EOC, complying to ITU-T G.991.2 Section 9.5.5.7.16. This shall give the LTU the capability of managing the remote NTU through virtual operation of the remote unit's VT100 menus.

7.3. SNMP Management

The TA3000 SHDSL T1/E1 LTU shall support SNMP management of both the local LTU and remote NTU. The following MIB's shall be supported.

- adTASHDSLT1E1 – this MIB controls the product specific configuration and status parameters for both the LTU and NTU.
- draft-ietf-adslmib-hdsl2-09 – this MIB controls the SHDSL specific configuration and status parameters for both the LTU and NTU.
- genport – this MIB is for general port information for individual line cards in the TA3000 shelf
- genslot – this MIB is for general shelf slot information for individual line cards in the TA3000 shelf
- rfc2863 – this MIB is for general interface information for individual line cards in the TA3000 shelf

7.4. SHDSL EOC Management

The TA3000 SHDSL T1/E1 LTU shall support EOC operation as defined in the ITU-T G.991.2 Section 9.5. Additional applicable proprietary messages shall be supported per the latest version of the Adtran SHDSL Proprietary EOC Protocol specification.

7.5. Configuration Options

The TA3000 SHDSL T1/E1 LTU shall provide the complete set of configurable options, with setting and default values as listed in Table 2. As noted, some options will be applicable or non-applicable, depending on the mode of operation. For example, when the LTU is in T1 mode, all related E1 options will be non-applicable. A non-applicable option setting shall still be changeable via any management method, but the setting shall take no affect until the option becomes applicable (e.g. LTU is in E1 mode).

Table 2 – Configuration Options List

Category	*Option*	*Setting*	*Default*
Unit Options	Data Mode	For Data Type = T1, Data Rate can be from 3 to 24 timeslots (i.e. 200k to 1.544Mbps). For Data Type – E1, Data Rate can be from 3 to 32 timeslots (i.e. 192k to 2.048Mbps).	Data Type = T1 Data Rate = 24
	Local Management	1 = Disabled 2 = Enabled	Enabled
	Clock Source	1 = Internal 2 = External	Internal
	Service State	1 = In Service 2 = Out of Service – Unassigned 3 = Out of Service – Maintenance	Out of Service - Maintenance
	External Port Alarms	1 = Disabled 2 = Enabled	Disabled
	Restore Factory Defaults		
	Firmware Upgrade		
	Change Password		
SHDSL Options	SES CVC Threshold	0 to 255 CVCs = SES Threshold	50
	SNR Margin Alarm Threshold	0 = Disabled 1 to 15 dB = Alarm Threshold	Disabled
	Loop Attenuation Alarm Threshold	0 = Disabled 1 to 127 dB = Alarm Threshold	Disabled
	ES 15 Minute Alarm Threshold	0 = Disabled 1 to 900 Seconds = Alarm Threshold	Disabled
	SES 15 Minute Alarm Threshold	0 = Disabled 1 to 900 Seconds = Alarm Threshold	Disabled
	UAS 15 Minute Alarm Threshold	0 = Disabled 1 to 900 Seconds = Alarm Threshold	Disabled
	CVC 15 Minute Alarm Threshold	0 = Disabled 1 to 65535 Errors = Alarm Threshold	Disabled
	LOSWS 15 Minute Alarm Threshold	0 = Disabled 1 to 900 Seconds = Alarm Threshold	Disabled
T1 Options (T1 Mode Only)	Line Coding	1 = AMI 2 = B8ZS	B8ZS
	Framing Mode	1 = Unframed 2 = SF 3 = ESF	ESF
	Idle Pattern	00h to FFh	7Fh
	FDL Monitoring (ESF Mode Only)	1 = Disabled 2 = Enabled	Disabled
E1 Options (E1 Mode Only)	Line Coding	1 = AMI 2 = HDB3	HDB3
	Framing Mode	1 = Unframed 2 = CCS 3 = CCS w/CRC-4	CCS
	Idle Pattern	00h to FFh	FFh
	ISDN-PRA V3 (CCS or CCS w/CRC-4 Mode Only)	1 = Disabled 2 = Enabled	Disabled
Test Options	Loopback Timeout	0 = Disabled 1 to 999 Minutes = Timeout	Disabled

	BERT Pattern	1 = ALT 2 = 2047 3 = 2e15 – 1 4 = QRSS	2e15 – 1
	BERT Pattern Polarity	1 = Normal 2 = Inverted	Normal

8. General Features

8.1. Unit Identification Information

The TA3000 SHDSL T1/E1 LTU shall respond to an EOC Inventory Response message, and also display the following information on a VT100 screen for each SHDSL NTU and LTU device in the circuit:

- SHDSL Version
- Vendor List Number
- Vendor Issue Number
- Vendor Software Version
- Unit Identification Code (CLEI)
- Vendor ID
- Vendor Model Number
- Vendor Serial Number
- Other Vendor Information

If a SHDSL device is manufactured by Adtran, the 'Other Vendor Information' field shall instead be displayed as:

- Manufacture Date (with international date format DD-Mmm-YY)
- PROM Checksum

8.2. Data Modes

The TA3000 SHDSL T1/E1 LTU shall be capable of operating in the following data modes.

- T1 with data rate of 200kbps to 1.544Mbps (3 to 24 timeslots)
- E1 with data rate of 192kbps to 2.048Mbps (3 to 32 timeslots)

The user shall be able to set the data mode at the LTU via any management method. The LTU shall automatically configure the remote NTU based on the LTU's local parameters.

8.3. Timing Sources

In the TA3000 SHDSL T1/E1 LTU, both transmit and receive clocking shall be controlled by a configurable option 'Clock Source' which shall have the following settings:

- Internal (derived from internal oscillator with better than 32ppm tolerance)
- External (G.703 port derived receive clock)

When a loss of signal occurs, the transmit timing will be internally loop-timed with an frequency accuracy of ±32 ppm. Refer to ITU-T G.991.2 sec 10.2, G.703 sec 9.1

8.4. Service States

The TA3000 SHDSL T1/E1 LTU shall provide a user selectable Service State option. The states are defined as follows:

- In Service
  - The LTU assumes provisioned functionality
  - Alarms are enabled
  - Firmware upgrades are allowed.
  - Provisioning changes are allowed.
  - Provisioning downloads are allowed.
  - All testing is allowed
  - Front Panel LED Indicators function as described.
  - Removal of LTU from system will generate an alarm.

- Out-of-Service Maintenance (OOS-M), same is In Service except:
  - Alarm Traps are suppressed. However, real-time alarm status is maintained.
  - The PWR LED shall be yellow.
  - Removal of LTU from system will not generate an alarm.
  - This is the factory default for the LTU.

- Out-of-Service Unassigned (OOS-U), same as OOS-M except:
  - Both SHDSL and T1/E1 interfaces are disabled.
  - AIS is generated toward the network and customer.
  - SHDSL and T1/E1 LED's are off.

8.5. Non-Volatile Memory

Current LTU configuration option settings, as listed in Table 2, shall be automatically saved into non-volatile memory, and automatically restored on power-up. The non-volatile memory shall not require maintenance during the lifetime of the product.

8.6. Factory Default Restoration

The capability shall be provided to restore all TA3000 SHDSL T1/E1 LTU configuration options to their factory default settings. This shall be accomplished via local VT100 menu screens or SNMP command.

8.7. Firmware Upgrade

The TA3000 SHDSL T1/E1 LTU shall be capable of receiving its application firmware via the following methods:

- Y-Modem through the SCU VT100 port. This interface is available through the VT100 menu system only.

- TFTP connection once the TFTP server's IP address and the software's filename have been specified at either the VT100 menu or SNMP interface. The TFTP transfer shall be able to be initiated from either the VT100 menu or SNMP interface.

Updating the TA3000 SHDSL T1/E1 LTU firmware shall not automatically cause an update of the NTU firmware.

8.7.1. Version Compatibility

A new version of LTU firmware shall not preclude management of the LTU, whether by VT100 screen or SNMP messages, by an older version. This implies that a configurable option may not be removed or be changed in the way it is addressed and set between one firmware version and the next.

8.8. Remote NTU Firmware Upgrade

The TA3000 SHDSL T1/E1 LTU shall be capable of receiving the remote NTU's application firmware via the following methods:

- Y-Modem through the SCU VT100 port. This interface is available through the VT100 menu system only.
- TFTP connection once the TFTP server's IP address and the software's filename have been specified at either the VT100 menu or SNMP interface. The TFTP transfer shall be able to be initiated from either the VT100 menu or SNMP interface.

Once the file transfer to the LTU has begun, the LTU shall download the NTU's firmware via proprietary EOC messages. Due to the latency in the EOC, it will take approximately 25 minutes to perform a download with a file size of 256KB.

The TA3000 SHDSL T1/E1 LTU shall also be capable of sending a command to the remote NTU to switch active images. This shall be performed by use of a proprietary EOC message.

8.9. Circuit ID

The TA3000 SHDSL T1/E1 LTU shall provide a 25 character ASCII string non-volatile register that may be programmed and passed over the EOC to the remote NTU, for the purpose of identifying the circuit. This 'Circuit ID' string shall automatically update and match on both the LTU and NTU when it is changed at the LTU. This is accomplished by a proprietary EOC message exchange. The 'Circuit ID' shall be displayed as a banner on every VT100 menu screen.

8.10. Date and Time

The TA3000 SHDSL T1/E1 LTU shall provide date and time non-volatile registers that may be programmed and passed over the EOC to the remote NTU per ITU-T G.991.2 Section 9.5. These date and time registers shall automatically update and match on both the LTU and NTU when changed at the SCU. Date and time shall be displayed as a banner on every VT100 menu screen.

8.11. Password Protection

An eight character ASCII string password non-volatile register shall be provided to protect access to the following VT100 menu configurable options and features:

- Upgrade Firmware
- Local Management
- Change Password

8.11.1. Local Management Access

Enabling and disabling local management port access shall be accomplished through VT100 menus and by SNMP messages. When disabled, it shall still be possible to monitor status of the network and customer interfaces, and view, but not change, configuration option settings.

9. SHDSL Port

The TA3000 SHDSL T1/E1 LTU SHDSL port shall comply with ITU-T Rec. G.991.2 (02/2001), ITU-T G.991.2: Amendment 1 Text (until officially published, use temporary document FC-020, Clearwater, Florida, USA, 10-14 December 2001), and ITU-T Rec. G.994.1 (02/2001) with the following clarifications:

- The SHDSL port shall meet the requirements of ITU-T G.991.2 Annex B only, including Section B5.3 Span Powering.
- ITU-T G.991.2 Annex E.7 - TPS-TC for Aligned European 2048Kbps digital Structured Leased Line (D2048S) and Fractional, shall be met when operating in G.704 framing mode. If the LTU is operating in unframed G.703 mode then alignment is not required.
- ITU-T G.994.1 requirements for power back-off (at minimum, a single 6dB step) shall be met.

9.1. SHDSL Line Rate

The TA3000 SHDSL T1/E1 LTU shall operate in ITU-T G.991.2 Section 5. The LTU shall support multirate line operation as follows:

- SHDSL Line Aggregate Data Rate = 208Kbps to 1.552Mbps in T1 mode (N x 64Kbps + 16Kbps, where N = 3 to 24). An extra 8khz is required for the SHDSL overhead and an additional 8khz is required for the T1 framing.
- SHDSL Line Aggregate Data Rate = 200Kbps to 2.056Mbps in E1 mode (N x 64Kbps + 8Kbps, where N = 3 to 32). An extra 8khz is required for the SHDSL overhead.
- Payload Data Rate = 200Kbps to 1.544Mbps in T1 mode (N x 64Kbps + 8Kbps, where N = 3 to 24)
- Payload Data Rate = 192Kbps to 2.048Mbps in E1 mode (N x 64Kbps, where N = 3 to 32)

If the link between the SHDSL NTU and LTU loses synchronization, then the units will continue to attempt to retrain per the LTU option settings.

9.2. SNR Margin Alarm Threshold

SNR margins shall be measured and passed over the EOC in accordance to ITU-T G.991.2 Sections 9.5.5.6 and 9.5.5.7. An alarm shall be set when the SNR margin exceeds a user programmable SNR margin alarm threshold register.

9.3. Loop Attenuation Alarm Threshold

Loop attenuation shall be measured and passed over the EOC in accordance to ITU-T G.991.2 Sections 9.5.5.6 and 9.5.5.7. An alarm shall be set when the loop attenuation exceeds a user programmable loop attenuation alarm threshold register.

9.4. SES CVC Threshold

The TA3000 SHDSL T1/E1 LTU shall provide a user programmable Severely Errored Second (SES) threshold. The threshold shall be the number of Code Violations (CVC) that will cause a SES to occur.

9.5. Performance Threshold Alarms

For the five performance statistics tracked for the SHDSL interface receiver, errored seconds (ES), severely errored seconds (SES), unavailable seconds (UAS), code violations count (CVC), and loss of sync word seconds (LOSWS), a settable threshold register shall be provided as defined in Section 7.4. When an individual statistic count exceeds the threshold value, an alarm shall be set. This alarm shall be displayed on the SHDSL port status screen and shall be provided via SNMP to the SCU.

9.6. Status and Alarms

In addition to indications by the front panel SHDSL and test status LED's, as described in Section 5.1.1, the TA3000 SHDSL T1/E1 LTU shall display on local VT100 management screens, the status information listed below for the SHDSL port.

- General Status:
  - Handshaking
  - Training, Alarm(s) Present
  - Trained, Alarm(s) Present
  - Trained, establishing EOC
  - Trained, EOC established
  - Out of Service

- Aggregate Rate:
  - 208Kbps to 1.552Mbps in T1 mode
  - 200Kbps to 2.056Mbps in E1 mode

- SNR Margin (current, minimum, and maximum)

- Loop Attenuation (current, minimum, and maximum)

Current Performance Statistic Counts:

- Errored Seconds (ES)
- Severely Errored Seconds (SES)
- Unavailable Seconds (UAS)
- Code Violations Count (CVC)
- LOSW Seconds (LOSWS)

- Loopback Status:
  - None

  - Dual Sided
  - Customer
  - Network

- BERT Status:
  - Off
  - Pattern Sync
  - Pattern Errors
  - No Pattern Sync

- Alarms:
  - Loss of Signal (per ITU-T G.991.2 Section 7.1.2.5.1)
  - CRC Error (per ITU-T G.991.2 Section 9.2.1)
  - Loop Attenuation Alarm (per ITU-T G.991.2 Section 9.2.5)
  - SNR Margin Alarm (per ITU-T G.991.2 Section 9.2.6)
  - Loss of Sync Word Failure (per ITU-T G.991.2 Section 9.2.7)
  - ES Threshold Alarm
  - SES Threshold Alarm
  - UAS Threshold Alarm
  - CVC Threshold Alarm
  - LOSWS Threshold Alarm

9.7. Performance History

The SHDSL LTU shall calculate the following performance statistics as defined in ITU-T G.991.2 Section 9.3 for each local active SHDSL loop:

- Errored Seconds (ES)
- Severely Errored Seconds (SES)
- Unavailable Seconds (UAS)
- Code Violations Count (CVC)
- LOSW Seconds (LOSWS)

These shall be locally accumulated into fifteen minute interval count registers for the current interval and the last 24 hours of operation, and into 24 hour total registers for the current period and the last 7 days, for display on local VT100 management screens and to send to the remote EMS via SNMP.

9.8. Physical Interface

9.8.1. Electrical Characteristics

The LTU shall adhere to the electrical characteristics of ITU-T G.991.2 Section 11 and Annex B only (and not Annex A).

SHDSL interface operation shall not be affected by polarity reversal of the Tip and Ring leads.

9.8.2. Span Powering

The TA3000 SHDSL T1/E1 LTU shall provide a power feed to the remote NTU that adheres to sections ITU-T G.991.2 Annex B.5.3 as it applies to STU-C's and the following guidelines:

- The voltage between the SHDSL pair shall be less than 120VDC.
- The LTU shall incorporate a current limiting circuit and allow no more than 150mA output current before disabling the power feed function.

10. G.703 Customer Port (E1 Mode)

10.1. Framing Modes and Data Rates

In E1 mode, the G.703 port shall operate in the following framing modes:

- 2.048Mbps unframed single service
- G.704 CCS framed, remotely delivered (or pass through framing), with or without CRC-4 multiframing, fractional supported with a data rate of 128Kbps to 1.984Mbps + 64K framing.

Channel associated signaling (CAS) framing shall not be required. In some situations, timeslot 16 may carry CAS data, but this data will be treated as any other transparent data channel by the LTU.

10.2. Line Coding

In E1 mode, the G.703 port shall operate in the following line coding methods:

- Alternate Mark Inversion (AMI)
- High-Density Bipolar 3 (HDB3)

10.3. Programmable Timeslot Idle Pattern

When the G.703 port is running in a fractional mode (i.e. rate < 2.048Mbps), unassigned G.703 port timeslot contents shall be filled per a programmable 8-bit idle pattern register.

10.4. ISDN-PRA V3

The LTU shall support an ISDN-PRA V3 service using ETS 300 233 as specified for an LT. The ISDN PRA service carried within the SHDSL payload will always be aligned in both directions. A brief summary of this functionality is as follows:

- Framing shall be transparent for the RAI, Sa4, Sa7, and Sa8 bits in both directions, except when there is a Fault Condition - FC4.
- Framing shall be transparent for Sa5 and Sa6 bits towards the TE.
- The LTU shall insert Sa5, Sa6 bits towards the network to indicate user G.703/G.704 faults.
- The LTU shall support CRC-4 processing and E-bit handling per ETR 001 option 2.

When the G.703 port is running in a fractional mode, CRC-4 calculations shall include idled timeslots with contents determined by the Programmable Timeslot Idle Pattern register.

10.5. Status and Alarms

In addition to indications by the front panel T1/E1, test, and alarm status LED's, the TA3000 SHDSL T1/E1 LTU shall display on a local VT100 management screen, the status information listed below for the local E1 port when active.

- General Status:
  - Normal
  - Minor alarms active
  - Major alarms active

- Data Rate:
  - 2.048Mbps (in unframed mode)
  - 192Kbps to 2.048Mbps (in framed mode)

- Framing Modes:
  - Unframed
  - CCS
  - CCS w/CRC-4

Current Performance Statistic Counts:

- Errored Seconds (ES)
- Severely Errored Seconds (SES)
- Unavailable Seconds (UAS)
- Code Violations Count (CVC)
- Indicators for signals
  transmitted towards network:
  - Tx Net AIS
  - Tx Net A-bit

  transmitted towards customer equipment
  - Tx Cust AIS

  received from the network
  - Net Sa-Bits

  received from the customer equipment
  - Cust Sa-Bits

- Alarms:
  - RED -- Loss of Signal (LOS)
  - RED -- Loss of Frame (LOF)
  - RED -- Loss of Multi-Frame Alignment (LOMF)
  - BLUE -- Received Alarm Indication Signal (Rx AIS)
  - YELLOW -- Received Remote Alarm Indication (Rx RAI)

Status information shall also be provided to the remote management system via SNMP commands.

10.6. Performance History

Table 3 – E1 Port Statistics Definitions

Statistic	*Framing Mode*	*Definition*
Errored Seconds (ES)	Unframed	LOS condition or BPV's > 0
	CCS	LOS or LOF condition, or if BPV's > 0 or FE's > 0
	CCSw/CRC-4	LOS, LOF, or LOMFA condition, or if FE's > 0 or CRC-4 errors > 0
Severely Errored Seconds (SES)	Unframed	LOS condition
	CCS	LOS or LOF condition, or if FE's > 4
	CCSw/CRC-4	LOS, LOF, or LOMFA condition, or if FE's > 4, or CRC-4 errors ≥ 300
Unavailable Seconds (UAS)	N/A	If 10 continuous SES's, then UAS; If 10 continuous seconds with no SES's, then no UAS
Code Violations Count (CVC)	Unframed	If BPV's > 0
	CCS	If BPV's > 0 or FE's > 0
	CCSw/CRC-4	If FE's > 0 or CRC-4 errors > 0

These also shall be locally accumulated into fifteen minute interval count registers for the current interval and the last 24 hours of operation, and into 24 hour total registers for the current period and the last 7 days, for display on local VT100 management screens and to send to the remote EMS via SNMP

11. G.703 Customer Port (T1 Mode)

11.1. Framing Modes and Data Rate

In T1 mode, the G.703 port shall operate in the following framing modes:

- 1.544Mbps unframed single service
- Framed in Superframe Format (SF) or Extended Superframe Format (ESF) with a data rate of 192Kbps to 1.536Mbps + 8K framing.

11.2. Line Coding

In T1 mode, the G.703 port shall operate in the following line coding methods:

- Alternate Mark Inversion (AMI)
- Bipolar with 8-Zero Substitution (B8ZS)

11.3. Programmable Timeslot Idle Pattern

When the G.703 port is running in a fractional mode (i.e. rate < 1.544Mbps), unassigned G.703 port timeslot contents shall be filled per a programmable 8-bit idle pattern register.

11.4. Facility Data Link Monitoring

When in ESF framing mode, the TA3000 SHDSL T1/E1 LTU shall monitor the FDL for the following codes.

- loopback codes
  - 11111111 01110100, loopup
  - 11111111 00000100, loopdown

- yellow alarm
  - 11111111 00000000

The ability to enable or disable detection of the loopback codes shall be made available via any management interface.

11.5. Status and Alarms

In addition to indications by the front panel T1/E1, test, and alarm status LED's, the TA3000 SHDSL T1/E1 LTU shall display on a local VT100 management screen, the status information listed below for the local T1 port when active.

- General Status:
  - Normal
  - Minor alarms active
  - Major alarms active

- Data Rate:
  - 1.544Mbps (in unframed mode)
  - 200Kbps to 1.544Mbps (in framed mode)

- Framing Modes:
  - Unframed
  - SF
  - ESF

Current Performance Statistic Counts:

- Errored Seconds (ES)
- Severely Errored Seconds (SES)
- Unavailable Seconds (UAS)
- Code Violations Count (CVC)
- Alarms:
  - RED -- Loss of Signal (LOS)
  - RED -- Loss of Frame (LOF)
  - BLUE -- Received Alarm Indication Signal (Rx AIS)
  - YELLOW -- Received Remote Alarm Indication (Rx RAI)

Status information shall also be provided to the remote management system via SNMP commands.

11.6. Performance History

Table 4 – T1 Port Statistics Definitions

Statistic	***Framing Mode***	***Definition***
Errored Seconds (ES)	Unframed	LOS condition or BPV's > 0
	SF	LOS or LOF condition, or if BPV's > 0 or FE's > 0
	ESF	LOS or LOF condition, or if BPV's > 0 or FE's > 0
Severely Errored Seconds (SES)	Unframed	LOS condition or BPV's > 1544
	SF	LOS or LOF condition, or if BPV's > 1544, or if FE's > 8
	ESF	LOS or LOF condition, or if BPV's > 1544, or if FE's > 8
Unavailable Seconds (UAS)	N/A	If 10 continuous SES's, then UAS; If 10 continuous seconds with no SES's, then no UAS
Code Violations Count (CVC)	Unframed	If BPV's > 0
	SF	If BPV's > 0 or FE's > 0
	ESF	If BPV's > 0 or FE's > 0

These also shall be locally accumulated into fifteen minute interval count registers for the current interval and the last 24 hours of operation, and into 24 hour total registers for the current period and the last 7 days, for display on local VT100 management screens and to send to the remote EMS via SNMP.

12. Test Capabilities

The TA3000 SHDSL T1/E1 LTU shall have the following test capabilities as detailed in the sub-sections below:

- Self diagnostics
- Local loopbacks
- EOC initiated remote loopbacks
- Internal bit error rate tester (BERT)

12.1. Self Diagnostics

The TA3000 SHDSL T1/E1 LTU shall perform power-up self diagnostic tests of its ROM and RAM, LED's, and non-volatile configuration settings as described below:

- ROM Test: On power-up, a checksum shall be calculated over the entire address space and compared to a known good stored checksum value. If the firmware is corrupt, the boot firmware shall stay in a mode to accept programming with a new valid firmware.

- RAM Test: On power-up, a check of RAM integrity shall be executed by writing and reading a fixed pattern to each RAM location.

- LED Test: On power-up, each LED shall illuminate in each of its normal operational colors, in a pattern that will easily show an LED hardware fault.

- Non-Volatile Memory and Configuration Checksum: The LTU shall maintain an internal checksum of its configuration settings.

The LTU shall complete self diagnostics and be ready to train to the SHDSL line within 10 seconds of power-up.

12.2. Local and Remote Loopbacks

For troubleshooting purposes, the TA3000 SHDSL T1/E1 LTU shall provide three types of loopback tests. These three loopback types shall be dual sided, network, and customer. Since all of the SHDSL timeslots are mapped to either the T1 or E1 port, it will be assumed that a customer loopback is in the direction of the SHDSL port and a network loopback is in the direction of the T1 or E1 port. Loopback tests shall be initiated from SNMP commands initiated by the element management system (EMS) or other means, local VT100 management screens, received V3 command, or by received FDL command. VT100 screens, as well as polled EOC status response messages, shall indicate the active or inactive status of each looping point, and if active, the type and originating source of the loopback test.

If not explicitly specified (e.g. FDL command for network loopback), the direction of a loopback initiated remotely by either FDL or SNMP command, shall be in the direction towards the requestor.

The TA3000 SHDSL T1/E1 LTU shall transmit the Alarm Indication Signal (AIS) in the non-looped direction during a loopback test. This is non-applicable if the loopback type is dual-sided.

The initiation or removal of any loopback test shall not cause a clock glitch on any interface. Loopbacks may be set by one source and removed by another source. It shall not be possible for the TA3000 SHDSL T1/E1 LTU to enter a looping state that cannot be returned to the unlooped state by the originating source. If the SHDSL line were to be dropped or if the LTU is power-cycled, all active loopback tests shall be released.

12.3. Bit Error Rate Tester (BERT)

The LTU shall provide an internal bit error rate tester (BERT) for the injection and observation of a pseudo-random bit sequence (PRBS) to and from the SHDSL interface. The BERT shall run only one test at a time. When the LTU is injecting PRBS, all ones shall be transmitted to the T1/E1 port. The LTU BERT shall provide the following ITU-T O.150 and O.151 compliant PRBS patterns:

- ALT
- 2047
- 2E15-1
- QRSS

The observation of data shall commence automatically when BERT test is started. The following statistics shall be available on the VT100 screens and by SNMP response message when polled by EMS:

- Bit Error Rate (of format from 0.00x10E-0 to 9.99x10E-9)
- Bit Error Count (the number of bit errors during the test period)
- Pattern Sync Loss Count (the number of times a PRBS pattern sync has been lost during the test period)
- Errored Seconds (a second that contains one or more PRBS bit errors)
- Total Elapsed Time (of format DD:HH:MM:SS)
- BERT Status
  - Pattern Sync
  - Off
  - Searching for pattern

The TA3000 SHDSL T1/E1 LTU shall be able to reset the BERT counters when requested to do so by the EMS or VT100 test screen. Injection of a single bit error from the EMS or VT100 test screen shall also be possible.

12.4. Test Management

As previously described, it shall be possible to configure the following test related functions:

- Loopback Timeout
- BERT Pattern
- BERT Pattern Polarity

13. International Compliance

The TA3000 SHDSL T1/E1 LTU shall comply with international standards for approval marking, environmental, EMC emissions, EMC power fault and lightning immunity, electrical safety, voltage variations, DC voltage tests, and network interfaces as listed in the sub-sections below.

13.1. Approval Marking

- CE Mark, ETL Registered, FCC Class B

13.2. Environmental

13.2.1. Operational Temperature and Humidity

- ETS 300 019-2-3 Class 3.1E (–5 to +55°C, 5 to 90% RH)

NOTE: Reliable operation shall be maintained in a 25°C ambient temperature environment where up to five units are stacked on top of each other.

13.2.2. Operation Shock and Vibration

- ETS 300 019-2-3 Class 3.1

13.2.3. Storage Temperature, Humidity, and Vibration

- ETS 300 019-2-1 Class 1.2

13.2.4. Transportation Temperature, Humidity, Shock, and Vibration

- ETS 300 019-2-2 Class 2.3

13.3. EMC Emissions

- EN 55022 Class B

13.4. EMC Immunity, Power Fault, and Lightning

- EN 300-386-2; K.20 (1996)

13.5. Electrical Safety

- EN 60950 with IEC 950 CB Scheme

Appendix A – SHDSL Backplane Connections

Table 5 – SHDSL Backplane Connections to a TA3010 Shelf

Slot Number	***Loop 1***
1	Pair 2; Pins 1,26
2	Pair 2; Pins 2,27
3	Pair 2; Pins 3,28
4	Pair 2; Pins 4,29
5	Pair 2; Pins 5,30
6	Pair 2; Pins 6,31
7	Pair 2; Pins 7,32
8	Pair 2; Pins 8,33
9	Pair 2; Pins 9,34
10	Pair 2; Pins 10,35
11	Pair 2; Pins 11,36
12	Pair 2; Pins 12,37
13	Pair 2; Pins 13,38
14	Pair 2; Pins 14,39
15	Pair 2; Pins 15,40
16	Pair 2; Pins 16,41
17	Pair 2; Pins 17,42
18	Pair 2; Pins 18,43
19	Pair 2; Pins 19,44
20	Pair 2; Pins 20,45
21	Pair 2; Pins 21,46
22	Pair 2; Pins 22,47

Appendix B – G.703 Backplane Connections

Table 6 – G.703 Backplane Connections to a TA3010 Shelf

Slot Number	*Tx*	*Rx*
1	Pair 6; Pins 1,26	Pair 5; Pins 1,26
2	Pair 6; Pins 2,27	Pair 5; Pins 2,27
3	Pair 6; Pins 3,28	Pair 5; Pins 3,28
4	Pair 6; Pins 4,29	Pair 5; Pins 4,29
5	Pair 6; Pins 5,30	Pair 5; Pins 5,30
6	Pair 6; Pins 6,31	Pair 5; Pins 6,31
7	Pair 6; Pins 7,32	Pair 5; Pins 7,32
8	Pair 6; Pins 8,33	Pair 5; Pins 8,33
9	Pair 6; Pins 9,34	Pair 5; Pins 9,34
10	Pair 6; Pins 10,35	Pair 5; Pins 10,35
11	Pair 6; Pins 11,36	Pair 5; Pins 11,36
12	Pair 6; Pins 12,37	Pair 5; Pins 12,37
13	Pair 6; Pins 13,38	Pair 5; Pins 13,38
14	Pair 6; Pins 14,39	Pair 5; Pins 14,39
15	Pair 6; Pins 15,40	Pair 5; Pins 15,40
16	Pair 6; Pins 16,41	Pair 5; Pins 16,41
17	Pair 6; Pins 17,42	Pair 5; Pins 17,42
18	Pair 6; Pins 18,43	Pair 5; Pins 18,43
19	Pair 6; Pins 19,44	Pair 5; Pins 19,44
20	Pair 6; Pins 20,45	Pair 5; Pins 20,45
21	Pair 6; Pins 21,46	Pair 5; Pins 21,46
22	Pair 6; Pins 22,47	Pair 5; Pins 22,47