Section 61246026L6-5B
Issue 2, September 1999
CLEI Code #T1L3K7WA_ _

T200 Low-Voltage HTU-R with Monitor Jack
High-bit-rate Digital Subscriber Line Remote Unit
Installation and Maintenance

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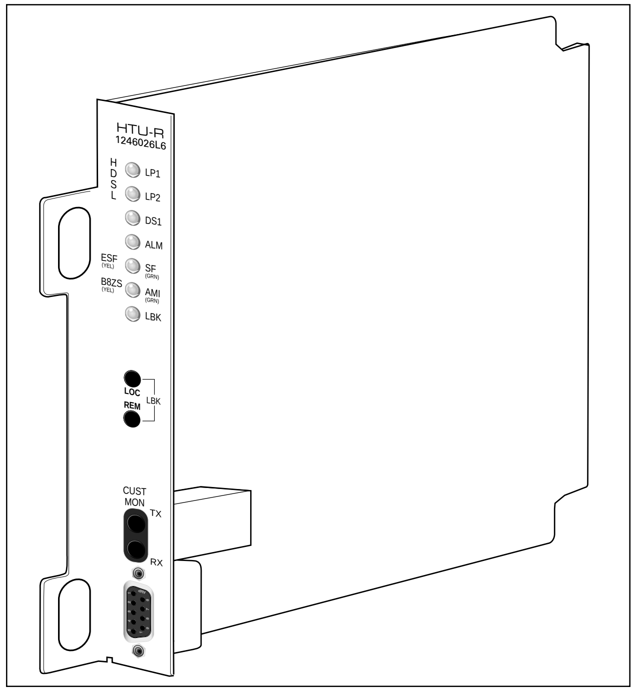


Figure 1. ADTRAN T200 Low Voltage HTU-R

1. GENERAL

The ADTRAN T200 Low Voltage HDSL Unit for the Remote end (HTU-R), ADTRAN part number 1246026L6, is a network terminating unit used to deploy an HDSL T1 circuit using 4-wire metallic facilities. The HTU-R is a T200 mechanics card which will fit any T200 or T400 mechanics enclosure. This includes the ADTRAN standalone metal enclosures (P/Ns 1242034LX), the ADTRAN HR12 HDSL remote shelf (P/N 1242007LX), or the ADTRAN HR4 HDSL remote shelf (P/N 1242008L1). Refer to appropriate ADTRAN practices for more information.

This version of the HTU-R works with multiple list versions of the HDSL transceiver unit for the central office (HTU-C), and HDSL Range Extenders (HREs) as listed on the next page.

Part Number	Description
1242002LX	220/E220 HTU-C
1242016LX	3192 HTU-C
1242023LX	DDM+ HTU-C
1244001LX	Low Voltage E220 HTU-C
1244002LX	Litespan HTU-C
1244041LX	Low Voltage T400 HRE
1244042LX	Low Voltage 819A HRE
1244044L1	Low Voltage 439 HRE
1245001LX	Low Voltage E220 HTU-C
1245002L6	Litespan HTU-C
1245003LX	Low Voltage DDM+ HTU-C
1245004LX	Low Voltage 3192 HTU-C
1245005L1	HLSS HTU-C
1245006L6	T200 HTU-C
1181101L1	Total Access HTU-C
1246001LX	E220/220 HTU-C
1246003LX	DDM+ HTU-C
1246004LX	3192 HTU-C
1245045LX	239 HRE
1245041LX	T200 HRE
1246041LX	T200 HRE
1246045LX	239 HRE

The Low Voltage HTU-R can be deployed in circuits using one HTU-C and one HTU-R. The Low Voltage HTU-R can also be deployed with one HTU-C M and up to two Low Voltage HREs in circuits requiring reach beyond standard CSA requirements. The Low Voltage HTU-R will not power an external T1 NIU.

The HTU-R terminates local loop HDSL signals originating from the Central Office (CO) unit and transforms the HDSL signal into traditional DS1 signals to be delivered to the customer.

The HDSL local loop operates as two independent subsystems each operating over a single twisted pair. The HTU-R communicates over these two twisted pairs to the HTU-C located at the CO. Each subsystem carries half of the total bandwidth along with a small amount of overhead used for maintenance and performance monitoring related functions. The unit is span powered by the HTU-C.

The effective range of an ADTRAN HDSL-based T1 circuit can be extended using the ADTRAN HDSL Range Extenders (HREs). An HRE can double the deployment range of standard HDSL and extend the digital subscriber loop serving range up to 24 kft with one HRE or 36 kft with two HREs on 24-gauge twisted pair wire.

For more information on HREs, refer to the appropriate ADTRAN practices.

The Low Voltage HTU-R (P/N 1246026L6) can be used with any Low Voltage HRE and any HTU-C to provide a fully span-powered extended range HDSL circuit. Span powering meets all requirements of Class A2 voltages as specified by Bellcore GR-1089-CORE.

Revision History

This practice has been reissued to update the unit illustations and remove a note regarding the DS1 transmit level setting.

Electrical Code Compliance

Table A shows the UL/CUL Telecommunications Codes for the HTU-R. The HTU-R complies with the requirements covered under UL 1459 third edition and is intended to be installed in an enclosure with an Installation Code (IC) of "B" or "E."

Table A. UL/CUL Telecommunications Codes

Code	Input	Output
IC	A	--
TC	X	X
PC	C	C

C UL US
LISTED
Custom Telecom
E190349

NOTE: This product is intended for installation in RESTRICTED ACCESS LOCATIONS only.

2. INSTALLATION

After unpacking the unit, immediately inspect it for possible shipping damage. If damage is discovered, file a claim immediately with the carrier, then contact ADTRAN customer service (see subsection 10 of this practice).

Except for DS1 (Tx) output level, the HTU-R is provisioned by the HTU-C. The settings on the HTU-C are encoded and transmitted to the HTU-R once the circuit has achieved synchronization. As with other provisioning options, enabling the NIU feature of the HTU-R is selected at the HTU-C.

Front Panel Indicators

There are seven front-panel-mounted status indicators. Each indicator is described in Table B.

Front Panel Switch

Two loopback (LBK) switches are accessible from the front panel. The REM loopback switch controls a loopback to the customer at the HTU-C. The LOC loopback switch controls a bilateral loopback at the HTU-R. See Table C for details.

Front Panel DS1 Monitor Jack

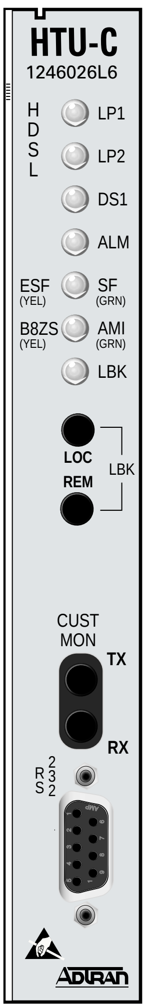
The HTU-R provides DS1 monitoring bantam jacks. These jacks provide a non-intrusive monitor point for DS1 traffic to and from the customer. For more details, refer to subsection 4 of this practice.

DS1 Tx Level Setting

The DS1 Tx Level is controlled by a jumper (P1) on the HTU-R card, as illustrated in Figure 2. The available settings are 0dB and -15dB.

Caution: The DS1 Tx Level Jumper should only be changed when the HTU-R is not **powered.**

Table B. Front Panel Indicators



Indicator	Description
LP1	Indicates HDSL signal quality on Loop 1 is in one of the following five states: *Off* .... No synchronization of HTU-C and HTU-R on Loop 1. *Red* .... Poor signal quality on Loop 1 (≥ 10^{-7} BER). *Yellow* .... Marginal signal quality on Loop 1 (≤ 2 dB margin above 10^{-7} BER). *Green* .... Good signal quality on Loop 1 (> 2 dB margin above 10^{-7} BER). *Blinking* .... Detected error on either end of Loop 1.
LP2	Indicates HDSL signal quality on Loop 2 is in one of the following five states: *Off* .... No synchronization of HTU-C and HTU-R on Loop 2 *Red* .... Poor signal quality on Loop 2 (≥ 10^{-7} BER) *Yellow* .... Marginal signal quality on Loop 2 (≤ 2 dB margin above 10^{-7} BER) *Green* .... Good signal quality on Loop 2 (> 2 dB margin above 10^{-7} BER) *Blinking* .... Detected error on either end of Loop 2
DS1	*Off* .... Customer-side DS1 signal is absent or is of a format that does not match the HDSL circuit provisioning *Blinking* .... Detected error on the DS1 interface *On Solid* .... Customer-side DS1 signal is present and synchronized
ALM	This LED indicates three possible alarm conditions: *Off* .... No alarm condition detected *Red* .... Detected local alarm condition (HTU-R) *Yellow* .... Detected remote alarm condition (HTU-C)
ESF/SF	This LED indicates three possible framing modes: *Yellow* .... Indicates DS1 is provisioned for ESF framing mode *Green* .... Indicates DS1 is provisioned for SF framing mode *Off* .... Indicates DS1 is provisioned for Unframed operation
B8ZS/AMI	This LED indicates two possible line codes: *Yellow* .... Indicates DS1 is provisioned for B8ZS coding *Green* .... Indicates DS1 is provisioned for AMI coding
LBK	This LED indicates three possible loopback conditions: *Off* .... Unit is not in loopback or armed state *Blinking* .... The loopback arming sequence has been detected. In this state the unit is armed but not in loopback. *On Solid* .... Active local loopback (HTU-R)

Table C. Front Panel Loopback Switches

Switch Label	Function
REM	Pressing this switch changes the HTU-C customer loopback state as follows: • If the HTU-C *is not* in loopback, pressing REM *activates* the loopback. • If the HTU-C *is* in loopback, pressing REM *deactivates* the loopback.
LOC	Pressing this switch changes the HTU-R customer loopback state as follows: • If the HTU-R *is not* in loopback, pressing LOC *activates* the bilateral loopback. • If the HTU-R *is* in loopback, pressing LOC *deactivates* the bilateral loopback.

3. CONNECTIONS

All connections of the HTU-R are made through card edge connectors. Table D gives the card edge pin assignments for the HTU-R circuit pack.

When the circuit pack is installed in any of the HTU-R enclosures, all connections are made through the enclosure backplanes. See the following ADTRAN Installation and Maintenance practices for more information:

Number	Description
61242007L1-5	HR12 Installation and Maintenance
61242008L1-5	HR4 Installation and Maintenance
61242034L2-5	T400 Single Mount Installation and Maintenance (removable RJ-48 jacks)
61245034L1-5	T200 Dual-slot Installation and Maintenance (APS Housing)

Caution: Ensure chassis ground is properly connected for either standalone or shelf-mounted applications.

4. HDSL SYSTEM TESTING

The T200 HTU-R provides diagnostic, loopback, and signal monitoring capabilities.

The seven front panel LEDs provide diagnostics for HDSL loops, DS1 signals, alarms, provisioning, and loopbacks. See subsection 2 of this practice for details.

The HTU-R provides local and remote loopback capabilities via the loopback switches or through the craft interface port (DB9) on the faceplate.

The DS1 MON jacks provide a non-intrusive access for DS1 signal monitoring.

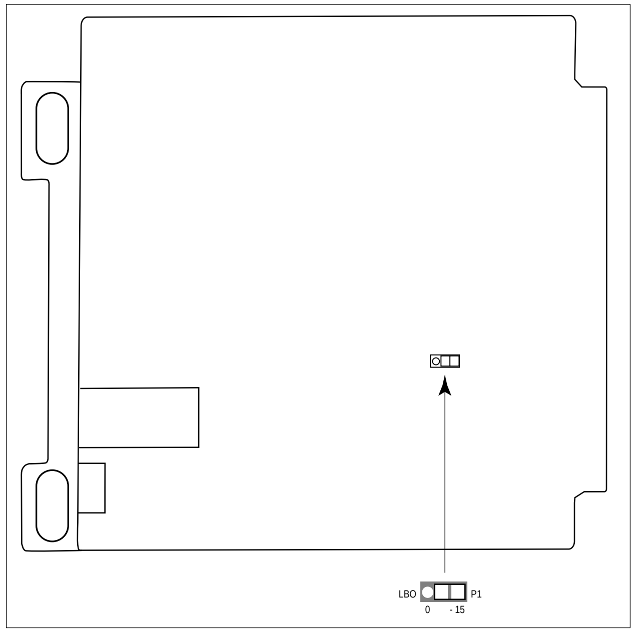


Figure 2. P1 Jumper Location

Table D. Card Edge Pin Assignments

Pin	Designation	Description
1	CH GND	Chassis ground
5	DS1-T1	DS1 receive out tip (to customer interface)
7	H1-T	HDSL Loop 1 tip (facility)
11	CH GND	Chassis ground
12	GND	Ground for protection switching
13	H1-R	HDSL Loop 1 ring (facility)
15	DS1-R1	DS1 receive out ring (to customer interface)
20	VCC	+5VDC for protection switching
27	CH GND	Chassis ground
32	PROT-4	Control line for protection switching
34	PROT-3	Control line for protection switching
38	PROT-2	Control line for protection switching
40	PROT-1	Control line for protection switching
41	H2-T	HDSL Loop 2 tip (facility)
47	H2-R	HDSL Loop 2 ring (facility)
49	DS1-R	DS1 transmit in ring (from customer interface)
55	DS1-T	DS1 transmit in tip (from customer interface)

DS1 MON Bantam Jacks

The jack labeled “MON” provides a non-intrusive access point for monitoring the transmit and receive signals at the DS1 interface point.

In general, the monitoring jacks provide a non-intrusive tap onto a signal line that permits the connection of test equipment to monitor the characteristics of that signal. For example, the DS1 MON jack on the HTU-R could be used to connect to a bit error rate tester to monitor for synchronization, test patterns, etc. Figure 3 is an illustration of specific jack detail.

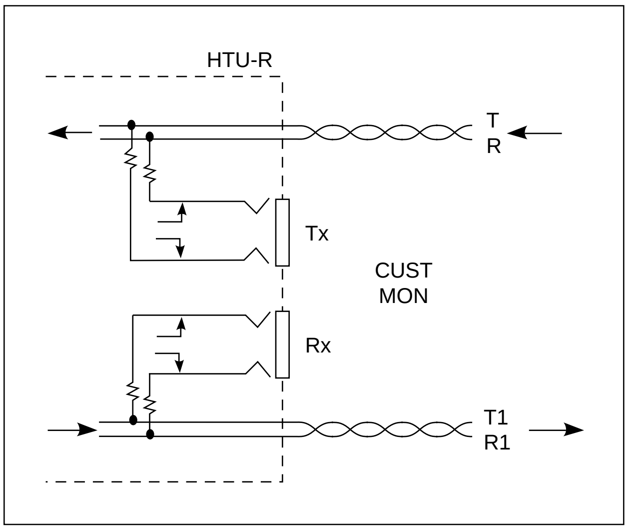


Figure 3. HTU-R MON Diagram

Note: For the MON jacks, the Tx and Rx indications relate to the direction of the signal to/from the HTU-R, respectively.

HTU-R Network Loopbacks

The HTU-R responds to multiple loopback activation processes. The loopback position is a logic loopback located within the HTU-R internal HDSL transceiver. See Figure 4.

First, manual loopback activation may be accomplished using the control port of the HTU-C. Refer to the ADTRAN HTU-C Installation and Maintenance practice (P/N 61246001LX-5) or other HTU-C practices for more information.

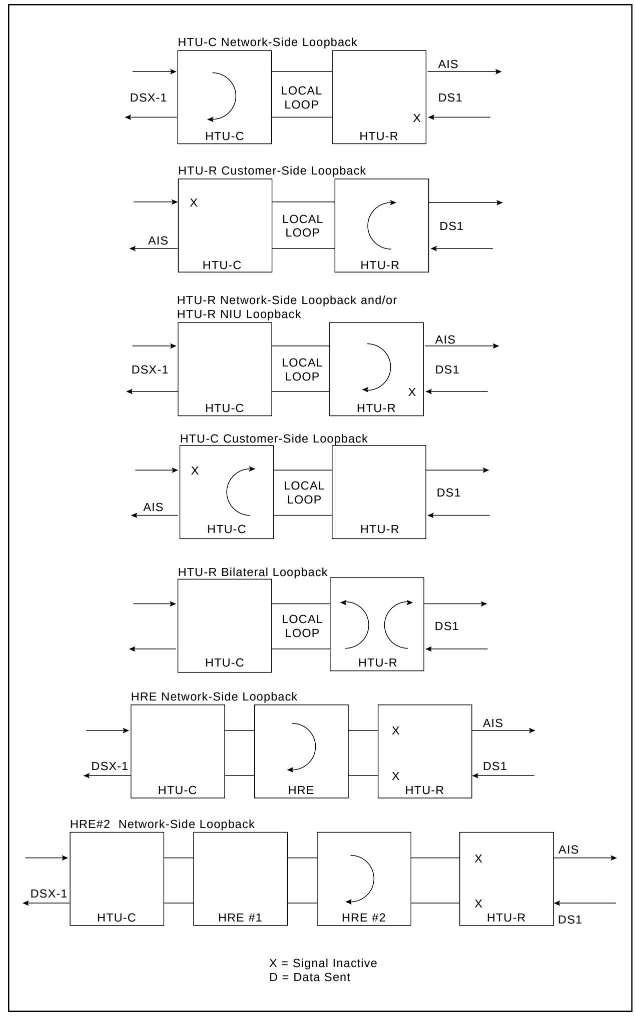


Figure 4. HDSL Loopbacks

Second, the HTU-R will respond to the industry defacto HDSL loopback codes as designated in the ANSI document T1E1.4/92. A synopsis of the method described by ANSI is presented in Appendix A.

Third, the HTU-C will respond to manual loopback activation by pressing the LOC LBK button on the faceplate. This will activate a bilateral loopback at the HTU-R.

Finally, the HTU-R responds to T1 Network Interface Unit (NIU) loopback codes as described in Bellcore TR-TSY-000312 if the HTU-R is optioned for NIU loopbacks. The NIU loopback codes are as follows:

In-band Codes:	Loop up	11000
	Loop down	11100
ESF Codes:	Loop up	0001 0010 1111 1111
	Loop down	0010 0100 1111 1111

Receiving the in-band codes for more than five seconds or the ESF codes four consecutive times will cause the appopriate loopback action.

The Low Voltage HTU-R will respond to the loop-up codes by activating the NIU loopback from either the disarmed or armed state. The loop-down codes will return the HTU-R to the state from the armed or loop-up state.

Refer to Appendix A for more details on loopbacks and loopback arming sequences.

Figure 4 illustrates all of the possible loopback locations of the ADTRAN HDSL equipment.

Customer Loopbacks

In addition to the loopbacks in the direction of the network, the HTU-R may also be looped back in the direction of the customer using the terminal control port of the HTU-C or the LOC LBK switch on the front panel of the HTU-R. The LOC LBK switch enables a bilateral loopback. The HTU-C can be looped to the customer using the REM LBK switch on the front panel of the HTU-R. The HTU-C and HTU-R Customer Side Loopbacks are illustrated in Figure 4.

Network and customer loopbacks are governed by the loopback timeout option configured on the HTU-C.

5. CONTROL PORT OPERATION

The HTU-C provides a faceplate-mounted DB9 connector that supplies an RS-232 interface for connection to a controlling terminal. The pinout of the DB9 is illustrated in Figure 5.

The terminal interface operates at data rates from 1.2 kbps to 19.2 kbps. The asynchronous data format is fixed at 8 data bits, no parity, and 1 stop bit. The supported terminal type is VT-100 or compatible.

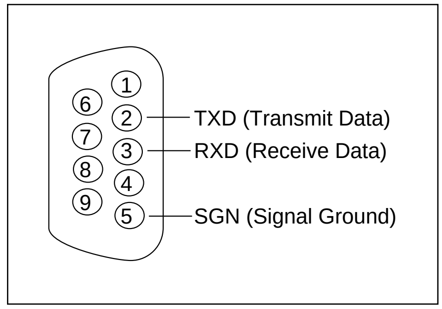


Figure 5. RS-232 (DB9) Pin Assignments

Many portable personal computers use power-saving programs that are known to interfere with applications running on the personal computer. If using a portable personal computer with terminal emulation capability, communication between the computer and the HDSL unit may be periodically disrupted if power saving programs are being used on the personal computer. The symptoms may include misplaced characters appearing on the screen and/or the occurrence of screen timeouts. These symptoms are not disruptive to the operation of the circuit and are avoidable if the power saving options are disabled or removed.

Operation

For abbreviations used in the screen diagrams, see Table E.

The screens illustrated in Figures 6 through 15 apply to an HDSL circuit deployed with ADTRAN's Low Voltage HDSL technology. The circuit includes an HTU-C, HTU-R, and two HREs. This scenario was chosen for inclusiveness of functionality; however, other configurations are possible and their displays will vary slightly from those shown in this section.

A terminal session will initiate upon plugging into the front panel interface port. An Introductory Menu will appear, as illustrated in Figure 6.

From the Introductory Menu, select the Main Menu by typing "M." The Main Menu provides access to detailed performance and configuration information, as illustrated in Figure 7.

Table E. Screen Abbreviations

Abbreviation	Definition
ES	Errored Seconds. DSX/DS1 .... SF: Second in which a BPV or frame bit error occurs. ESF: Second in which a BPV or CRC error occurs. HDSL .... Second in which a CRC error occurs.
SES	Severely errored seconds. DSX/DS1 .... SF: Second in which 1544 BPVs or 8 frame bit errors occurs. ESF: Second in which 1544 BPVs or 320 CRC errors occur. HDSL .... Second in which 165 CRC errors occurs.
UAS	Unavailable seconds. DSX/DS1 .... Second in which there is a loss of signal or sync. HDSL .... Second in which there is a loss of signal or sync.
SF	Superframe format.
ESF	Extended superframe format.
B8ZS	Bipolar with 8 zero substitution.
AMI	Alternate mark inversion.
LBO	Line build-out.
BPV	Bipolar violation. DSX/DS1 .... Second in which a bipolar violation occurs.
NIU	T1 Network Interface Unit.
S/N	Serial number.
15M	15-minute period.
24H	24-hour period.

From the Main Menu, the following screens can be accessed.

1. Current System Status
2. Performance History
3. ADTRAN Information
4. Loopback Options
5. Self Test
6. Provisioning
7. Troubleshooting

H. Alarm History

S. Set Time/Date/Circuit ID

The Current System Status screen illustrated in Figure 8 provides quick access to status information for both the HTU-C and HTU-R. Type “H” to view the Current System Status screen for HRE #1, illustrated in Figure 8A. Type “H” again to view the current system status for HRE #2. At each 15-minute interval, the performance information is transferred to the 15-minute performance data register accessed from the Performance History screen. This unit displays performance information in 15-minute increments for the last 24-hour period. At each 24-hour interval, the performance data is transferred into the 24-hour performance data register also accessed using the Performance History screen. The Performance History screen is illustrated in Figure 9. Type “H” to view the Performance History screen for HRE #1, illustrated in Figure 9A. Type “H” again for the Performance History of HRE #2.

Note: Upon entering the terminal screens at the HTU-R, note the current time as it relates to the 15-minute registers’ time stamp. Resetting the current time may be necessary to reflect the appropriate time intervals. When the current time is reset, the HTU-R will not lose any Performance History data.

From the Current System Status screen, type “Z” to reset the current performance registers to zero on both the Current System Status and Performance History screens. A prompt will require user confirmation to execute the zero register function.

Figures 8 and 8A consolidate current information for the HDSL, DSX-1, and DS1 interfaces. A key to the information provided is found in the center of the screen. Arrows indicate the key applies to both the HTU-C and HTU-R.

LOSS .... Pulse Attenuation Measurement [1]
SYNC .... HDSL Loop 1 and Loop 2 Sync Status
ES 15M/24H ..... Errored Seconds [2]
SES 15M/24H ... Severely Errored Seconds [2]
UAS 15M/24H .. Unavailable Seconds [2]

An indication of Pair Reversal (if present) is given at the bottom of the first key column. Status and configuration information for the DS1 and DSX-1 signals is located in the center of the screen near the bottom.

FRAME ...... T1 Framing Format selected
CODE .... T1 Line Code selected
LBO .... Line Build-Out selected (for DSX-1); Customer Signal of 0 or -15 dB (for DS1)
NIU .... Network Interface Unit enabled
BPV .... Bipolar Violations detected (DSX-1 and DS1)
ES .... Errored Seconds (DSX-1 and DS1)
SES .... Severely Errored Seconds (DSX-1 and DS1)
UAS .... Unavailable Seconds (DSX-1 and DS1)
Alarms .... Lists current alarm condition status

A measure of signal quality for each HDSL loop is displayed in graphic form on the bottom of the screen. The measure is from 0 (poor signal quality) to 9 (excellent signal quality). Guidelines for interpreting the indicators are given below.

0 .... Noise margin is ≤ 0 dB (≈ 10^{-7} BER)
1-8 .... Margin measurement above 10^{-7} BER in dB
9 .... Margin is ≥ 9 dB (excellent quality) above 10^{-7} BER

The HDSL Loopback and Self-Test Option Screens, illustrated in Figures 10 and 11, may be used to evoke or terminate loopbacks and self-tests. These screens also display the status of current loopback conditions.

The Provisioning Screen, illustrated in Figure 12, displays current provisioning settings but does not provide a means for changing the system configuration. Provisioning changes are only allowed at the CO end of the circuit.

The Troubleshooting Display, illustrated in Figure 13, is a graphic depiction of an HDSL circuit. The unit reviews red, yellow, and blue alarm conditions in the circuit to automatically predict where a fault is located. Once a fault location is suspected, the corresponding portion of the circuit on the screen is highlighted, and a message describing the failure will appear.

The Alarm History Screen, illustrated in Figure 14, provides detailed information on the alarm history of the HDSL and T1 spans. Information provided includes alarm location, type, first and last time/date, current status, and count.

The Set Time/Date/Circuit ID menu screen, illustrated in Figure 15, provides additional provisioning options. Enter the time parameters as military time (for example, enter 3:15 p.m. as “15:15:00”). Enter the date parameters in mm/dd/yy format. Enter the Circuit ID as a 25-character alphanumeric string.

Note: If the HTU-R is connected to a HTU-C that is being controlled by a HFAC unit, the time, date, and circuit ID should be set via the HTU-R terminal screen to match the corresponding data on the network end.

[1] LOSS is typically several dB less than the insertion loss measured at 200 kHz. The LOSS measurement is a better indication of the loop’s attenuation of the 2B1Q signal than the insertion loss measured at a single frequency. Adtran HDSL can operate on cables with an excess of 30 dB LOSS.

[2] The first number is for the current 15-minute period and the second is the current 24-hour period (Loop 1 and Loop 2 numbers are displayed).

```
CIRCUIT ID:                                                   01/01/99  00:10:57

                                   ADTRAN
                            901 Explorer Boulevard
                         Huntsville, Alabama 35806-2807

---------------------- For Information or Technical Support -------------------
       Support Hours ( Normal 7am - 7pm CST, Emergency 7 days x 24 hours )
Phone: 800.726.8663 / 888.873.HDSL  Fax: 256.963.6217  Internet: www.adtran.com
-------------------------------------------------------------------------------
HTU-C INFORMATION       SIGNAL QUALITY    HTU-R INFORMATION       SIGNAL QUALITY
--------------------     [X]   9    [X]    --------------------     [X]   9    [X]
S/N :                   L[X]   8   L[X]    S/N :                   L[X]   8   L[X]
CLEI:                   O[X]   7   O[X]    CLEI:                   O[X]   7   O[X]
MANF:   /               O[X]   6   O[X]    MANF:   /               O[X]   6   O[X]
                        P[X]   5   P[X]                            P[X]   5   P[X]
HRE #1 INFORMATION       [X]   4    [X]    HRE #2 INFORMATION       [X]   4    [X]
--------------------    1[X]   3   2[X]    --------------------    1[X]   3   2[X]
S/N : B905A5505          [X]   2    [X]    S/N : A917C2045          [X]   2    [X]
CLEI: T1RGDJEDAA         [X]   1    [X]    CLEI: T1R6DTEDAA         [X]   1    [X]
MANF: 05/99              [X]   0    [X]    MANF: 06/99              [X]   0    [X]
                            AT HTU-C                                   AT HTU-R

                       Press "M" to view Main Menu.
```

Figure 6. Introductory Menu Screen

```
CIRCUIT ID:                                                   01/01/99  00:09:42


                              ADTRAN HDSL MAIN MENU


                             1) CURRENT SYSTEM STATUS
                             2) PERFORMANCE HISTORY
                             3) ADTRAN INFORMATION
                             4) LOOPBACK OPTIONS
                             5) SELF-TEST
                             6) PROVISIONING
                             7) TROUBLESHOOTING
                             H) ALARM HISTORY
                             S) SET TIME/DATE/CIRCUIT ID


                 Choose a screen by pressing the corresponding number.
```

Figure 7. HDSL Main Menu Screen

```
CIRCUIT ID:                                                  01/01/99  00:10:04
LOOP #1 <NETWORK> LOOP #2    CURRENT SYSTEM STATUS    LOOP #1 <CUSTOMER>LOOP #2
---- HTU-C ----                             ---- HTU-R -----
29(29) dB       29(29) dB    <-  LOSS  CUR(MAX) ->    29(29) dB       30(30) dB
   YES             YES       <-  SYNC           ->       YES             YES
000/00000       000/00000    <-  ES    15M/24H  ->    000/00000       000/00000
000/00000       000/00000    <-  SES   15M/24H  ->    000/00000       000/00000
000/00000       000/00000    <-  UAS   15M/24H  ->    000/00000       000/00000
    LOOPBACKS INACTIVE                                    LOOPBACKS INACTIVE

HTU-C SIGNAL QUALITY      DSX-1                    DS1    HTU-R SIGNAL QUALITY
 MIN[X]   9    [X]MIN    ---------------    MIN[X]   9    [X]MIN
    [X]L  8   L[X]        ESF     <-  FRAME ->     ESF        [X]L  8   L[X]
    [X]O  7   O[X]        B8ZS    <-  CODE  ->     B8ZS       [X]O  7   O[X]
    [X]O  6   O[X]        399-533 <-  LBO   ->     0 dB       [X]O  6   O[X]
    [X]P  5   P[X]        N/A     <-  NIU   ->       NO       [X]P  5   P[X]
    [X]   4    [X]        00000   <-  BPV   ->    00000       [X]   4    [X]
    [X]1  3   2[X]        00000   <-  ES    ->    00000       [X]1  3   2[X]
    [X]   2    [X]        00000   <-  SES   ->    00000       [X]   2    [X]
    [X]   1    [X]        00000   <-  UAS   ->    00000       [X]   1    [X]
    [X]   0    [X]        NONE    <- ALARMS ->    NONE        [X]   0    [X]

       Press “Z” to zero registers, “X” to restart MIN/MAX, “M” for Main Menu
             “H” for HDSL Range Extender #1 (HRE) View.
```

Figure 8. Current System Status Screen

```
CIRCUIT ID:                                                  01/01/99  00:10:18
LOOP #1 <NETWORK> LOOP #2    CURRENT SYSTEM STATUS    LOOP #1 <CUSTOMER>LOOP #2
---- HRE  #1 ----                           ---- HRE  #1 ----
27(27) dB       28(28) dB    <-  LOSS  CUR(MAX) ->    29(29) dB       29(29) dB
   YES             YES       <-  SYNC           ->       YES             YES
000/00000       000/00000    <-  ES    15M/24H  ->    000/00000       000/00000
000/00000       000/00000    <-  SES   15M/24H  ->    000/00000       000/00000
000/00000       000/00000    <-  UAS   15M/24H  ->    000/00000       000/00000
    LOOPBACK  INACTIVE

HRE#1 NET SIGNAL QUALITY  N = NETWORK SIDE RECEIVER    HRE#1 CUST SIGNAL QUALITY
 MIN[X]   9    [X]MIN     C = CUSTOMER SIDE RECEIVER       MIN[X]   9    [X]MIN
    [X]L  8   L[X]                                             [X]L  8   L[X]
    [X]O  7   O[X]    ____ LP1  ____ LP1  ____      ____      [X]O  7   O[X]
    [X]O  6   O[X]   |HTUC|    |HRE1|    |HRE2|    |HTUR|     [X]O  6   O[X]
    [X]P  5   P[X]   |    |===N|    |C===|    |====|    |     [X]P  5   P[X]
    [X]   4    [X]   |    |    |    |    |    |    |    |     [X]   4    [X]
    [X]1  3   2[X]   |    |===N|    |C===|    |====|    |     [X]1  3   2[X]
    [X]   2    [X]   |____|    |____|    |____|    |____|     [X]   2    [X]
    [X]   1    [X]         LP2       LP2                      [X]   1    [X]
    [X]   0    [X]                                            [X]   0    [X]

       Press “Z” to zero registers, “X” to restart MIN/MAX, “M” for Main Menu
             “P” for previous view, “H” for HDSL Range Extender #2 (HRE) view.
```

Figure 8A. Current System Status Screen - HRE

```
CIRCUIT ID:                                                  01/01/99  00:10:33
      24 HOUR REGISTERS     PERFORMANCE HISTORY     15 MINUTE REGISTERS
      –ES----SES---UAS–                           –ES-SES-UAS–––––––––ES-SES-UAS-
      00000 00000 00000   <---CURRENT--->         000 000 000
12/31 ----- ----- -----   <-- HISTORY -->   00:00 --- --- ---  20:00 --- --- ---
12/30 ----- ----- -----     |         |     23:45 --- --- ---  19:45 --- --- ---
12/29 ----- ----- -----     |  PAGE#  |     23:30 --- --- ---  19:30 --- --- ---
12/28 ----- ----- -----     |      [1]|     23:15 --- --- ---  19:15 --- --- ---
12/27 ----- ----- -----     |         |     23:00 --- --- ---  19:00 --- --- ---
12/26 ----- ----- -----     |         |     22:45 --- --- ---  18:45 --- --- ---
12/25 ----- ----- -----   <--         |     22:30 --- --- ---  18:30 --- --- ---
                                      |     22:15 --- --- ---  18:15 --- --- ---
VIEW 1 : HTU-C DSX-1                  |     22:00 --- --- ---  18:00 --- --- ---
                                      |     21:45 --- --- ---  17:45 --- --- ---
1->|H|-3---|H|-----|H|---4-|H|-->     |     21:30 --- --- ---  17:30 --- --- ---
   |T|     |R|     |R|     |T|        |     21:15 --- --- ---  17:15 --- --- ---
   |U|     |E|     |E|     |U|        |     21:00 --- --- ---  17:00 --- --- ---
<--|C|-5---|1|-----|2|---6-|R|<-2     |     20:45 --- --- ---  16:45 --- --- ---
                                      |     20:30 --- --- ---  16:30 --- --- ---
Press view number to select view      -->   20:15 --- --- ---  16:15 --- --- ---
Press “H” to view HRE #1 history
                                  PAGE COMMANDS| “B” - Page Back
                                               | “F” - Page Forward
                         Press  “M” to go to Main Menu
```

Figure 9. Performance History Screen

```
CIRCUIT ID:                                                  01/01/99  00:10:44
      24 HOUR REGISTERS     PERFORMANCE HISTORY     15 MINUTE REGISTERS
      –ES----SES---UAS–                           –ES-SES-UAS––––––––ES-SES-UAS-
      00000 00000 00000   <---CURRENT--->         000 000 000
12/31 ----- ----- -----   <-- HISTORY -->   00:00 --- --- ---  20:00 --- --- ---
12/30 ----- ----- -----     |         |     23:45 --- --- ---  19:45 --- --- ---
12/29 ----- ----- -----     |  PAGE#  |     23:30 --- --- ---  19:30 --- --- ---
12/28 ----- ----- -----     |      [1]|     23:15 --- --- ---  19:15 --- --- ---
12/27 ----- ----- -----     |         |     23:00 --- --- ---  19:00 --- --- ---
12/26 ----- ----- -----     |         |     22:45 --- --- ---  18:45 --- --- ---
12/25 ----- ----- -----   <--         |     22:30 --- --- ---  18:30 --- --- ---
                                      |     22:15 --- --- ---  18:15 --- --- ---
VIEW 1 : HRE #1 NETWORK LP1           |     22:00 --- --- ---  18:00 --- --- ---
                                      |     21:45 --- --- ---  17:45 --- --- ---
-->|H|–1---|H|---2–|H|-----|H|-->     |     21:30 --- --- ---  17:30 --- --- ---
   |T|     |R|     |R|     |T|        |     21:15 --- --- ---  17:15 --- --- ---
   |U|     |E|     |E|     |U|        |     21:00 --- --- ---  17:00 --- --- ---
<--|C|–3---|1|---4–|2|-----|R|<--     |     20:45 --- --- ---  16:45 --- --- ---
                                      |     20:30 --- --- ---  16:30 --- --- ---
Press view number to select view      -->   20:15 --- --- ---  16:15 --- --- ---
Press “H” to view HRE #2 history
Press “P” for previous view       PAGE COMMANDS| “B” - Page Back
                                               | “F” - Page Forward
                         Press  “M” to go to Main Menu
```

Figure 9A. Performance History Screen - HRE

```
CIRCUIT ID:                                                 01/01/99  00:11:09
                              LOOPBACK OPTIONS
                _____         _____         _____         _____
               |HTU-C|       |HRE 1|       |HRE 2|       |HTU-R|
               |     |  LP1  |     |  LP1  |     |  LP1  |     |
            --->|-----|<=====>|-----|<=====>|-----|<=====>|-----|<--
               |     |       |     |       |     |       |     |
           NET |     |       |     |       |     |       |     | CUST
               |     |  LP2  |     |  LP2  |     |  LP2  |     |
            <---|-----|<=====>|-----|<=====>|-----|<=====>|-----|->
               |     |       |     |       |     |       |     |
               |_____|       |_____|       |_____|       |_____|

                  1) LOOPBACK TO NETWORK  AT HTU-C = INACTIVE
                  2) LOOPBACK TO CUSTOMER AT HTU-C = INACTIVE
                  3) LOOPBACK TO NETWORK  AT HTU-R = INACTIVE
                  4) LOOPBACK TO CUSTOMER AT HTU-R = INACTIVE
                  5) LOOPBACK TO NETWORK  AT HRE-1 = UNAVAILABLE
                  6) LOOPBACK TO CUSTOMER AT HRE-1 = UNAVAILABLE
                  7) LOOPBACK TO NETWORK  AT HRE-2 = UNAVAILABLE
                  8) LOOPBACK TO CUSTOMER AT HRE-2 = UNAVAILABLE

              Press corresponding number to toggle loopback option.
                      Press “M” to return to the Main Menu
```

Figure 10. Loopback Options Screen

```
CIRCUIT ID:                                                 01/01/99  00:11:33



                                  SELF-TEST



                 Press “S” to initiate HTU-C and HTU-R self-tests.

                        Press “M” to return to the Main Menu.
```

Figure 11. Self-Test Options Screen

```
CIRCUIT ID:                                                      01/01/99  00:11:47
                                 PROVISIONING

     *   DSX-1 LINE BUILDOUT    =  399-533 FEET
     *   DSX-1/DS1 LINE CODE    =  B8ZS
     *   DSX-1/DS1 FRAMING      =  ESF
     *   NIU LOOPBACK           =  DISABLED
     *   LOOPBACK TIMEOUT       =  NONE
     *   DS1 TX LEVEL           =  0 dB
     *   HTUC SHELF ALARM       =  DISABLED
     *   DS0 BLOCKING (XX = BLOCKED):
       01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24



             * Option not configurable from this terminal

             The DS1 Output level can be configured using a strap
             on the circuit board of the HTU-R.  All other changes
             must be made from the HTU-C in the central office.

             "M"   - to return to the main menu
```

Figure 12. Provisioning Screen

```
CIRCUIT ID:                                                      01/01/99  00:12:13
                                 TROUBLESHOOTING DISPLAY
                       _____       _____       _____       _____
                      |HTU-C|     |HRE 1|     |HRE 2|     |HTU-R|
                      |     |     |     |     |     |     |     |
                      |     |     |     |     |     |     |     |
                  --->|     |<=1=>|     |<=1=>|     |<=1=>|     |<--
                      |     |     |     |     |     |     |     |
           NET(DSX-1) |     |     |     |     |     |     |     | CUST(DS1)
                      |     |     |     |     |     |     |     |
                  <---|     |<=2=>|     |<=2=>|     |<=2=>|     |-->
                      |     |     |     |     |     |     |     |
                      |     |     |     |     |     |     |     |
                      |_____|     |_____|     |_____|     |_____|

                                 NO ALARM CONDITIONS




                         Press "M" to return to the Main Menu
```

Figure 13. Troubleshooting Display

```
CIRCUIT ID:                                                       01/01/99  00:12:45
                              T1 Alarm History
LOCATION   ALARM       FIRST                LAST                  CURRENT   COUNT
--------------------------------------------------------------------------------
HTU-C      RED(LOS)                                               OK         000
 (DSX-1)   YELLOW                                                 OK         000
           BLUE(AIS)                                              OK         000

HTU-R      RED(LOS)                                               OK         000
 (DS1)     YELLOW                                                 OK         000
           BLUE(AIS)                                              OK         000
                              HDSL Span History
--------------------------------------------------------------------------------
SPAN 1     LP1 HLOS                                               OK         000
           LP2 HLOS                                               OK         000

HTU-C      LP1 MRGN                                               OK         000
           LP2 MRGN                                               OK         000

HRE-1      LP1 MRGN                                               OK         000
           LP2 MRGN                                               OK         000


    Press: C to clear history : H to scroll span alarms : M for main menu
```

Figure 14. Alarm History

```
CIRCUIT ID:                                                       01/01/99  00:13:03



                             SET TIME/DATE/CIRCUIT ID



                            1) SET TIME
                            2) SET DATE
                            3) SET CIRCUIT ID





              Choose an option by pressing the corresponding number.
                         Press “M” to return to Main Menu.
```

Figure 15. Set Time/Date/Circuit ID

6. HDSL DEPLOYMENT GUIDELINES

The ADTRAN HDSL system is designed to provide DS1-based services over loops designed to comply with Carrier Service Area (CSA) guidelines. CSA deployment guidelines are given below.

1. All loops are non-loaded only.
2. For loops with 26-AWG cable, the maximum loop length including bridged tap lengths is 9 kFt.
3. For loops with 24-AWG cable, the maximum loop length including bridged tap lengths is 12 kFt.
4. Any single bridged tap is limited to 2 kFt.
5. Total bridged tap length is limited to 2.5 kFt.
6. The total length of multi-gauge cable containing 26-AWG cable must not exceed

   $12 - \{(3*L^{26}) - (9-L^{BTAP})\}$ (in kFt)

   L^{26} = Total length of 26-AWG cable excluding bridged taps (in kFt)

   L^{BTAP} = Total length of all bridged taps (in kFt)

This deployment criteria is summarized in the chart shown in Figure 16. Loop loss per kFt for other wire is summarized in Table F.

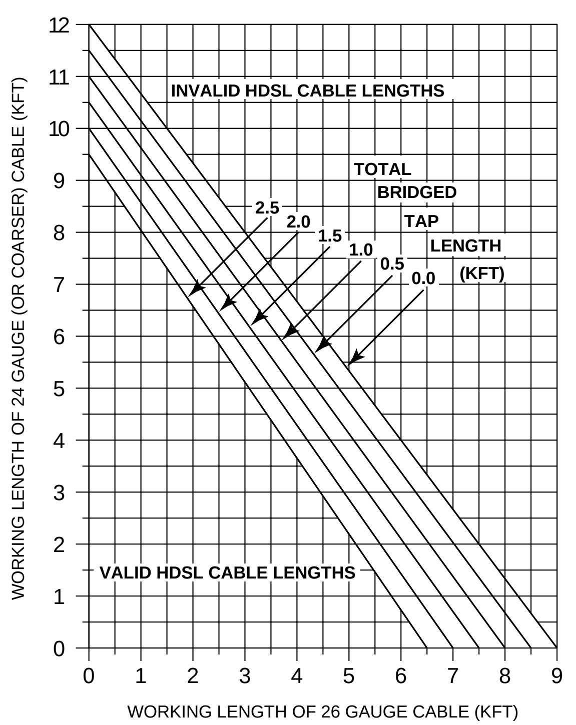


Figure 16. HDSL Deployment Guidelines

Table F. HDSL Loss Values
(200 kHz cable loss in dB/kFt at 135Ω)

Cable Gauge	Cable Type	Temperature 68°	90°	120°
26	PIC	3.902	4.051	4.253
26	Pulp	4.030	4.179	4.381
24	PIC	2.863	2.957	3.083
24	Pulp	3.159	3.257	3.391
22	PIC	2.198	2.255	2.333
22	Pulp	2.483	2.45	2.629
19	PIC	1.551	1.587	1.634
19	Pulp	1.817	1.856	1.909

Recommended maximum local loop loss information for PIC cable at 70°F, 135 Ω, resistive termination is provided in Table G.

Table G. Loop Insertion Loss Data

Frequency (Hz)	Maximum Loss (dB)
3,000	12.0
10,000	15.0
50,000	25.5
100,000	30.0
150,000	32.75
200,000	35.25

An approximation for the maximum amount of wideband noise on an HDSL local loop as measured by a 50 kbps filter is ≤ 31 dBrn.

An approximation for the maximum level of impulse noise as measured using a 50 kbps filter on an HDSL loop is ≤ 50 dBrn.

Note: These approximations are to be used as guidelines only and may vary slightly on different loops. Adhering to the guidelines should produce performance in excess of 10^{-7} BER.

7. TROUBLESHOOTING PROCEDURES

Use Table H to troubleshoot the ADTRAN HTU-R.

8. MAINTENANCE

The ADTRAN HTU-R requires no routine maintenance. In case of equipment malfunction, use the faceplate Bantam jack connector to help locate the source of the problem.

ADTRAN does not recommend that repairs be performed in the field. Repair services may be obtained by returning the defective unit to the ADTRAN Customer Service RMA Department.

9. PRODUCT SPECIFICATIONS

Table I lists the HTU-R specifications.

10. WARRANTY AND CUSTOMER SERVICE

ADTRAN will replace or repair this product within ten years from the date of shipment if it does not meet its published specifications or fails while in service.

For detailed warranty, repair, and return information refer to the ADTRAN Telco Network Equipment Warranty, Repair, and Return Policy and Procedure (document number 60000087-10A).

Return Material Authorization is required prior to returning equipment to ADTRAN.

For service, RMA requests, or further information, contact one of the following numbers:

ADTRAN Customer Service:
ADTRAN Telco Technical Support . (800) 726-8663
Standard support hours .... Monday-Friday
7 a.m. - 7 p.m. CST
Emergency support .... 7 days/week, 24 hours/day

Sales .... (800) 827-0807

Customer and Product
Support (CAPS) .... (256) 963-8722

Repair and Return Address:
ADTRAN, Inc.
Customer and Product Support (CAPS)
901 Explorer Boulevard
Huntsville, Alabama 35806-2807

Table H. Troubleshooting Guide

Condition	Solution
All front panel indicators are *off*.	1. Make sure the HTU-R is properly seating in the housing. 2. Verify that the HTU-C is delivering sufficient simplex voltage to the loops, if line powered. The HTU-C should apply approximately -137 VDC between loops on point-to-point circuits or with only one HRE. Circuits with two HREs will apply a voltage of approximately -190 VDC between the loops. A minimum of approximately 65V should be present between the HDSL loops at the HTU-R. 3. If steps 1 and 2 pass, replace the HTU-R.
Power is present and adequate, but loop sync is not available (LP1 and/or LP2 LEDs are *off*).	1. Verify that the loop conforms with CSA guidelines (not too long, etc.). 2. Verify that the tip and ring of each HDSL loop belong to the same twisted pair. 3. Verify that loop loss at 196 kHz is not greater than 35 dB. 4. Verify that noise on both HDSL loops is within acceptable limits (see subsection 6). 5. If steps 1 through 4 pass and loop sync is still not available, replace the unit with one known to be in proper working condition.

Table I. ADTRAN T200 Low Voltage HTU-R Specifications

Loop Interface	
Modulation Type	2B1Q
Mode	Full Duplex, Echo Cancelling
Number of Pairs	Two
Bit Rate	784 kbps per pair
Baud Rate	392K baud per pair
Service Range	Defined by Carrier Service Area Guidelines
Loop Loss	35 dB maximum @ 196 kHz
Bridged Taps	Single Taps ≤ 2 kFt, Total Taps ≤ 2.5 kFt
Performance	Compliant with Bellcore TA-NWT-001210
Return Loss	20 dB (40 kHz to 200 kHz)
HDSL Tx Signal Level	13.5 dBm
Input Impedance	135 Ω
DS1 Channelization	Channels 1-12 on HDSL Loop 1, Channels 13-24 on HDSL Loop 2
Customer Interface	
4-wire DS1 (T1.403-compatible) (ITU-T I.431 compliant)	
DS1 Signal Output Level	0 or -15 dB
DS1 Input Signal Level	0 to -22.5 dB
DS1 Line Coding	AMI, B8ZS
DS1 Framing Format	SF, ESF, Unframed
Power	
Span-powered by HTU-C	
Clock Sources	
Clock Sources	Internal, HDSL Loop Derived
Internal Clock Accuracy	± 25 ppm, (exceeds Stratum 4). Meets T1.101 timing requirements.
Tests	
Diagnostics	Loopback (HTU-R), initiated with HDSL in-band codes, initiated with T1 NIU in-band codes, initiated with HTU-C command, initiated manually, HTU-R control port. Self-Test.
Physical	
Dimensions	0.7" High, 5.5" Wide, 6.0" Deep
Weight	< 1 pound
Environment	
Temperature	Operating (Standard): -40°C to +70°C; Storage: -40°C to +85°C
Relative Humidity	Up to 95% non-condensing
Part Number	
HTU-R T200 Circuit Pack	1246026L6

Appendix A
HDSL LOOPBACKS

This Appendix describes the use and operation of loopback control code sequences used in ADTRAN's HDSL system. Loopback control codes are governed by the HTU-C (and HRE(s) if deployed). Two types of HTU-Cs exist which enable two different sets of loopback codes -- Standard or Enhanced loopbacks. The Standard loopbacks are those that have been contained in ADTRAN's HDSL product family beginning with 2nd Generation products. The Enhanced loopbacks are contained in selected ADTRAN HTU-C units. The following table denotes whether the HTU-C (part number) contains Standard or Enhanced loopback capabilities.

Standard Loopback

Part Number	Description
1242002LX	220/E220 HTU-C
1242016L1	3192 HTU-C
1242023L1	DDM+ HTU-C
1244001L1	E220/220 Low Voltage T1 HTU-C
1244002L1 - L3	Litespan AHDSL
1244002L4 - L6	Litespan AHT1U
1245001L1	E220/220 Low Voltage 5th GEN HTU-C
1245001L2 & L4	E220/220 HTU-C M
1245003L1 & L2	DDM+ 5th GEN HTU-C
1245004L1 & L2	3192 5th GEN HTU-C

Enhanced Loopback

Part Number	Description
1181101L1	Total Access HTU-C
1245001L6 - L8	E220/220 HTU-C M R
1245002L6	Litespan HTU-C
1245003L6 - L8	DDM+ HTU-C M R
1245004L6 - L8	3192 HTU-C M R
1246001L4 - L8	E220/220 HTU-C M
1246003L4 - L8	DDM+ HTU-C M
1246004L4 - L8	3192 HTU-C M

The loopback capabilities of both the HRE and the HTU-R loopback capabilities are controlled from the central office unit (HTU-C).

NOTE: If the HTU-C on a circuit contains Standard loopbacks, then refer to subsection 1 of this Appendix to determine its loopback capabilities. If the HTU-C on a circuit contains Enhanced loopbacks, then refer to subsection 2 of this Appendix to determine its loopback capabilities.

1. Standard Loopbacks

This subsection describes operation of the HDSL system in detection of in-band and ESF facility data link loopback codes. The operation of the loopback commands in the ADTRAN HDSL system is compliant with the recommendation to ANSI recorded in T1E1.4/92. The HDSL network loopback points described below are illustrated in Figures A-1 and A-2.

The HTU-C loopback is a regenerative loopback of the DSX-1 signal toward the network.

The HTU-R loopback is a regenerative loopback of the DS1 signal toward the network. This loopback is in addition to a separate Smartjack loopback. Separate activation sequences are provided for the HTU-R and the Smartjack loopback initiation. The HDSL loopbacks are implemented such that the downstream HDSL elements (toward the customer) remain synchronized.

Upon deactivation of a loopback, the HDSL system will synchronize automatically. It should be noted that the synchronization process of the HDSL system upon deactivation of the HRE loopback, could take up to 15 seconds to ensure all system elements are synchronized.

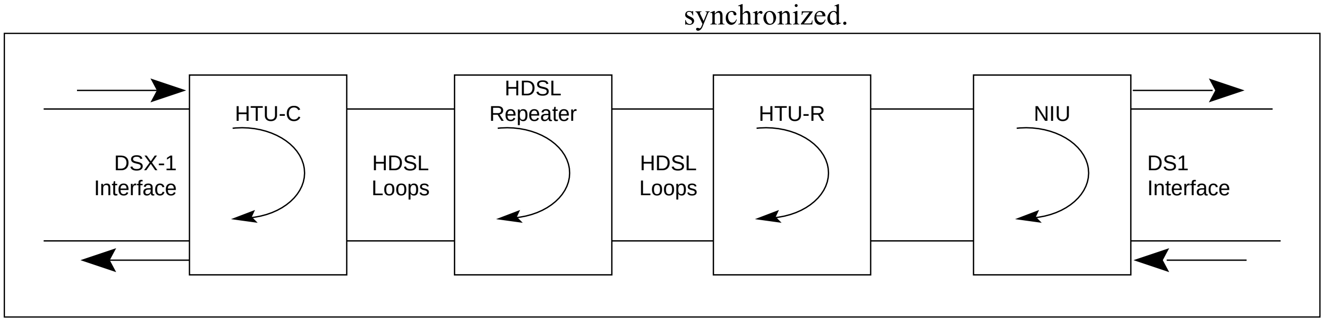


Figure A-1. HDSL Loopback Points

Loopback Process

In general, the loopback process for the HDSL system elements is modeled on the corresponding DS1 system process. Specifically, the HTU-C loopback is similar to an intelligent office repeater loopback and the HTU-R loopbacks are similar to an inline T1 repeater loopback.

Each HDSL system element is independently described by the state diagram shown in Figure A-2. The four states are disarmed, loop-up, armed, and loop-up/timeout-disable.

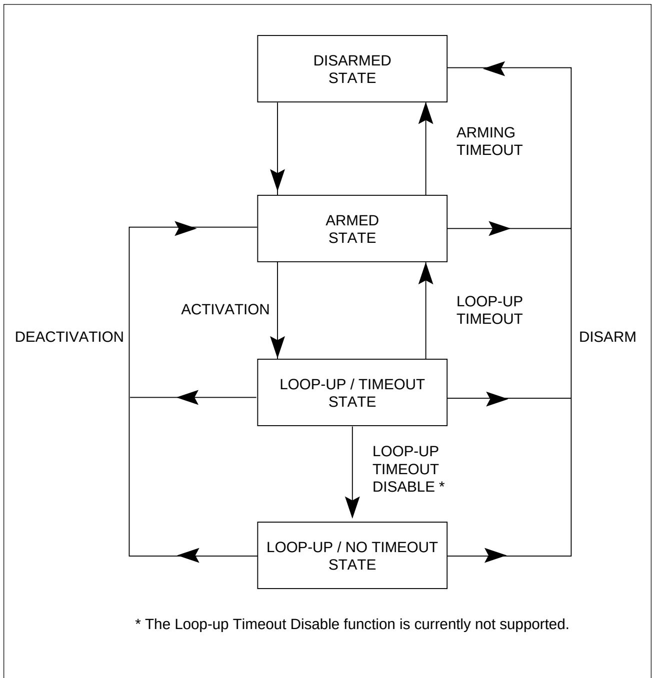


Figure A-2. HDSL Element State Diagram

State transitions result from in-band, ESF data link sequences, and timeout operations. The sequences and timeouts are as follows:

- Arming (in-band and ESF)
- Activation
- Deactivation
- Disarming (in-band and ESF)
- Loop-up Timeout
- Arming Timeout

A summary of timeout and control sequences is given in Table A-1.

In-band control code sequences are transmitted over the DS1 link by either the unframed or overwrite method. The HDSL elements respond to either method.

The unframed method produces periodic control sequences, and the normal DS1 framing bit is omitted.

The overwrite method produces periodic control sequences. However, once per frame, the framing bit overwrites one of the bits in the control sequence.

The unit can detect the loopback activation or deactivation code sequence *only* if an error rate of $1E^{-03}$ or better is present.

In all control code sequences presented, the in-band codes are shown leftmost bit transmitted first, and the ESF data link codes with rightmost bit transmitted first.

Disarmed State

The disarmed state is the normal mode of operation. Each HDSL element is transparent to the data flow. However, the in-band data flow and the ESF data link are monitored for the arming sequence.

The in-band control code sequence used to simultaneously arm the loopback capability of all HDSL elements is the standard 5-bit in-band sequence used for NIU Smartjack loop-up. Each HDSL element arms after receiving the following code for five seconds:

Arm Sequence

11000 for 5 seconds

The arming process ensures unambiguous race-free operation of HDSL element arming and Smartjack loop-up. The HDSL unit can detect the sequence without interfering with the detection by the Smartjack. Presently, the Smartjack loop-up response requires a duration of at least five seconds. The objective of the HDSL detection scheme is to arm the HDSL elements without interfering with the Smartjack loop-up.

The requirement imposed on the arm sequence is that the Smartjack should loop-up and all HDSL elements make a transition from the disarmed state into the armed state. All other control code sequences are ignored in the disarmed state.

Table A-1. HDSL Standard Loopback Control Codes

Name	Code	Detection Time	Comments
Arming (In-band) Arming (ESF)	11000 0001 0010 1111 1111	5 Seconds 4 Repetitions	Signal sent in-band or over ESF data link. HDSL elements in disarmed state make transition to armed state. Detection of either code results in Smartjack loop-up, if NIU loopback is enabled.
Activation (HTU-C) Activation (HDSL Range Extender) Activation (HTU-R)	1101 0011 1101 0011 1100 0111 0100 0001 1100 0111 0100 0010	> 4 Seconds > 4 Seconds > 4 Seconds	Signal sent in-band. HDSL elements in armed state make transition to loop-up state. Loop-up state timeout is programmable from the HTU-C.
Deactivation (all HDSL elements)	1001 0011 1001 0011	> 5 Seconds	Signal sent in-band. HDSL element in loop-up state makes transition to armed state.
Disarming (In-band) Disarming (ESF)	11100 0010 0100 1111 1111	5 Seconds 4 Repetitions	Signal sent in-band or over ESF data link. HDSL elements in any state make transition.
Arming Timeout	N/A	2 Hours	HDSL elements in armed state make transition to disarmed state.
Loop-up Timeout	N/A	Programmable from HTU-C: None, 20, 60, or 120 minutes	HDSL element in loop-up makes transition to armed state.

The ESF data link sequence used to simultaneously arm the loopback capability of all HDSL elements is the standard 16-bit ESF data link sequence used for NIU Smartjack loop-up.

ESF Arm Sequence
0001 0010 1111 1111
for 4 repetitions

Race-free operations of the HDSL element arming and Smartjack loop-up is accomplished as described for the in-band code. For example, the ESF arm sequence causes the Smartjack to loop-up and all of the HDSL elements to move from the disarmed state into the armed state. All other ESF data link control code sequences are ignored in the disarmed sate.

Armed State

In the armed state, the HDSL system element continues to be transparent to data flow. However, the in-band data flow is monitored for the activation and disarming sequences. The ESF data link is monitored for the disarming sequence.

All other in-band and ESF data link control code sequences are ignored in the armed state. An arming timeout value causes automatic return to the disarmed state.

Transition from armed to loop-up state: An in-band control code sequence is used to command a specific HDSL element to move from the armed state into the loop-up state. Each HDSL element has a unique 16-bit activation control code sequence as shown in the following example:

HTU-C Activation Sequence
101 0011 1101 0011

HTU-R Activation Sequence
1100 0111 0100 0010

The designated HDSL element will loop-up after receiving the proper activation sequence.

Transition from armed to disarmed state: All HDSL elements can be commanded to move from the armed state into the disarmed state by the standard 5-bit in-band disarming sequence used for NIU Smartjack loop-down. Each HDSL element must disarm after receiving the following code for five seconds:

Disarm Sequence
11100

The disarming process ensures race-free operation of HDSL element disarming and Smartjack loop-down. Duration of the disarm sequence may need to exceed 24 seconds to allow detection and loop-down of up to three HDSL elements and the Smartjack.

All HDSL elements can be commanded to move from the armed state into the disarmed state by the ESF DATA LINK disarming sequence used for NIU Smartjack loop-down as follows:

<u>ESF Disarm Sequence</u>
0010 0100 1111 1111
for four repetitions per element in loopback

The disarming process ensures race-free operation of HDSL element disarming and Smartjack loop-down. Duration of the disarm sequence may need to exceed 16 repetitions to allow detections and loop-down of up to three HDSL elements and the Smartjack. This sequence will loop-down the Smartjack and the HDSL element.

All HDSL elements will automatically move from the armed state into the disarmed state when a default timeout value of two hours is reached.

<u>Arming Timeout</u>
2 Hours

Loop-up State

In the loop-up state, the selected HDSL element provides continuous loop-up of the DS1 signal. However, the data flow is monitored for the in-band deactivation sequence, the in-band disarming sequence, and the ESF data link disarming sequence. Also, a loop-up timeout value causes automatic return to the armed state. All other control code sequences are ignored in the loop-up state.

Transition from loop-up to armed state: Any HDSL element can be commanded to move from the loop-up state into the armed state by a single in-band 16-bit deactivate control code sequence. The same deactivation sequence as shown is used for all HDSL elements.

<u>Deactivation</u>
After receiving sequence for > 5 seconds

Duration of the deactivation sequence may need to exceed 18 seconds to allow detection and loop-down of up to three HDSL elements. The deactivation sequence does not disarm the HDSL elements. They can still respond to activation sequence control codes. All HDSL elements automatically move from the loop-up state into the armed state when the selected loop-up timeout value is reached.

<u>Loopup Timeout</u>
programmable from HTU-C at
None, 20, 60, or 120 minutes

Transition from loop-up to disarmed state: All HDSL elements can be simultaneously commanded to move from the loop-up state into the disarmed state by either the standard 5-bit in-band disarming sequence used fro NIU Smartjack loop-down, or by the ESF DATA LINK command, as previously described.

2. Enhanced Loopbacks

HDSL Maintenance Modes

This subsection describes operation of the HDSL system with regard to detection of in-band and ESF facility data link loopback codes.

Upon deactivation of a loopback, the HDSL system will synchronize automatically. Note that the synchronization process of the HDSL system upon deactivation of the HRE loopback could take up to 15 seconds, ensuring all system elements are synchronized.

Loopback Process Description

In general, the loopback process for the HDSL system elements is modeled on the corresponding DS1 system process. Specifically, the HTU-C loopback is similar to an Intelligent Office Repeater loopback and the HTU-R loopbacks are similar to an in-line T1 Repeater loopback.

In-band control code sequences are transmitted over the DS1 link by either the *unframed* or *overwrite* method. The HDSL elements respond to either method.

The unframed method produces periodic control sequences and the normal DS1 framing bit is omitted.

The overwrite method produces periodic control sequences. However, once per frame, the framing bit overwrites one of the bits in the control sequence.

The unit can detect the loopback activation or deactivation code sequence *only* if an error rate of $1E^{-03}$ or better is present.

DDS Latching Loopback Operation

If the unit is optioned for FT1 mode, then DDS Latching Loopback operation is supported as described in Bellcore TA-TSY-000077, Issue 3, Section 5.1.3. The HTU-C and any HRE units which are in the HDSL circuit are treated as Identical Tandem Dataports and the HTU-R is treated as a Different Tandem Dataport. For a complete description of the DDS Latching Loopback codes, refer to Bellcore TA-TSY-000077, Issue 3, Section 5.1.3.

Loopback Control Codes

A summary of control sequences is given in Tables A-2 and A-3.

NOTE: In all control code sequences presented, the in-band codes are shown left-most bit transmitted first, and the ESF data link codes with right-most bit transmitted first.

Table A-2. HDSL Loopback Control Codes

Source	Code	Name
Abbreviated	(N) 3in7 (1110000)	Loopback data from network toward network in the HTUR.
	(N) 4in7 (1111000)	Loopback data from network toward network in the HTUC.
	(N) 2in6 (110000)	Loopback data from network toward network in first HRE.
	(N) 3in6 (111000)	Loopback data from network toward network in second HRE.
	(C) 6in7 (1111110)	Loopback data from customer toward customer in HTUC.
	(C) 5in7 (1111100)	Loopback data from customer toward customer in HTUR.
	(C) 4in6 (111100)	Loopback data from customer toward customer in first HRE.
	(C) 5in6 (111110)	Loopback data from customer toward customer in second HRE.
	(N) FF1E	Loopback data from network toward network at HTUC.
Wescom	(C) 3F1E	Loopback data from customer toward customer at HTUC.
	(N) FF04	Loopback data from network toward network at HRE1.
	(N) FF06	Loopback data from network toward network at HRE2.
	(C) 3F04	Loopback data from customer toward customer at HRE1.
	(C) 3F06	Loopback data from customer toward customer at HRE2.
	(N) FF02	Loopback data from network toward network at HTUR.
	(C) 3F02	Loopback data from customer toward customer at HTUR
	(N) 1in6 (100000)	Loopback data from network toward network at HTUR.
	(N) .... FF48 (ESF-DL)	Loopback data from network toward network at HTUR.
	(N/C) 1in3 (100)	Loopdown everything.
	(N/C) FF24 (ESF-DL)	Loopdown everything.

Notes:
The Source column indicates which side of the interface the control codes are sent from. For example, an (N) indicates a network sourced code while a (C) indicates a customer sourced code.
All codes are inband unless labeled ESF-DL
All codes listed above must be sent for a minimum of 5 seconds in order for them to be detected and acted upon.

Table A-3. Inband Addressable Loopback Codes

Function	Code	Response
ARM	11000 (also known as a 2-in-5 pattern)	The HTU-R will loopup towards the network. No AIS or errors will be sent as a result of this loopback. The HTU-C and HRE will ARM.
DISARM	11100 (also known as a 3-in-5 pattern)	The HTU-C and HRE are removed from the armed state. If any of the units are in loopback when the 11100 pattern is received, they will loopdown. The LBK LEDs will turn off on all units.
HTU-C NETWORK LOOPUP	D3D3 (1101 0011 1101 0011)	If the units have been armed and no units are in loopback*, the HTU-C will loopup towards the network, 2 seconds of AIS (all 1s) will be sent, 5 seconds of data will pass, and then 231 bit errors will be injected into the DSX-1 signal. As long as the pattern continues to be sent, 231 errors will be injected every 20 seconds. When the pattern is removed, the unit will remain in loopback. If the pattern is reinstated, the injection of 231 bit errors will resume at 20 second intervals.
HRE1 NETWORK LOOPUP	C741 (1100 0111 0100 0001)	If an HRE is present, the units have been armed, the HRE will loopup towards the network, 2 seconds of AIS (all 1s) will be sent, 5 seconds of data will pass, and then 10 bit errors will be injected into the DSX-1 signal. As long as the pattern continues to be sent, 10 errors will be injected every 20 seconds. When the pattern is removed, the unit will remain in loopback. If the pattern is reinstated, the injection of 10 bit errors will resume at 20 second intervals.
HRE2 NETWORK LOOPUP	C754 (1100 0111 0101 0100)	If a second HRE is present, the units have been armed, the HRE will loopup towards the network, 2 seconds of AIS (all 1s) will be sent, 5 seconds of data will pass, and then 200 bit errors will be injected into the DSX-1 signal. As long as the pattern continues to be sent, 200 errors will be injected every 20 seconds. When the pattern is removed, the unit will remain in loopback. If the pattern is reinstated, the injection of 200 bit errors will resume at 20 second intervals.
LOOPDOWN	9393 (1001 0011 1001 0011)	Any HTU-C and HRE units currently in loopback towards the network will loopdown and will not attain the armed state.
QUERY LOOPBACK	D5D5 (1101 0101 1101 0101)	If the units are armed and the HTU-C, HRE, or HTU-R are in network loopback, errors are injected into the DSX-1 signal upon detection of the query loopback pattern. As long as the pattern continues to be sent, errors are injected again every 20 seconds. The number of errors injected each time depends on which unit is in loopback. 231 errors are injected if the HTU-C is in network loopback, 20 at a time if the HTU-R is in network loopback, and 10 at a time if HRE #1 is in network loopback, and 200 at a time if HRE #2 is in network loopback.
LOOPBACK TIMEOUT OVERRIDE	D5D6 (1101 0101 1101 0110)	If the units are armed and this pattern is sent, the loopback timeout will be disabled. The timeout option will be updated on the PROVISIONING menu of the HTU-R (viewable through the RS-232 port) to NONE. As long as the units remain armed, the timeout will remain disabled. When the units are disarmed, the loopback timeout will return to the value it had before the D5D6 code was sent.
SPAN POWER DISABLE	6767 (0110 0111 0110 0111)	If the units are armed and this pattern is sent, the HTU-C will deactivate its span power supply, turning off the HTU-R and HRE (if present). As long as the pattern continues to be sent, the span power supply will remain disabled. When the pattern is no longer being sent, the HTU-C will reactivate its span power supply, turning the remote unit(s) on. All units will retrain and return to the disarmed and unlooped state.

Note: all codes listed above must be sent for a minimum of 5 seconds in order for them to be detected and acted upon.
* If NIU is enabled, then the HTU-R can be in network loopback when the HTU-C or HRE loopup codes are sent.