ADTRAN AHT1U
LOW VOLTAGE ASYNCHRONOUS HTU-C LINE CARD
FOR DSC COMMUNICATIONS CORPORATION
LITESPAN® CHANNEL BANK ASSEMBLIES
INSTALLATION/MAINTENANCE

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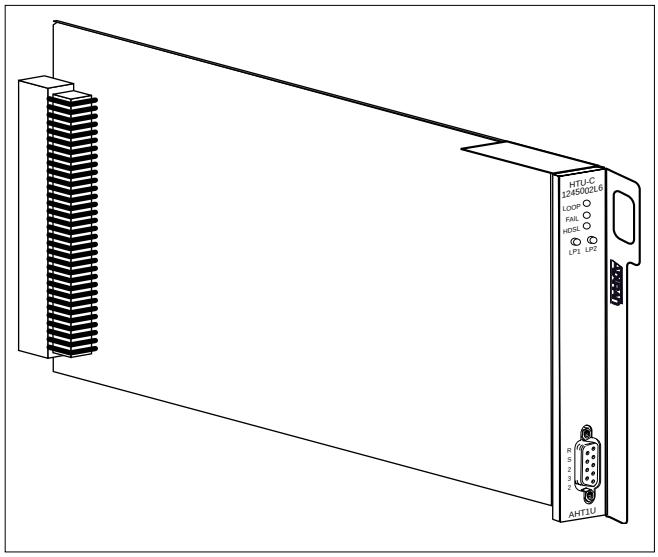

Figure 1. ADTRAN AHT1U

1. GENERAL

The ADTRAN Low Voltage asynchronous Litespan HDSL Transceiver Unit for the Central Office (HTU-C) list 6, is a DS1 interface unit that provides full T1 service over 4-wire interface facilities. The Low Voltage Litespan HTU-Cs combine ADTRAN HDSL technology and DSC Litespan technology to provide an HDSL interface to a Litespan system.

ADTRAN's Low Voltage Litespan HTU-C is certified by DSC to safely operate in Litespan 2000 and Starspan systems. The unit is licensed under the Asynchronous High-bit-rate Digital Subscriber Line TI Interface Unit (AHT1U) channel unit type. Figure 1 is an illustration of the ADTRAN AHT1U.

Features

- RS-232 maintenance port
- Lightning and power cross-protection, static discharge immunity, and local power bus fusing for line card safety and protection
- 784 kbps dual duplex 2B1Q HDSL transmission over two wire pairs
- Front panel status LED
- Performance monitoring and alarm reporting
- Low power consumption
- -135 volt span powering capability of the Low Voltage HRE and HTU-R
- Corrosion-preventive sealing current over both twisted copper pairs
- Troubleshooting functionality

Asynchronous counterparts to the Litespan HTU-C (AHT1U) are the asynchronous DSX-1 interface unit (ADS1U) and the asynchronous T1 interface unit (AT1U). ADTRAN provides the AHT1U (P/N 1245002L6) for connection to narrowband and wideband service pairs.

The List 6 provides the most flexibility for installations where the narrowband/wideband service connection is not known. It also provides flexibility of switching between narrowband and wideband services without needing a different HTU-C.

CAUTION

If the List 6 is used in applications where narrowband and wideband copper service wire pairs are connected simultaneously, only one service pair may have terminating equipment connected to the HTU-C. Also, copper service wire pairs not in use are considered as bridge taps to the HDSL loops in service and should be entered into the deployment calculations listed in subsection 6 of this practice. If the bridged taps presented by the unused loop violates the CSA guidelines, the unused pair should be disconnected.

Each ADTRAN Litespan HTU-C line card provides a 1.544 Mbps data transport over two unconditioned CSA copper pairs that are in accordance with TA-NWT-001210. These CSA loops can range up to 12 kft of 24-AWG twisted pair wire. All comply with Bellcore GR1089-CORE, UL1459, FCC Class A subpart J, and DSC requirements for a generic subscriber interface unit.

The Litespan HTU-C can be used in Litespan 2000, Litespan 2012, and Litespan ONU channel bank assembly (CBA) systems containing Litespan system software versions of 7.1.3 or higher. Each HTU-C works with the following multiple list versions of the HDSL unit remote end (HTU-R), and HDSL Range Extender (HRE):

- 1245024L1, Low Voltage T400 HTU-R
- 1245021L1, Low Voltage HTU-R T200 circuit pack
- 1245026L1 - L7, Low Voltage HTU-R T200, DB9
- 1244021L1, Low Voltage HTU-R T400 circuit pack
- 1244022L1, Low Voltage HTU-R standalone
- 1244041LX, Low Voltage T400 HRE
- 1244042L1, Low Voltage 819A HRE
- 1244044L1, Low Voltage 439 HRE

The HTU-C can be deployed in circuits consisting of one HTU-C and one HTU-R. When deployment requires the HRE, which doubles the service range, the HTU-C can be deployed with one Low Voltage HRE (T400, 819A, or 439) and one Low Voltage HTU-R.

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

Lightning and power cross-protection is provided at each twisted pair interface of the ADTRAN HTU-C line card. Local power bus fusing is also used to protect the Litespan channel bank backplane, Litespan bank power supplies, and neighboring Litespan line cards in the event of catastrophic line card failure.

The Litespan HTU-C uses a DC-to-DC converter to derive span powering voltage from the Litespan -48 VDC switched battery supply. The Litespan HTU-C can span power HREs and HTU-Rs as listed above.

Simplex current of 30 to 155 mA of current may be coupled onto the HDSL loop span to power the HTU-R and HRE when deployed (see Figure 2). Span powering voltages meet all requirements of Class A2 voltages as specified by Bellcore GR-1089-CORE.

Revision History

This practice has been reissued to incorporate new wording in the features subsection.

2. APPLICATIONS

The ADTRAN HDSL system provides a cost-effective alternative for deploying T1 service over metallic cable pairs. In contrast with traditional T1 service equipment, ADTRAN HDSL can be successfully deployed over two unconditioned, non-loaded, bridged-tapped copper pair CSA loops (see subsection 6 of this practice).

Litespan HDSL deployment is typically made from a Litespan 2000, Litespan 2012, or Litespan ONU channel bank assembly. Figure 3 shows possible ADTRAN HDSL deployments from a Litespan channel bank assembly.

ADTRAN HDSL systems can be deployed quickly without the use of expensive T1 repeater equipment on standard CSA loops while using the existing massive copper-fed twisted line pairs in use by the industry.

ADTRAN uses negative ground-referenced span powering voltage (-135 VDC) on HDSL loop 2 while loop 1 remains at ground. This prevents corrosion associated with positive ground reference voltage while providing power for the HTU-R. HTU-R span powering can be disabled to allow locally-powered HTU-R applications, if desired.

If normal CSA loops need expanding beyond the maximum range of an HTU-C/HTU-R HDSL system, a span-powered HRE can be added to effectively double the HDSL serving area. Addition of a span-powered HRE still allows span powering to be passed through to a span-powered HTU-R, providing a totally span-powered HDSL system. However, addition of an HRE adds to the total power consumption from the Litespan channel bank assembly and requires recalculation of the power budget deployment guidelines (see subsection 6). HRE deployment may limit total Litespan linecard deployment.

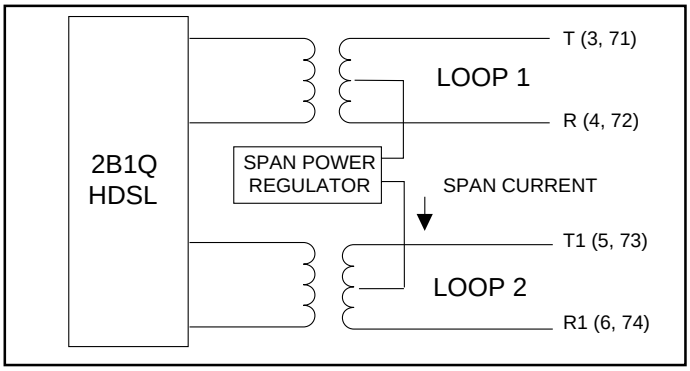

Figure 2. HTU-C Span Powering Diagram

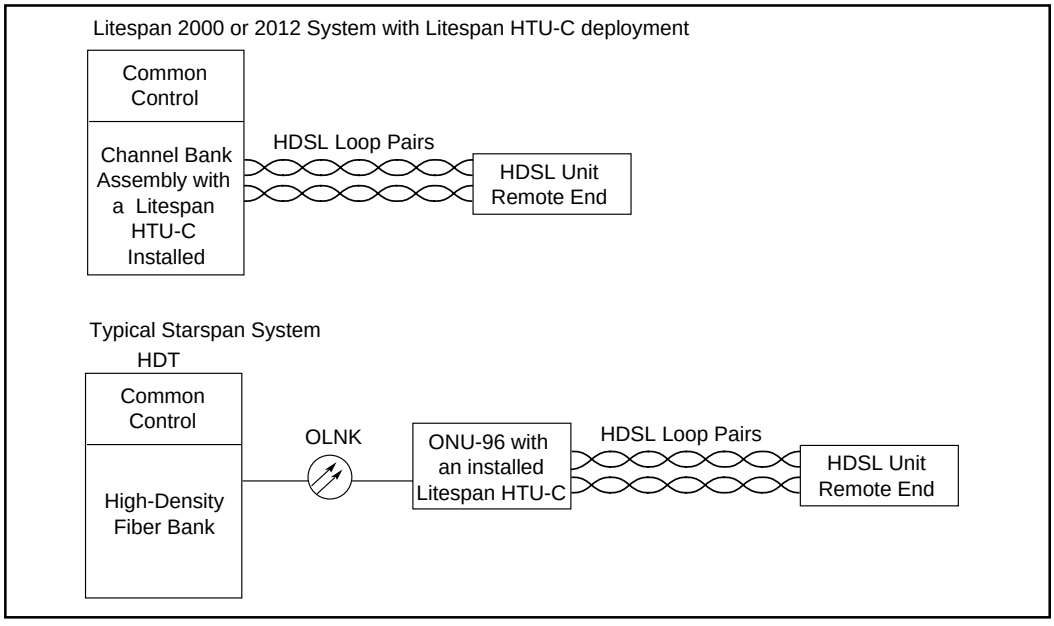

Figure 3. Deployments from a Litespan Channel Bank Assembly

3. INSTALLATION

After unpacking the unit, inspect it for possible shipping damage. Make sure the desired Litespan HTU-C list number appears at the top of the faceplate. If damage is discovered, file a claim immediately with the carrier, then contact ADTRAN Customer Service (see subsection 10 of this practice).

The Litespan HTU-C plugs directly into a Litespan channel bank assembly channel unit slot. Litespan system software must be 7.1.3, or higher. See Figure 4 for card edge connections.

Upon insertion of an HTU-C, the FAIL LED should turn *on* immediately. The FAIL LED will remain *on* until the Litespan bank recognizes the insertion of the card and downloads the AHT1U channel unit type code into the linecard. Typically, the FAIL LED will remain *on* for approximately 15 to 20 seconds (time may vary). Approximately 3 to 4 seconds after the FAIL LED turns *off*, the HDSL LED will turn *on red* and remain so until the HTU-C and HTU-R units synchronize with each other over both HDSL loops.

CAUTION

Prior to installing or removing the Low Voltage Litespan HTU-C, make sure to observe the following warning:

If the Low Voltage Litespan HTU-C is removed from a linecard slot, wait at least 15 seconds before reinsertion If connected to the MTI craft interface terminal, wait until the message "AID:MJ,UEQ.."appears (where "AID" is the access identifier). This informs the Litespan common control assembly that the HTU-C has been removed from its slot, after which the common control assembly begins looking for the reinsertion of the linecard. Reinsertion any earlier than this may temporarily lock the HTU-C into a nonfunctional state because the common control assembly will not send the AHT1U equipment type code to the HTU-C linecard.

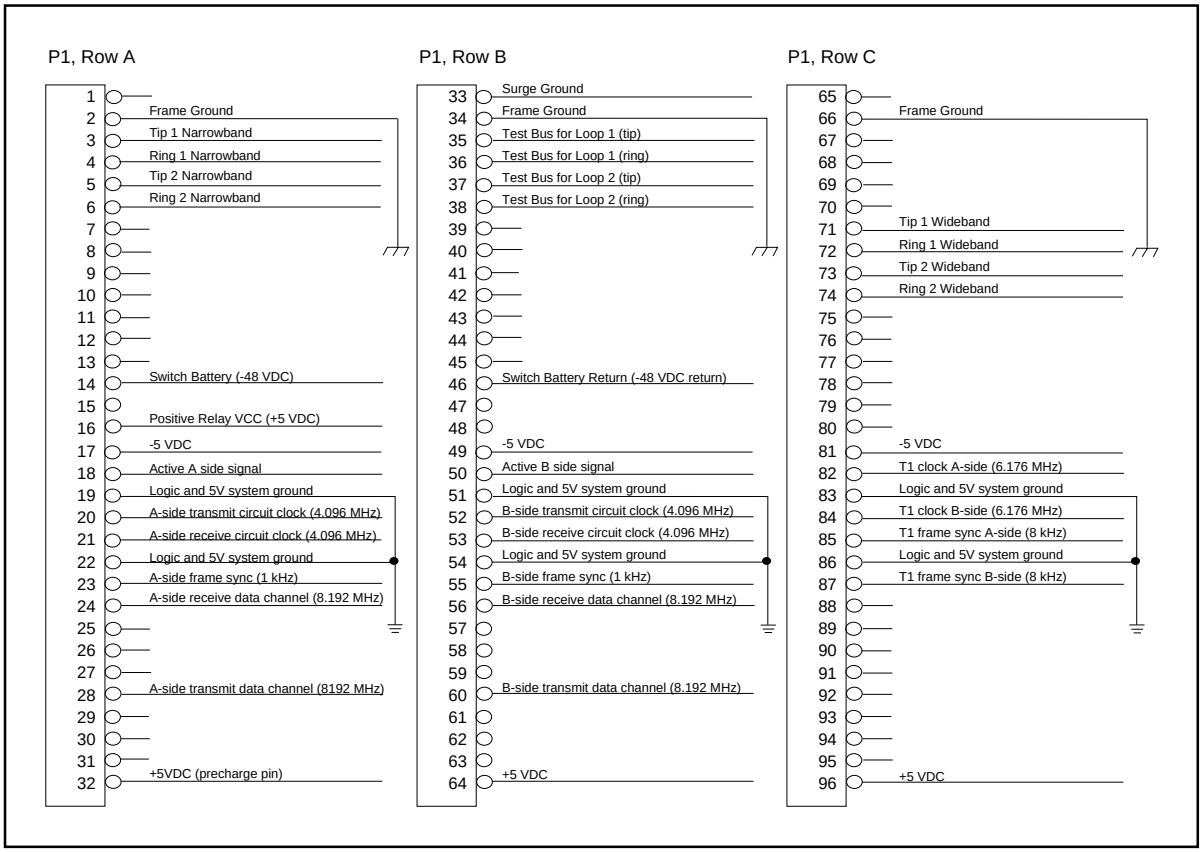

Figure 4. HTU-C Card Edge Connections

Provisioning

The Litespan HTU-C is provisioned in two steps. First, local HTU-C provisioning is set using the RS-232 port. Typical T1 provisioning options are set for the Litespan HTU-C.

Second, Litespan system provisioning through a Litespan craft interface port allows a data cross-connection between the Litespan HTU-C and another linecard in the asynchronous T1 linecard class or another Litespan HTU-C. If the cross-connected unit is *not* an HTU-C, then T1 provisioning of the cross-connected unit may be accomplished through the Litespan craft interface port. If the cross-connected unit is another Litespan HTU-C, however, provisioning of the cross-connected unit must be performed at the front panel craft interface port.

For complete Litespan cross-connection provisioning information, refer to TL1 software documentation release 7.1, or higher.

4. CONTROL PORT OPERATION

The Litespan HTU-C provides a faceplate-mounted female DB9 connector that supplies an RS232 interface for connection to a controlling terminal. The pinout of the DB9 is illustrated in Figure 5. The linecard must be provisioned through the control port. Switches or jumpers are not provided.

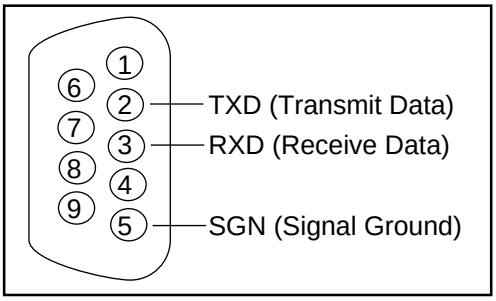

Figure 5. RS232 (DB9) Connector

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.

NOTE

If you are using a personal computer (PC) with terminal emulation capability, be sure to disable any power saving programs. Otherwise, communication between the PC and the HDSL unit may be disrupted, resulting in misplaced characters or screen timeouts.

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

Table A. 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 occur
	ESF — Second in which 1544 BPVs or 320 CRC errors occur
	HDSL — Second in which a 165 CRC error 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	Fifteen-minute period
24H	Twenty-four-hour period

The screens illustrated in Figures 6 through 14 are for an HDSL circuit deployed with ADTRAN HDSL technology. The circuit includes an HTU-C, HTU-R and HRE for inclusiveness of functionality. Other configurations are possible and their displays will vary slightly from those shown in this section.

Initiate a terminal session by entering multiple space bar characters; the number of which will determine the speed of the terminal. Once the speed has been determined, an Introductory Menu will appear.

From the Introductory Menu, the Main Menu may be selected. The Main Menu provides access to detailed performance and configuration information, as shown in Figure 6, HDSL Main Menu Screen.

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

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

Current System Status

The Current System Status screens, illustrated in Figures 7 and 8, provide quick access to status information for both the HTU-C and HTU-R. Type "H" to view the Current System Status screen for the HRE, illustrated in Figure 7.

The Elapsed Time display indicates the period of time since the unit began collecting performance information. At each 15-minute interval, the performance information is transferred to the 15-minute performance data register accessed from the Performance History screen. At each 24-hour interval, the performance data is transferred into the 24-hour performance data register also accessed using the Performance History screen.

At the Current System Status screen, type "Z" to reset the performance registers to zero at both the Current System Status and Performance History screens.

Figure 8 consolidates 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
SYNC ..... HDSL loop 1 and loop 2 sync status
ES 15M/24H ..... Errored seconds [1]
SES 15M/24H ... Severely errored seconds [1]
UAS 15M/24H .. Unavailable seconds [1]

An indication of pair reversal (if present) appears 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 coded 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 (DSX1- and DS1)
ES ..... Errored seconds (DSX1- and DS1)
SES ..... Severely errored seconds (DSX1- and DS1)
UAS ..... Unavailable seconds (DSX1- 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 as follows:

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

Predicting performance based upon signal quality varies with each loop. Generally, a noise margin of 0 or higher will support a bit error rate (BER) of better than 10^{-7}.

[1] 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).

Performance Monitoring

The Performance History screen is shown in Figures 9 and 10. Type "H" to view the Performance History screen for the HRE. See Figure 9 for the HRE Performance Monitoring screen. Type "H" to select the view number from the view location diagram located at the lower left of the screen to see the performance monitoring information collected at every receiver location throughout the Low Voltage HDSL system.

Once all performance monitoring locations have filled up (after initial powerup), each successive performance monitoring register update overrides the oldest performance monitoring data. The current performance monitoring registers are indicated by the key at the center of the screen. Previous performance monitoring registers are also indicated by the key at the center of the screen. Each previous performance monitoring register has a minus sign followed by a number. A number "5" in the 24-hour register, for example, represents 24-hour data from five 24-hour periods ago. A number "2" in the 15-minute register represents 15-minute data taken from two 15-minute periods ago.

Loopback Options

The HDSL loopback screens are illustrated in Figure 12. Terminate or evoke loopbacks using these screens. Refer to Appendix A for detailed HDSL loopback information.

Control Port Provisioning

During a terminal session, type "5" from the Main menu to view the Provisioning screen, illustrated in Figure 13. This screen displays the current system configuration and allows for changing this configuration. Provisioning changes are only allowed at the Litespan HTU-C and not at the HTU-R. The HTU-R provisioning is set directly from the provisioning information entered at the HTU-C. The HTU-C stores its provisioning information in an EEPROM so that it remembers the past provisioning changes to determine its operating mode in the event of power loss to the HTU-C.

Provisioning options 6 through 9 will not appear on the HTU-R provisioning screen, and the alarm setting provision on the HTU-R provisioning screen is meaningless in a Litespan environment and should be ignored.

DSX-1 in the HDSL screens actually refers to a virtual DS1 channel provided by the time slot interchanger unit (TSI) of the Litespan CBA to the Litespan linecard (see DSC Litespan documentation for more detail). The actual DSX-1 monitoring point is at the T1 framer onboard the HTU-C linecard.

This monitoring point receives the DS1 cross-connected data recovered from the DS1 virtual tributary presented to the linecard.

The asynchronous DS1 gate array on the HTU-C line card is responsible for providing the DS1 cross-connected data that is recovered from the DS1 virtual tributary.

Provisioning options are summarized in Table B. Each option may be changed to any one of the listed settings.

Troubleshooting

The Troubleshooting screen, illustrated in Figure 14, graphically depicts 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.

```
CIRCUIT ID: EMUL                                          10/06/98  00:25:00

                              ADTRAN HDSL MAIN MENU


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




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

Figure 6. HDSL Main Menu Screen

```
CIRCUIT ID: XXX                                              10/06/98  09:22:14
LOOP #1 <NETWORK> LOOP #2    CURRENT SYSTEM STATUS    LOOP #1 <CUSTOMER>LOOP #2
-------- HRE  #1 --------                             -------- HRE  #1 --------
30(30) dB       31(31) dB    <-  LOSS  CUR(MAX) ->    31(31) dB       30(30) dB
   YES             YES       <-  SYNC           ->       YES             YES
000/00000       003/00003    <-  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                                   LOOPBACK  INACTIVE

                         N = NETWORK SIDE RECEIVER
  HRE1 NET MARGIN (dB)   C = CUSTOMER SIDE RECEIVER      HRE1 CST MARGIN (dB)
        CUR/MIN/MAX                                           CUR/MIN/MAX

                    ____                ____                ____
    LP1   12/00/00  |HTUC|  LOOP1   |HRE1|   LOOP1  |HTUR|    LP1   13/00/00
    LP2   13/00/00  |    |========N|    |C========|    |    LP2   16/00/00
                    |    |         |    |         |    |
                    |    |========N|    |C========|    |
                    |____|  LOOP2  |____|   LOOP2 |____|


       Press “Z” to zero registers, “X” to restart MIN/MAX, “M” for Main Menu
             “P” for previous view.
```

Figure 7. Current System Status, HRE Dual Loop Screen

```
LOOP #1 <NETWORK> LOOP #2    CURRENT SYSTEM STATUS    LOOP #1 <CUSTOMER>LOOP #2
--------- HTU-C ---------                             --------- HTU-R ---------
31(31) dB       30(30) dB    <-  LOSS  CUR(MAX) ->    31(31) dB       31(31) 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

                          DSX-1                     DS1
  HTU-C MARGIN (dB)      ------------------------------    HTU-R MARGIN (dB)
        CUR/MIN/MAX      ESF     <-  FRAME ->     ESF            CUR/MIN/MAX
                         B8ZS    <-  CODE  ->    B8ZS
    LP1   11/09/12       N/A     <-  LBO   ->    0 dB       LP1   13/13/14
    LP2   12/11/12       N/A     <-  NIU   ->     YES       LP2   14/13/15
                         00000   <-  BPV   ->   00000
                         00000   <-  ES    ->   00000
                         00000   <-  SES   ->   00000
                         00000   <-  UAS   ->   00000
                         NONE    <- ALARMS ->    NONE
                            SEALING CURRENT PRESENT
       Press “Z” to zero registers, “X” to restart MIN/MAX, “M” for Main Menu.
```

Figure 8. Current System Status, Dual Loop Screen

```
CIRCUIT ID: XXX                                              10/06/98  09:23:09
      24 HOUR REGISTERS     PERFORMANCE HISTORY     15 MINUTE REGISTERS
     ---ES---SES--UAS-                          --ES-SES-UAS----ES-SES-UAS-
      00000 00000 00000   <---CURRENT--->         000 000 000
10/05 ----- ----- -----   <--          -->  09:15 000 000 000  05:15 --- --- ---
10/04 ----- ----- -----     |          |    09:00 --- --- ---  05:00 --- --- ---
10/03 ----- ----- -----     |          |    08:45 --- --- ---  04:45 --- --- ---
10/02 ----- ----- -----     |          |    08:30 --- --- ---  04:30 --- --- ---
10/01 ----- ----- -----     |PREVIOUS  |    08:15 --- --- ---  04:15 --- --- ---
09/30 ----- ----- -----     |          |    08:00 --- --- ---  04:00 --- --- ---
09/29 ----- ----- -----   <--          |    07:45 --- --- ---  03:45 --- --- ---
                                       |    07:30 --- --- ---  03:30 --- --- ---
VIEW 1 : HRE NETWORK LP1               |    07:15 --- --- ---  03:15 --- --- ---
                                       |    07:00 --- --- ---  03:00 --- --- ---
-->|H|<-----1->|H|<-2----->|H|-->     |    06:45 --- --- ---  02:45 --- --- ---
   |T|         |R|          |T|        |    06:30 --- --- ---  02:30 --- --- ---
   |U|         |E|          |U|        |    06:15 --- --- ---  02:15 --- --- ---
<--|C|<-----3->|1|<-4----->|R|<--     |    06:00 --- --- ---  02:00 --- --- ---
                                       |    05:45 --- --- ---  01:45 --- --- ---
Press view number to select view       -->  05:30 --- --- ---  01:30 --- --- ---
                          Press “P” for previous view
                         Press “B” to go back 8 hours

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

Figure 9. HRE Performance History, Dual Loop Screen

```
CIRCUIT ID: XXX                                              10/06/98  09:18:35
      24 HOUR REGISTERS     PERFORMANCE HISTORY     15 MINUTE REGISTERS
     ---ES---SES---UAS---                      ---ES-SES-UAS-----ES--SES--UAS-
      00000 00000 00000   <-- CURRENT -->        000 000 000
10/05 ----- ----- -----   <--          -->  09:15 000 000 000  05:15 --- --- ---
10/04 ----- ----- -----     |          |    09:00 --- --- ---  05:00 --- --- ---
10/03 ----- ----- -----     |          |    08:45 --- --- ---  04:45 --- --- ---
10/02 ----- ----- -----     |          |    08:30 --- --- ---  04:30 --- --- ---
10/01 ----- ----- -----     |PREVIOUS  |    08:15 --- --- ---  04:15 --- --- ---
09/30 ----- ----- -----     |          |    08:00 --- --- ---  04:00 --- --- ---
09/29 ----- ----- -----   <--          |    07:45 --- --- ---  03:45 --- --- ---
                                       |    07:30 --- --- ---  03:30 --- --- ---
VIEW 1 : HTU-C DSX-1                   |    07:15 --- --- ---  03:15 --- --- ---
                                       |    07:00 --- --- ---  03:00 --- --- ---
1->|H|<--3----LOOP1----4-->|H|-->      |    06:45 --- --- ---  02:45 --- --- ---
   |T|                     |T|         |    06:30 --- --- ---  02:30 --- --- ---
   |U|                     |U|         |    06:15 --- --- ---  02:15 --- --- ---
<--|C|<--5----LOOP2----6-->|R|<--2     |    06:00 --- --- ---  02:00 --- --- ---
                                       |    05:45 --- --- ---  01:45 --- --- ---
Press view number to select view       -->  05:30 --- --- ---  01:30 --- --- ---

                          Press “B” to go back 8 hours

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

Figure 10. Performance History, Dual Loop Screen

```
CIRCUIT ID: XXX                                              10/06/98  08:57:23

                                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                       HTU-R INFORMATION
-----------------                      ------------------
S/N :                                   S/N :
CLEI:                                   CLEI:
MANF:   /                               MANF:









                          Press “M” to view Main Menu.
```

Figure 11. ADTRAN Information, Dual Loop Screen

```
CIRCUIT ID: XXX                                              10/06/98  09:23:42
                              LOOPBACK OPTIONS

                 _____                 _____                 _____
            |HTU-C|               |HRE 1|               |HTU-R|
            |     |      LP1      |     |     LP1       |     |
          --->|-----|<=============>|-----|<=============>|-----|<---
            |     |               |     |               |     |
          NET |     |               |     |               |     | CUST
            |     |      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 = INACTIVE
              6) LOOPBACK TO CUSTOMER AT HRE-1 = INACTIVE



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

Figure 12. Loopback Options, Dual Loop Screen

```
CIRCUIT ID: EMUL                                             10/06/98  00:23:50
                                 PROVISIONING

      A.  DSX-1/DS1 LINE CODE    =  B8ZS
      B.  DSX-1/DS1 FRAMING      =  AUTO
      *   NIU LOOPBACK           =  ENABLED
      C.  NEW ENGLAND 1:6 LPBK   =  ENABLED
      D.  LOOPBACK TIMEOUT       =  NONE
      E.  CUSTOMER LOSS RESPONSE =  AIS
      F.  LATCHING LOOPBACK MODE =  T1
      *   PRM MODE               =  SPRM
      *   DS1 TX LEVEL           =  0 dB
      G.  SPAN POWER             =  ENABLED
      H.  SINGLE LOOP OPERATION  =  DISABLED
      I.  SINGLE LOOP AIS        =  ENABLED



                  * Option not configurable from this terminal

     Press:  Option letter - to change option setting
             Enter - to implement and save current setting changes
             “M”   - to return to the main menu
```

Figure 13. Provisioning Screen

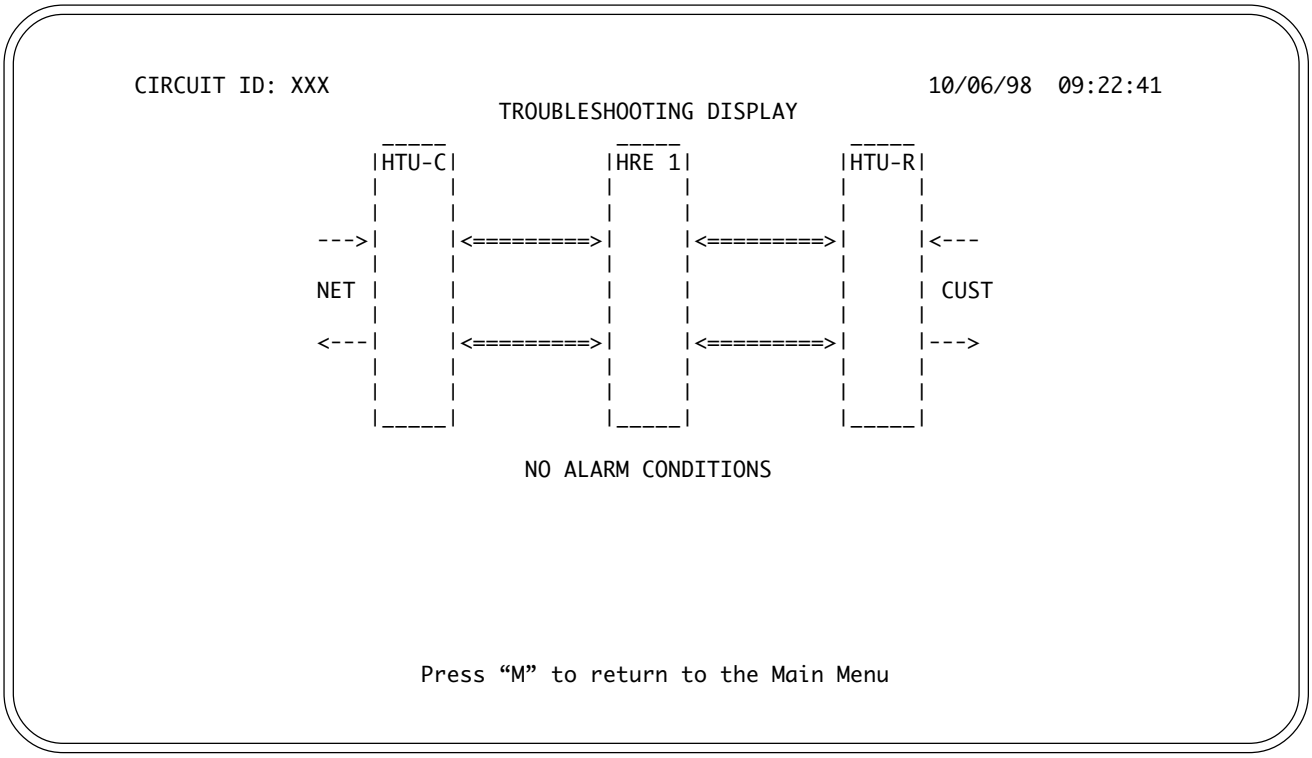

Figure 14. Troubleshooting, Dual Loop Screen

5. ALARMS

Alarms are indicated by the Low Voltage Litespan HTU-C in the following ways:

- HTU-C DB9 control port screen alarms
- Faceplate LEDs
- Standing alarms (through direct access to the Litespan, or remote access through a modem connection)

The HTU-C DB9 control port screen alarms are presented on the Current System Status and Troubleshooting screens. Red, yellow, and blue alarms at both DSX-1 and DS1 interfaces plus HDSL loop synchronization loss conditions are reported. Table C defines faceplate LED alarm functions.

TL1 provides alarm support through TL1 retrieval of standing alarms from the Litespan database. Table D defines the TL1 alarm conditions.

Table B. Provisioning Options

(Default settings are indicated in **bold** typeface)

Option (Mode)	Select	Description
DSX-1/DS1 Line Coding (Code)	**B8ZS**	**B8ZS line code enabled**
	AMI	AMI line code enabled
DSX-1/DS1 Framing (FRMG)	**Auto**	**Unit automatically detects for SF or ESF framing**
	ESF	ESF framing enabled
	SF	SF framing enabled
	UNF	No framing enabled
	FFFC [1]	Forced Framing Format Conversion (ESF to SF)
Loopback Timeout (LBTO)	None	No timeout of loopbacks is enabled
	60 minutes	60-minute loopback enabled
	120 minutes	**120-minute loopback enabled**
DS1 Output Level (TXLV) [2]	**0 dB**	**DS1 signal level delivered to customer is set at 0 dB**
	-15 dB	DS1 signal level delivered to customer is set at -15 dB
-135 VDC Span Powering (SPWR)	**Enabled**	**Enables the high voltage module onboard the HTU-C to provide -135 VDC of span powering to connecting HDSL equipment**
	Disabled	Disables -135 VDC span powering
Single Loop Operation	Enabled	
	Disabled	**Select Disabled for full T1 operation over both HDSL loops and alarm reporting for both HDSL loops**
Single Loop AIS	**Enabled**	**AIS is provided to the network when only one HDSL loop is out of synchronization, or when a signal loss is detected at the HTU-R T1 receiver. This blocks all T1 DS0s while only one HDSL loop is out of synchronization. In HDSL applications involving an HRE, an HDSL loop synchronization loss on any leg of the HDSL circuit will cause AIS. In all HDSL applications, AIS will not be generated when a loopback to the network is made at the HTU-C, HRE, or HTU-R. However, AIS will be generated to the network with an HTU-C customer loopback.**
	Disabled	AIS is provided to the network when both HDSL loops are out of synchronization, or when a signal loss is detected at the HTU-R T1 receiver. This allows either DS0s 1 through 12 or 13 through 24 to be passed until full T1 bandwidth is restored. In HDSL applications involving repeaters, AIS is provided to the network when an HDSL leg in both loops are out of synchronization. In all HDSL applications, AIS will not be generated when a loopback to the network is made at the HTU-C, HRE, or HTU-R. However, AIS will be generated to the network with an HTU-C customer loopback.
DS1 Latching Loopback	T1	When optioned for T1 mode, the unit does not respond to DDS Latching Loopback codes
	FT1 [3]	DDS Latching Loopback operation is supported. The AHT1U 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.
Customer LOS Response	AIS	Send AIS to network upon T1 loss of signal or T1 AIS from customer
	LPBK	HTU-R initiates a network loopback upon T1 loss of signal or T1 AIS from customer
	CDI [4]	HTU-R send customer disconnect indication upon loss of signal or T1 AIS from customer

[1] The FFFC mode sets the HTU-C to ESF and the HTU-R to SF. This mode should be used to force SF (DS1 from customer) to ESF (DSX-1 to network) conversion in the absence of network-provided ESF framing.

[2] This option is provisioned at the HTU-R.

[3] When operating in FT1 mode and during periods of T1 loss of signal, LOS, or T1 AIS from the customer CI, the HDSL system will send in the network direction from the HTU-C a Fractional DS1 idle signal consisting of a repeating 7E (HEX) byte payload within a framed/unframed T1 signal. In addition, when optioned for FT1 mode, the setting for Customer Loss Response is ignored.

[4] The CDI is generated by transmitting the framing received from the network while overwriting the payload with a repeating pattern. For applications where the DS1 is Extended Superframe, the data link is overwritten with a Yellow Alarm that is interrupted once every second by a 100 milli-second code burst of 7E (HEX).

Table C. LED Alarms

Indicator	Description
LOOP	Illuminates when a loopback to the network is in progress.
FAIL	Illuminates upon HTU-C powerup. Remains On until the HTU-C is successfully initialized. The length of time to complete this procedure is dependent on activity of the terminal control processor in the common control assembly of the Litespan system. Illuminates when the module is unable to operate as required.
HDSL	Initially Off. Upon successful powerup of the HTU-C linecard, and when the 6811 microcontroller on the HTU-C releases the reset line internal to the linecard, the HDSL LED will illuminate Red to indicate that HDSL loops are out of synchronization. When HDSL loops are synchronized between the HTU-C and HTU-R or HRE, the HDSL LED will change from Red to Yellow or turn Off. In HRE applications, loop synchronization must be on both sides of the HRE. A Yellow HDSL LED indicates that HDSL loops are both in synchronization, but a Yellow or Red alarm exists at the DS1 interface at the HTU-R. When the HDSL LED is Off, both HDSL loops are in synchronization and no red or yellow alarm conditions exist at the HTU-R DS1 interface.
LP1	Indicates five possible states of the quality of the HDSL signals on Loop 1: Off .....No synchronization of HTU-C and HTU-R on Loop 1 Yellow ....Marginal signal qauality 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 ..An error detected on either end of Loop 1 will cause this LED to blink briefly
LP2	Indicates five possible states of the quality of the HDSL signals on Loop 2 Off .....No synchronization of HTU-C and HTU-R on Loop 2 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 ..An error detected on either end of Loop 2 will cause this LED to blink briefly

Table D. TL1 Alarm Conditions

TL1 Alarm	TL1 Alarm Description	Implications
AID,T1:MJ,LOS,SA	The access identifier (CBA slot) has a major service-affecting alarm because of a loss of sync condition on the HDSL loops or loss of signal at the HTU-R DS1.	There is an HDSL loss of sync in any HDSL leg, or DS1 loss of signal at the HTU-R DS1 interface. The HTU-C is in startup ,or a problem exists on the local loop or customer interface.
AID,EQPT:MJ,UEQ,SA	The access identifier (CBA slot) has a major service-affecting alarm because no channel unit is installed in an equipped CBA slot.	No channel unit is installed in a slot which should be equipped. The HTU-C is not inserted properly in the correct slot, or the unit is defective.
AID,EQPT:MJ,MEA,SA ...	The access identifier (CBA slot) has a major service-affecting alarm because of equipment type mismatch.	The equipment installed in the channel bank slot differs from the equipment type reserved in the software record of the Litespan database. To clear the alarm delete the equipment record (i.e., dlt-eqpt::cot-1-15 with TL1) and reinsert the card, or equip the slot with the currently reserved equipment type.
AID,EQPT:MJ,FAIL,SA ...	The access identifier (CBA slot) has a major service-affecting equipment failure.	The Low Voltage Litespan HTU-C is unable to operate normally or has failed a diagnostic test. See subsection 10 of this practice.

NOTE AID is the access identifier (i.e., cot-1-15).

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 the following:

$12 - \{(3*L^{26})/9\} - L^{BTAP}$ (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 15.

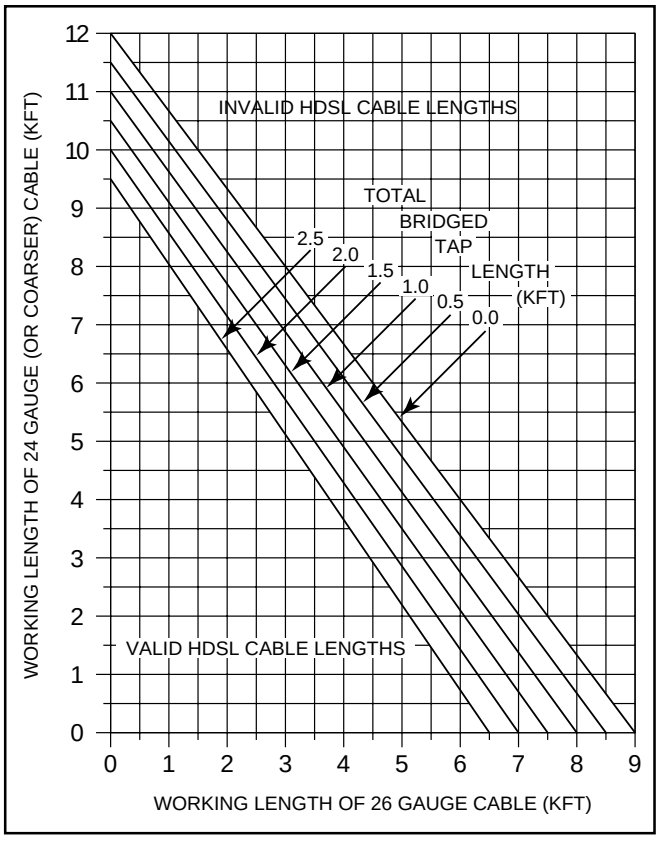

Figure 15. HDSL Deployment Guidelines

Loop loss per kft for other wire is summarized in Table E.

Table E. 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	2.450	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, 135Ω, resistive termination is provided in Table F.

Table F. Loop Insertion Loss Data

Frequency (Hz)	Maximum Loss (dB)
3000	12.0
10,000	15.0
50,000	25.5
100,000	30.0
150,000	32.75
196,000	35.00
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.

Table G. Worksheet PW-1 Replacements

Configuration	A Column Factor	B Column Factor	C Column Factor
Original Worksheet PW-1 values for AHT1U with no repeater and a span-powered HTU-R.	0.430	0.076	0.200
NOTE **Do not use original worksheet values with ADTRAN products.**			
ADTRAN Low Voltage Litespan HTU-C and an HTU-R, P/N 1245021L1 or 1245026L1.	0.525	0	0.120
ADTRAN Low Voltage Litespan HTU-C with an HRE P/N 1244041 or 1244042, and an HTU-R P/N 1245021L1 or 1245026L1.	1.525	0	0.225

Table H. Power Parameters for Replacements to Worksheet PW-1

(all worst-case HDSL loop power measurements)

Power Bus	ADTRAN Low Voltage Litespan HTU-C and a Low-Voltage HTU-R, P/N 1245021 or 1245026L1	ADTRAN Low Voltage Litespan HTU-C with an HRE P/N 1244041L2 or 1244042L1, and an HTU-R P/N 1245021L1 or 12450026L1
+5V	525 mA	525 mA
-5V	0 mA	0 mA
-48V switch battery	120 mA	255 mA
-48V talk battery	0 mA	0 mA
Power consumption	8.4 watts	14.9 watts
Power Dissipation	3.86 watts	4.61 watts

When deploying any of the Low Voltage Litespan HTU-Cs, the power requirements for the application should also be considered for product mix calculations and maximum number of low Voltage Litespan HTU-Cs within a channel bank assembly. Use Worksheet PW-1 in the Engineering and planning section of DSC practice, OSP TL1 software documentation release 7.1, or higher to determine whether a particular combination of channel units is within power-drain specifications. When using ADTRAN Low Voltage Litespan HTU-C, use the replacement factors listed in Table K instead of the ones listed in Worksheet PW-1. The power parameters shown in Table H are for four configurations listed in Table G. These values are derived from an HDSL system with worst-case power measurements.

7. TROUBLESHOOTING PROCEDURES

Table I is a troubleshooting guide for the Low Voltage Litespan HTU-C.

8. MAINTENANCE

The ADTRAN Low Voltage Litespan HTU-C requires no routine maintenance.

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 (see subsection 11 of this practice).

9. PRODUCT SPECIFICATIONS

Product specifications are listed in Table J.

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 (see ADTRAN Equipment Warranty, Repair, and Return Policy and Procedure).

Return Material Authorization (RMA) 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
RMA (repair service) ..... (256) 963-8722

Repair and Return Address:

ADTRAN, Inc.
Customer and Product Support (CAPS) Department
901 Explorer Boulevard
Huntsville, Alabama 35806-2807

Table I. Troubleshooting Guide

Condition	Solution
At powerup, all front panel indicators are *off*.	1. Verify that the channel bank or ONU BPS power LEDs are on. 2. Make sure that the unit is fully and correctly inserted into the channel bank or ONU. 3. If step 1 fails, contact DSC customer service (see subsection 10 of this practice). If step 1 passes, but step 2 fails, replace the HTU-C.
The FAIL LED remains *on*.	1. Verify that the channel bank or ONU BPS FAIL LEDs are off. 2. Verify that the equipment type for the Litespan HTU-C slot is AHT1U. Using TL1, equipment type is shown with the command rtrv-eqpt::AID, where AID is the access identifier (i.e., cot-1-15). 3. If step 1 fails, contact DSC customer service (see subsection 10). If step 1 and step 2 pass, replace the HTU-C. If step 1 passes but step 2 fails, delete the equipment record (i.e., dlt-eqpt::cot-1-15 with TL1) and reinsert the card, or equip the slot with the currently reserved equipment type.
The FAIL LED is *off*, but the HDSL LED remains *red*.	1. Check that neither HDSL loop is open. 2. Check that neither or both HDSL lops are shorted. 3. Verify the loop conforms to CSA guidelines and is not too long. Loop loss at 200 kHz should be less than 35.25 dB. 4. Verify that both HDSL loops have acceptable noise limits (see subsection 6). 5. Verify that tip and ring of each HDSL loop belongs to the same twisted pair. 6. If steps 1 through 5 pass, but the HDSL LED remains red, replace the HTU-C. 7. If step 6 fails, replace the HTU-R and the HRE.
The FAIL LED is *off*, but the HDSL LED remains *yellow*.	1. Check that the framing and line coding are set appropriately for T1 data at the HTU-R and for cross-connected T1 data coming to the HTU-C 2. Check that the DS1 LED at the HTU-R is green. 3. If step 1 fails, change the appropriate framing and line coding (see Control Port Provisioning). If step 1 passes, but step 2 fails, a problem may exist at the HTU-R T1 interface. If the problem does not exist at the T1 interface, replace the HTU-C.

Table J. ADTRAN AHT1U Specifications

Loop Interface	
Modulation Type	2B1Q
Mode	Full duplex, echo cancelling
Number of pairs	Two, with connections to narrowband and wideband
Bit Rate	784 kbps per pair
Baud Rate	392 baud per pair
Service range	Defined by CSA guidelines
Loop Loss	36 dB maximum @ 200 kHz
Bridged Taps	Single Taps < 2 kft, total taps ≤ 2.5 kft
Performance	Compliant with Bellcore TA-NWT-001210
HDSL Tx Signal Level	13.5 dBm
Input Impedance	135Ω
Return Loss	20 dB (40 kHz to 200 kHz)
Power	
Power Consumption	+5V: 2.7 watts typical; 48V (see Table H). Includes HTU-C, HTU-R, and with or without and HRE
Maximum Power Dissipation with an HRE	< 8.5 watts (see Table H)
Span Power	-135 VDC internally generated from the -48 VDC switch battery
Fusing	-48 VDC (switch battery) is current-limited by a 500 mA Slo-Blo® subminiature surface-mount fuse. +5 VDC is current-limited by a 3A quick-acting subminiature surface-mount fuse.
Clock	
Clock Sources	Internal, DSX-1 derived
Internal Clock Accuracy	± 25 ppm, (exceeds Stratum 4). Meets T1.101 timing requirements
Tests	
Diagnostics	Local loopback (HTU-C), remote loopback (HTU-R), troubleshooting screen
Physical	
Mounting	Litespan 2000 CBA, Litespan 2012 CBA, or an ONU CBA
Dimensions	4.42" high x 0.84" wide x 10.4" deep (11.22 cm x 2.13 cm x 26.4 cm)
Weight	Less than one pound
Environment	
Temperature	Operating (standard): -40°C to +70°C, Storage: -40°C to 85°C
Humidity	Up to 95% noncondensing
Electrical/Safety Protection	Complies with Bellcore GR1089-CORE, UL1459, FCC Class A subpart J, and DSC requirements for a generic subscriber interface unit.
Control Port	
Interface	RS232 (DB9)
Terminal Type	VT 100, or compatible
Async Speed	1.2 kbps to 19.2 kbps
Data Format	8 data bits, no parity, 1 stop bit
Part Numbers	
1245002L6	Asynchronous HTU-C Linecard Unit (AHT1U), Narrowband and Wideband

Appendix A
HDSL LOOPBACKS

HDSL MAINTENANCE MODES

This appendix 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 inline 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. The HTU-R will establish a network loopback upon detection of standard DDS NI-NEI/RPTR loopback sequence. When using HRE(s) in the circuit, each HRE will respond as a down stream DS0 DP tandem element and provide a network loopack.

Loopback Control Codes

A summary of control sequences is given in Tables A-1 and A-2.

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-1. HDSL Loopback Control Codes

Type	Source	Code	Name
Abbreviated	(N)	3in7 (1110000)	Loopback data from network toward network in the HTU-R.
	(N)	4in7 (1111000)	Loopback data from network toward network in the HTU-C.
	(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 HTU-C.
	(C)	5in7 (1111100)	Loopback data from customer toward customer in HTU-R.
	(C)	4in6 (111100)	Loopback data from customer toward customer in first HRE.
	(C)	5in6 (111110)	Loopback data from customer toward customer in second HRE.
Wescom	(N)	FF1E	Loopback data from network toward network at HTU-C.
	(C)	3F1E	Loopback data from customer toward customer at HTU-C.
	(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 HTU-R.
	(C)	3F02	Loopback data from customer toward customer at HTU-R.
	(C)	FF48 (ESF-DL)	Loopback data from customer toward customer at HTU-R.
	(N)	1in6 (100000)	Loopback data from network toward network at HTU-R.
	(N)	FF48 (ESF-DL)	Loopback data from network toward network at HTU-R.
	(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-2. Inband Addressable Loopback Codes

Function and Code	Response
Arm ..... 11000 (also known as a 2-in-5 pattern)	NIU Loopback Enabled: 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 Loop-up D3D3 (1101 0011 1101 0011)	If the units have been armed and no units are in loopback*, the HTU-C will loop up 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.
HRE Network Loop-up C741 (1100 0111 0100 0001)	If an HRE is present, the units have been armed, the HRE will loop up 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 Loop-up C754 (1100 0111 0101 0100)	If a second HRE is present, the units have been armed, the HRE will loop up 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 loop down and will remain in 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 the HRE 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.