# T200 HDSL4 Transceiver Unit for the Remote End Installation and Maintenance Practice

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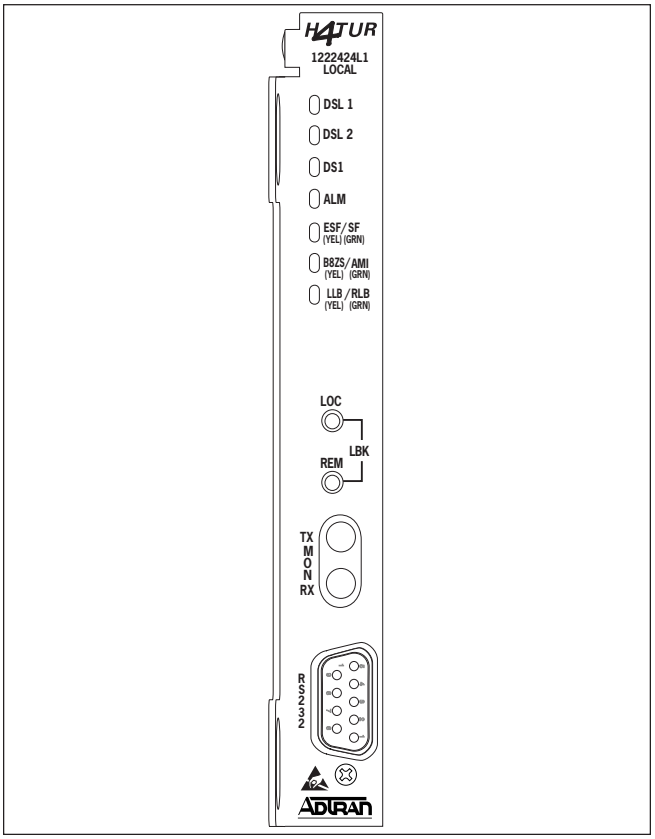



**Figure 1. ADTRAN T200 H4TU-R**

## 1. GENERAL

The ADTRAN 4-wire T200 HDSL4 transceiver unit for the remote end (H4TU-R), P/N 1222424L1, is a network terminating unit used to deploy an HDSL4 T1 circuit using 4-wire metallic facilities. See **Figure 1**. The T200 H4TU-R is a T200 mechanics card which will fit Type 200 or Type 400 mechanic enclosures. The T200 H4TU-R can be housed in the ADTRAN standalone metal enclosures or shelf units as indicated in **Table 1**.

**Table 1. T200 H4TU-R Compatible Housings**

| Part Number | Description | Reference |
|---|---|---|
| 1242034Lx | T400 Single Mount Housing | 61242034L2-5<br>61242034L3-5 |
| 1245034L1 | T200 Dual Mount Housing | 61245034L1-5 |
| 1242007Lx | HR12 Remote Shelf | 61242007Lx-5 |
| 1242008L1 | HR4 Remote Shelf | 61242008L1-5 |

This version of the H4TU-R works with multiple list versions of the HDSL4 transceiver unit for the central office (H4TU-C) and repeater (H4R) as listed below.

| Unit Number | Description |
|---|---|
| 118141XL1 ..... | Total Access 3000 H4TU-C |
| 122x401L1 ..... | 220/E220 H4TU-C |
| 122x403L1 ..... | DDM+ H4TU-C |
| 122x404L1 ..... | 3192 H4TU-C |
| 122x407L1 ..... | H4TU-C for Soneplex |
| 122x441L1 ..... | T200 H4R |
| 122x445L1 ..... | 239 H4R |

*Note: x = any generic number*

The H4TU-R can be deployed in circuits using one H4TU-C, one H4TU-R, and up to two H4Rs.

The H4TU-R terminates local loop HDSL4 signals originating from the Central Office (CO) unit and transforms the HDSL4 signal into traditional DS1 signals to be delivered to the customer.

The H4TU-R (P/N 1222424L1) is intended for local power (±48V) only. If a span powered unit is needed, order P/N 122x426L1. A local power supply is available from ADTRAN by ordering P/N 1353.DSK48V04.

### Revision History

This is the second release of this document. This revision is to update the Screens.

## 2. INSTALLATION


After unpacking the unit, inspect it for damage. If damage is discovered, file a claim with the carrier, then contact ADTRAN. For more information, refer to the *Warranty and Customer Service section*.

The settings on the H4TU-C are encoded and transmitted to the H4TU-R once the circuit has achieved synchronization. There are no switch settings on the H4TU-R.

### Remote Provisioning

This H4TU-R can be used to provision the entire HDSL4 circuit via the craft interface.

### Compliance

**Table 2** shows the compliance codes for the H4TU-R. This product is intended for installation in restricted access locations only and is intended for installation in equipment with a Type "B" or "E" enclosure.

**Table 2. Compliance Codes**

| Code | Input | Output |
|---|---|---|
| Power Code (PC) | F | C |
| Telecommunication Code (TC) | X | X |
| Installation Code (IC) | A | – |

**WARNING**

Up to –200 VDC may be present on telecommunications wiring. Ensure chassis ground is properly connected.

This product meets all requirements of Bellcore GR-1089-CORE (Class A2) and is NRTL listed to the applicable UL standards.

## 3. CONNECTIONS

All connections of the H4TU-R are made through card edge connectors. **Table 3** gives the card edge pin assignments for the H4TU-R circuit pack.

**CAUTION**

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

**Table 3. T200 H4TU-R Edge Connector Wiring**

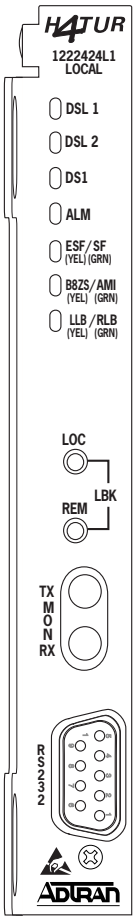
| Pin # | Description |
|---|---|
| 1 | Chassis Ground |
| 5 | DS1 Tx Tip |
| 7 | HDSL4 Tip (Loop 1) |
| 11 | Chassis Ground |
| 12 | GND Protect Switching |
| 13 | HDSL4 Ring (Loop 1) |
| 15 | DS1 Tx Ring |
| 17 | –48 VDC Return |
| 20 | VCC |
| 27 | Chassis Ground |
| 35 | –48 VDC |
| 40 | Protection Control |
| 41 | HDSL4 Tip (loop 2) |
| 47 | HDSL4 Ring (Loop 2) |
| 49 | DS1 Rx Ring |
| 55 | DS1 Rx Tip |

## 4. HDSL4 SYSTEM TESTING

The T200 H4TU-R provides diagnostic, loopback, and signal monitoring capabilities.

The seven front panel LEDs provide diagnostics for HDSL4 loops, DS1 signals, alarms, provisioning, and loopbacks. See **Table 4**.

**Table 4. Front Panel Indicators**




| Name | Indication | Description |
|---|---|---|
| **DSL 1** | Green | Normal operation; signal quality (SNR Margin) ≥ 3 dB and no errors detected at the H4TU-R |
| | Red | Severely impaired operation; signal quality (SNR Margin) < 3 dB or errors detected at the H4TU-R |
| **DSL 2** | Green | Normal operation; signal quality (SNR Margin) ≥ 3 dB and no errors detected at the H4TU-R |
| | Red | Severely impaired operation; signal quality (SNR Margin) < 3 dB or errors detected at the H4TU-R |
| **DS1** | Green | DS1 signal from CPE is present at the H4TU-R |
| | Red | DS1 signal from CPE is absent at the H4TU-R |
| **ALM** | OFF | No active alarm condition detected |
| | Yellow | Remote (H4TU-C) alarm condition detected |
| | Red | Alarm condition detected either locally (H4TU-R) or locally and remotely (H4TU-R and H4TU-C) |
| **ESF/SF** | OFF | Received DS1 signal is UNFRAMED |
| | Yellow | Received DS1 signal framing is ESF |
| | Green | Received DS1 signal framing is SF |
| **B8ZS/AMI** | Yellow | Unit is receiving B8ZS line data from customer DS1 |
| | Green | Unit is receiving AMI line data from customer DS1 |
| **LLB/RLB** | OFF | Unit is NOT in loopback |
| | Yellow | Unit is in local loopback, providing bidirectional loopback at the H4TU-R |
| | Green | Unit in remote loopback, Providing bidirectional loopback at the H4TU-C |

The H4TU-R provides a bidirectional loopback via the loopback button on the front panel. Refer to the *H4TU-R Network Loopbacks* and *Customer Loopbacks* subsections for more details.

The H4TU-R also provides a nonintrusive test point of the DS1 signal via the jack labeled **MON** on the front panel.

### DS1 MON Bantam Jacks

The **MON** jack provides a nonintrusive access point for monitoring the characteristics of the transmit and receive signals at the DS1 interface point.

For example, the DS1 **MON** jack on the H4TU-R could be used to connect to a bit error rate tester to monitor for synchronization, test patterns, etc. **Figure 2** is an illustration of specific jack detail.

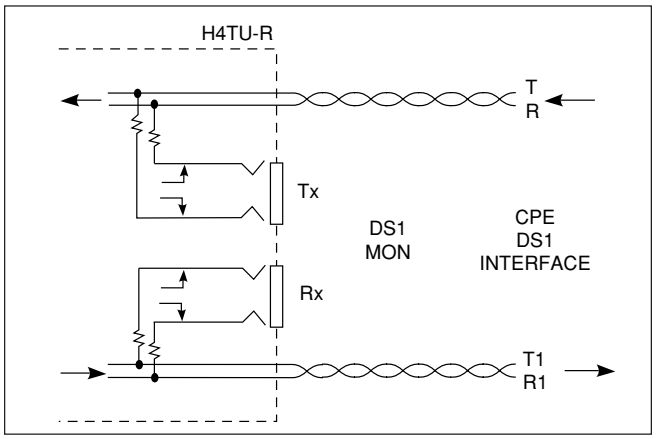



**Figure 2. H4TU-R MON Diagram**

**NOTE**

For the MON jacks, the Tx and Rx indications relate to the direction of the CPE signal.

### H4TU-R Network Loopbacks

The H4TU-R responds to multiple loopback activation processes. The loopback position is a logic loopback located within the H4TU-R internal HDSL4 transceiver. See **Figure 3**.

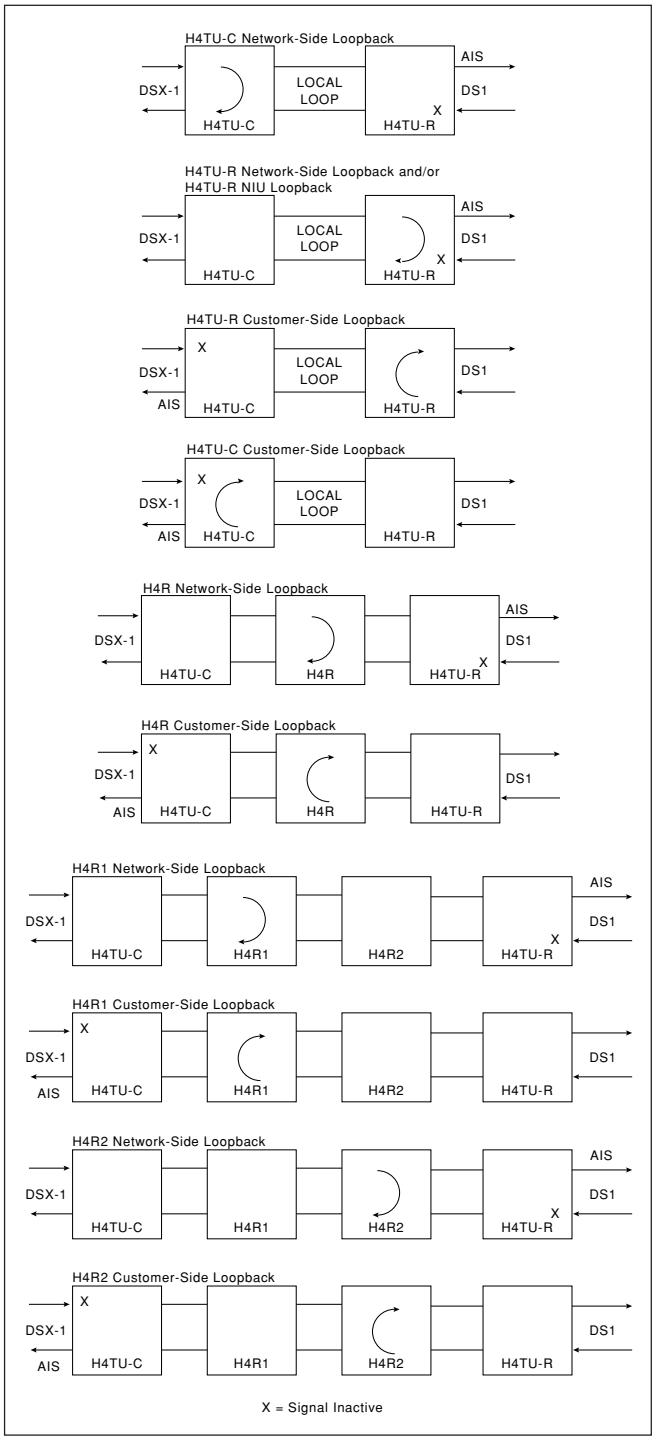



**Figure 3. HDSL4 Loopbacks**

The T200 H4TU-R responds to loopbacks processes as follows:
First, manual loopback activation may be accomplished using the control port of the H4TU-R.

Second, the H4TU-R will respond to the industry standard 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 H4TU-R responds to T1 Network Interface Unit (NIU) loopback codes as described in Bellcore TR-TSY-000312. The NIU loopback codes are as follows:

In-Band Codes

Loop up ..... 11000 (2 in 5)
Loop down .. 11100 (3 in 5)

ESF Codes

Loop up ..... 1111 1111 0100 1000 (FF48)
Loop down .. 1111 1111 0010 0100 (FF24)

Receiving the in-band codes for more than five seconds or the ESF codes four consecutive times will cause the appropriate loopback action. The ESF codes must be transmitted in the Facility Data Link (FDL).

**NOTE**

The NIU loopback option must be enabled before the H4TU-R can respond to the NIU loopback.

The H4TU-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 H4TU-R to the previous state from the armed or loop up state.

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

Figure 3 illustrates all of the possible loopback locations of the ADTRAN HDSL4 equipment.

### Customer Loopbacks

In addition to the loopbacks in the direction of the network, the H4TU-R may also be looped back in the direction of the customer. The H4TU-C and H4TU-R Customer Side Loopbacks are illustrated in Figure 3.

**NOTE**

Network and customer loopbacks are governed by the loopback time out option. (Default=120 minutes.)

## 5. FRONT PANEL OPERATION

The front panel contains two pushbuttons labeled **LOC** and **REM**.

The LOC pushbutton controls a bidirectional loopback at the H4TU-R. Pressing the button causes a bidirectional loopback to occur. If the bidirectional loopback is active, pressing the button a second time will disable the loopback.

The REM pushbutton controls a bidirectional loopback at the H4TU-C. Pressing the button causes a bidirectional loopback to occur. If the loopback is active, pressing the button a second time will disable the loopback.

## 6. CONTROL PORT OPERATION

The H4TU-R provides a front panel-mounted DB-9 connector that supplies an RS-232 interface for connection to a controlling terminal. The pinout of the DB-9 is illustrated in **Figure 4**.

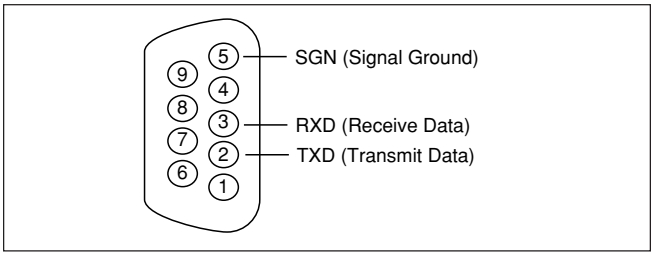



**Figure 4. RS-232 (DB-9) Connector Pinout**

The terminal interface operates at data rates from 1.2, 2.4, 4.8, 9.6, and 19.2 kbps. The asynchronous data format is fixed at 8 data bits, no parity, and 1 stop bit.

**NOTE**

If you are using a personal computer with terminal emulation capability, be sure to disable any power-saving programs. Otherwise, communication between the PC and the HDSL4 unit may be disrupted, resulting in misplaced characters or screen time outs.

## Operation

For abbreviations used in the screen diagrams, see **Table 5**.

The screens illustrated in Figures 5 through 21 apply to an HDSL4 circuit deployed with ADTRAN HDSL4 technology. The circuit includes an H4TU-C, up to two H4Rs and an H4TU-R. Other configurations are possible (for example, an HDSL4 repeater of another vendor's equipment), and their displays will vary slightly from those shown in this section.

**Table 5. Screen Abbreviations**

| Abbreviation | Definition |
|---|---|
| ES | Errored Seconds |
| | DSX/DS1 ..... (SF) The number of seconds in which a BPV or frame bit error occured |
| | (ESF) The number of seconds in which a BPV or CRC error occurs |
| | HDSL4 ..... The number of seconds in which a CRC error occurs |
| SES | Severely Errored Seconds |
| | DSX/DS1 ..... (SF) The number of seconds in which 1544 BPVs or 8 frame bit errors occur |
| | (ESF) The number of seconds in which 1544 BPVs or 320 CRC errors occur |
| | HDSL4 ..... The number of seconds in which 50 CRC errors occur |
| UAS | Unavailable Seconds |
| | DSX/DS1 ..... The number of seconds in which there is a loss of signal |
| | HDSL4 ..... The number of seconds in which there is a loss of 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 ..... The number of seconds in which a bipolar violation occurs |
| NIU | T1 Network Interface Unit |
| S/N | Serial Number |
| 15M | 15-Minute Period |
| 24H | 24-Hour Period |

A terminal session is initiated by entering multiple spacebar characters, which are used by the H4TU-R to determine the speed of the terminal. Once the speed has been determined, an HDSL4 Main Menu (**Figure 5)** is displayed.

The Main Menu provides access to detailed performance and configuration information. Selecting the corresponding number or letter can access the following screens:

1. HDSL4 Unit Information
2. Provisioning
3. Span Status
4. Loopbacks and Test
5. Performance History
6. Scratch Pad, Circuit ID, Time/Date
7. Terminal Modes
8. Alarm History
9. Event History
10. System PM/Screen Report
11. Virtual Terminal Control

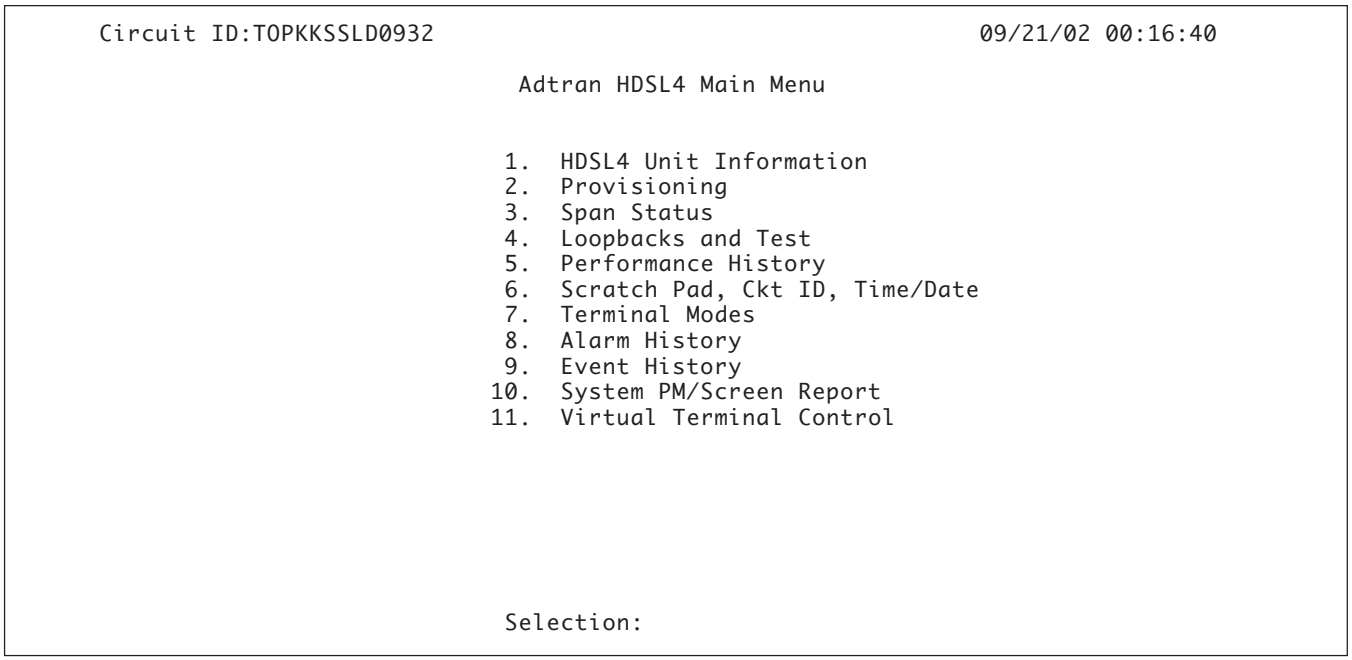



**Figure 5. HDSL4 Main Menu**

The HDSL4 Unit Information screen (**Figure 6)** provides detailed product information on each component in the HDSL4 circuit. This screen also displays contact information for ADTRAN Technical Support, Internet site, and address.

The Provisioning screen (**Figure 7)** displays the current provisioning settings for the HDSL4 circuit. To change a particular option setting, select the appropriate number, and a new menu will appear with a list of the available settings.

**NOTE**

The provisioning options listed in Figure 7 are the factory default values.

```
Circuit ID:TOPKKSSLD0932                                    09/21/02 00:19:15


                                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
--------------------------------------------------------------------------------

              ADTN H4TU-C                        ADTN H4TU-R
              P/N: 1221404L1                     P/N: 1222424L1
              S/N: AC21A2513                     S/N: AC24A3578
             CLEI: T1L3ZBZAAA                   CLEI: T1L5HHUCAA
             Manf: 07/10/2002                   Manf: 06/29/2002
              Ver: 24  1 A00000                  Ver: 21  2 A01

             ADTN H4R1
             P/N: 1221441L1
             S/N: CC12A0433
            CLEI: T1R6TJEDAA
            Manf: 04/02/2002
             Ver: 21  1 A00001
```

**Figure 6. Unit Information Screen**

```
Circuit ID:TOPKKSSLD0932                                    09/21/02 00:27:39



                              Provisioning

                        1.  DSX-1 Line Buildout     =  0-133 Feet
                        2.  DSX-1/DS1 Line Code     =  B8ZS
                        3.  DSX-1/DS1 Framing       =  ESF
                        4.  Smartjack Loopback      =  Disabled
                        5.  Forced Frame Conversion =  Enabled
                        6.  Loopback Timeout        =  120 Min
                        7.  Latching Loopback Mode  =  T1 (Disabled)
                        8.  DS1 TX Level            =  -7.5 dB
                        9.  Customer Loss Indicator =  AIS
                       10.  PRM Setting             =  None
                       11.  Loop Atten Alarm Thres  =  34dB
                       12.  SNR Margin Alarm Thres  =  04dB
                       13.  Remote Provisioning     =  Enabled




                                 Selection:
```

**Figure 7. Provisioning Screen**

The Span Status Screen (**Figure 8)** provides quick access to status information for each HDSL4 receiver in the circuit.

The Detailed Status (**Figure 9**) displays the HDSL4 margin, attenuation, and estimated insertion loss. From this screen, Min/Max can be reset.

**NOTE**

The insertion loss reading shown on the Detailed Status screen is an approximation that is valid for some loops. Caution should be used when using this value.

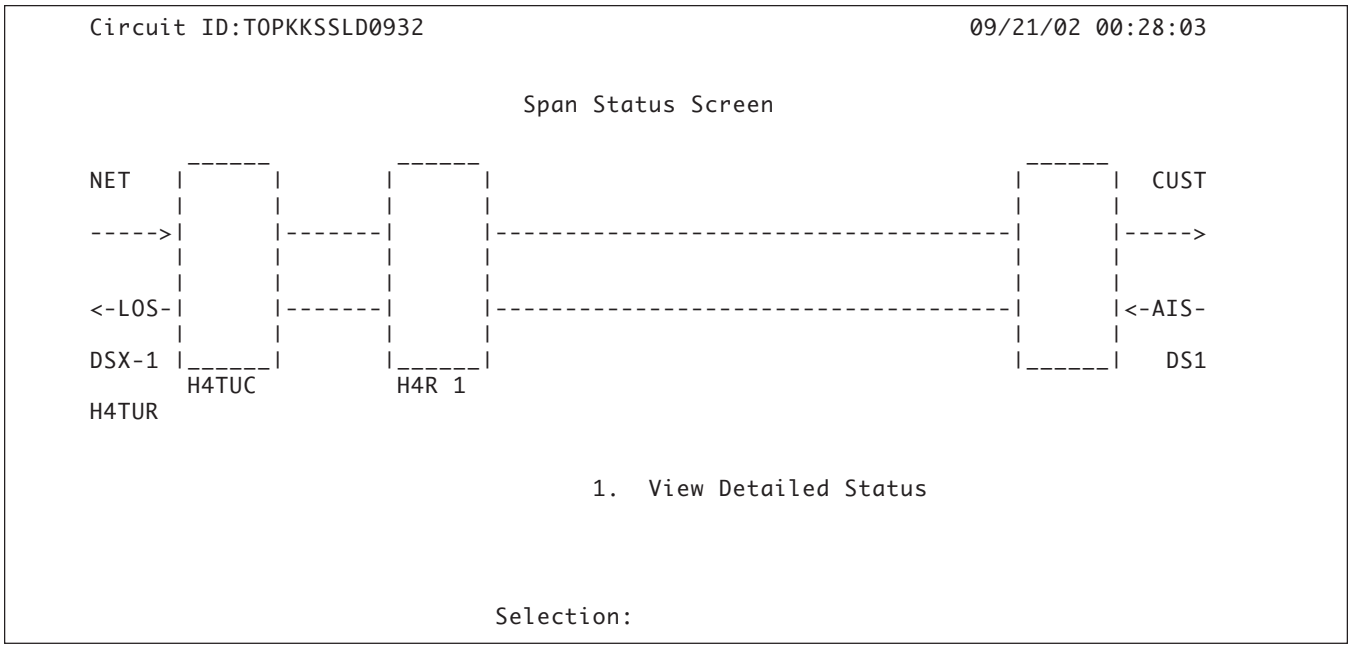



**Figure 8. Span Status Screen**

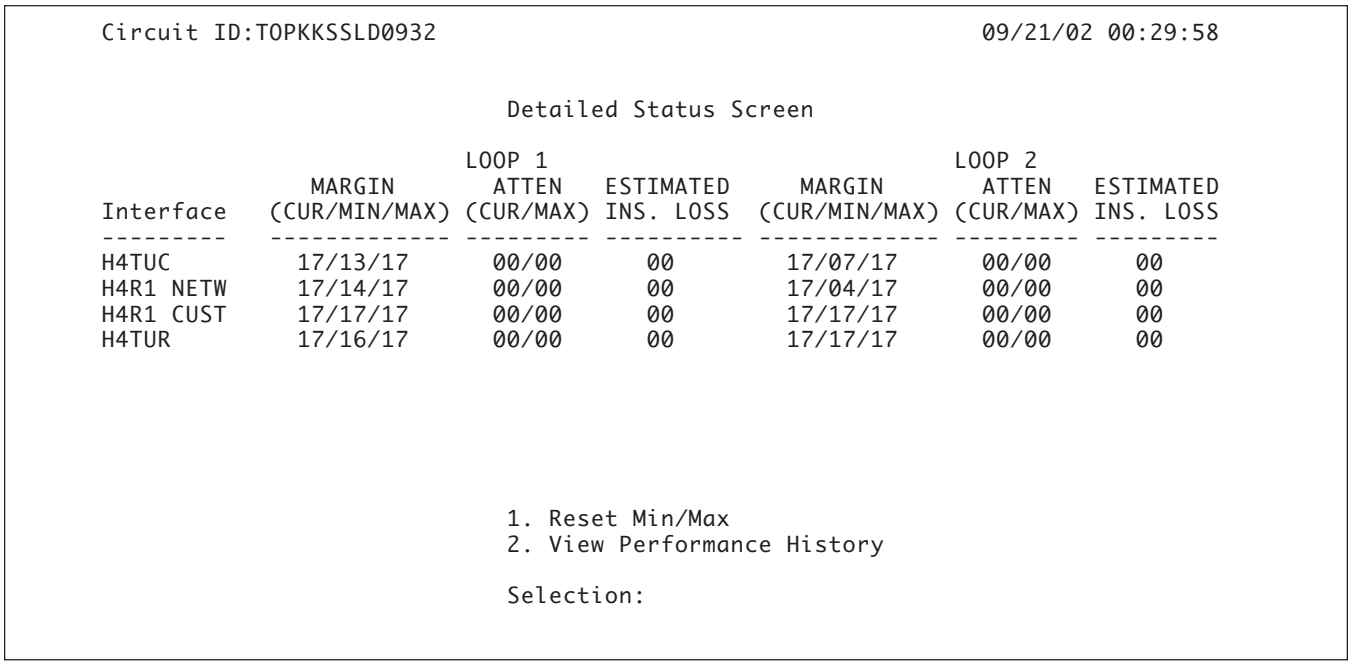



**Figure 9. Detailed Status Screen**

The Loopback and Test Commands screen (**Figure 10)** provides the user with the ability to invoke or terminate all available HDSL4 loopbacks. Each HDSL4 circuit component can be looped toward the network or customer from this screen.

The Performance History screens (**Figure 11** and **Figure 12)** display the historical HDSL4 and T1 performance data in several different registers.

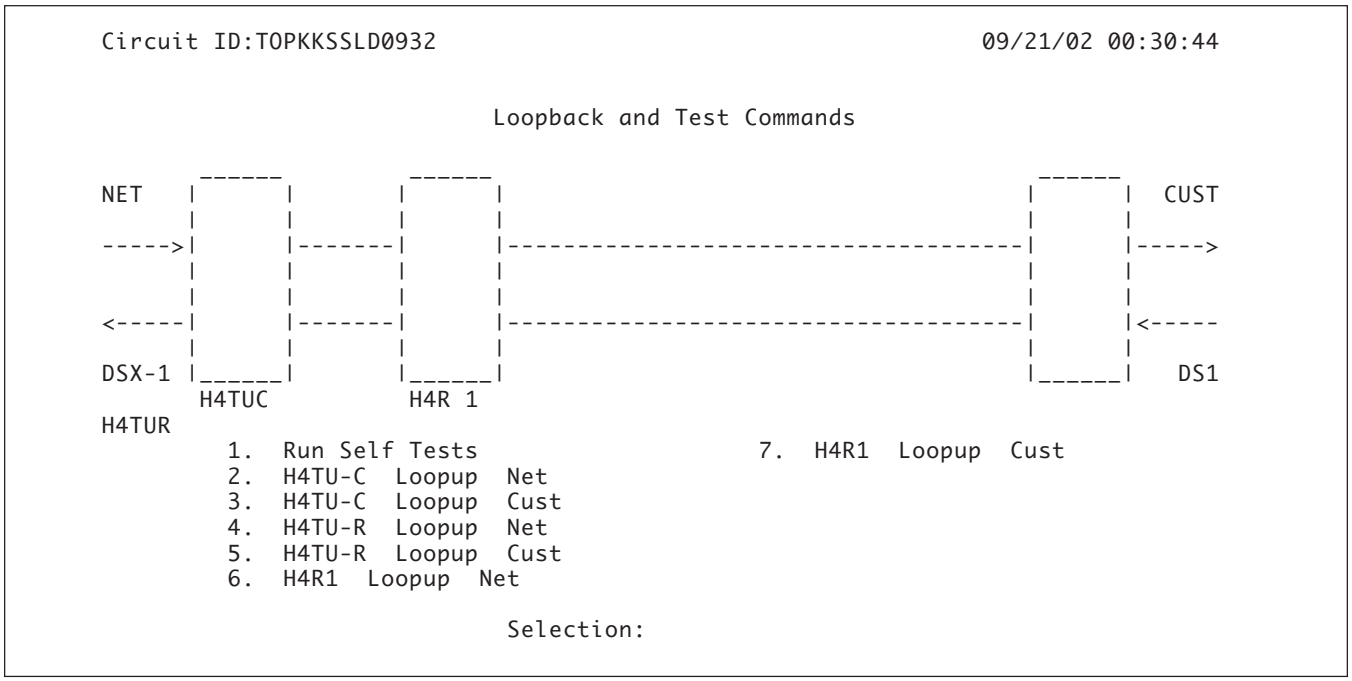



**Figure 10. Loopbacks and Test Screen**

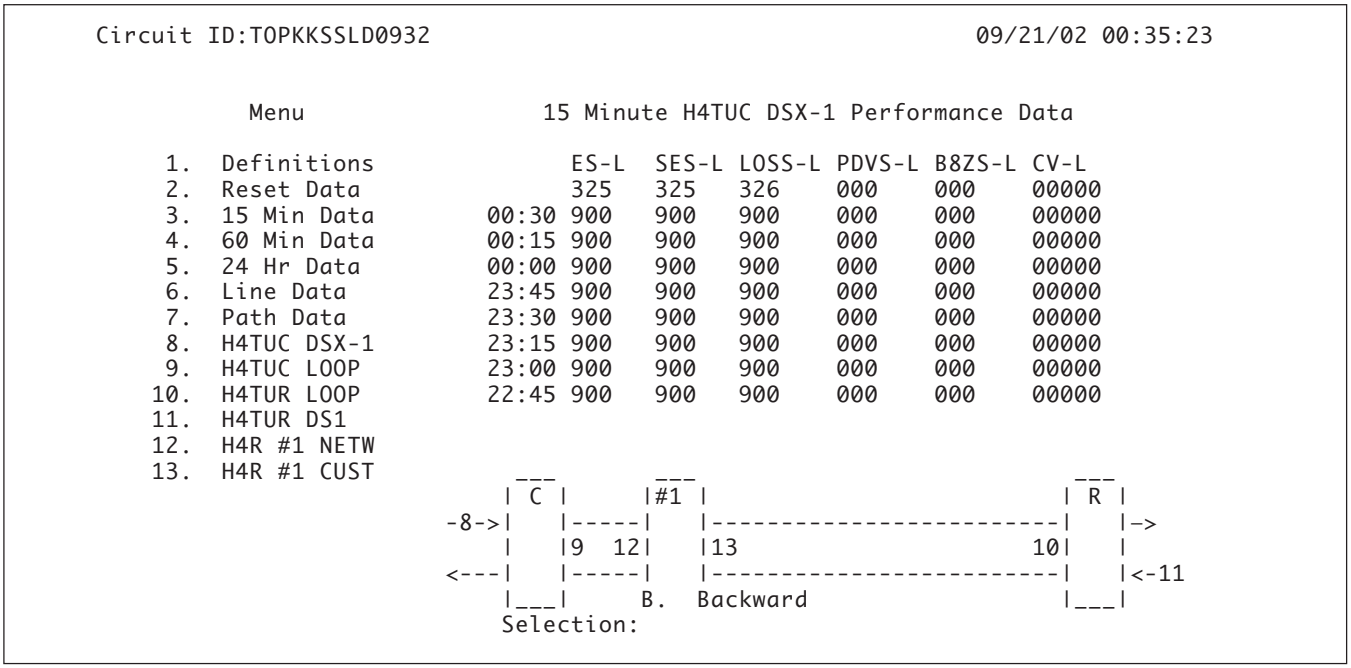



**Figure 11. 15-Minute Performance History Line Data Screen**

At each 15-minute interval, the performance information is transferred to the 15-minute performance data register. This unit stores performance data 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 registers. This unit stores up to 31 days of 24-hour interval data.

To view the performance data, select the desired module and interface. Line (L) and Path (P) are available.

Abbreviations used in the Performance History screens are defined in Data Definition screens. See **Figure 13** and **Figure 14**.

```
Circuit ID:TOPKKSSLD0932                                    09/21/02 00:36:26


          Menu                  24 Hour H4TUC DSX-1 Performance Data

     1.  Definitions                ES-L  SES-L LOSS-L PDVS-L B8ZS-L CV-L
     2.  Reset Data                 02189 02189 02190  00000  00000  0000000
     3.  15 Min Data          09/20 65535 65535 65535  00002  00000  0000002
     4.  60 Min Data          09/19 65535 65535 65535  00002  00000  0000002
     5.  24 Hr Data           09/18 65535 65535 65535  00001  00000  0000001
     6.  Line Data            09/17 65535 65535 65535  00004  00000  0000004
     7.  Path Data            09/16 65535 65535 65535  00000  00000  0000000
     8.  H4TUC DSX-1          09/15 65535 65535 65535  00002  00000  0000002
     9.  H4TUC LOOP           09/14 65535 65535 65535  00004  00000  0000004
    10.  H4TUR LOOP
    11.  H4TUR DS1
    12.  H4R #1 NETW
    13.  H4R #1 CUST
                              ___       ___                          ___
                             | C |     |#1 |                        | R |
                          -8->|   |-----|   |------------------------|   |--->
                             |   |9  12|   |13                   10|   |
                          <---|   |-----|   |------------------------|   |<-11
                             |___|     B.  Backward                  |___|
                            Selection:
```

**Figure 12. 24-Hour Performance History Line Data Screen**

```
Circuit ID:TOPKKSSLD0932                                    09/21/02 00:41:23


                        Performance Data Definitions

H4TUC, H4TUR, and H4R LOOP Related:     HDSL4 Framing
  ES-L    Errored Seconds                 CRC>=1 or LOSW>=1
  SES-L   Severely Errored Seconds        CRC>=50 or LOSW>=1
  UAS-L   Unavailable Seconds             >10 cont. SES-Ls

DS1 and DSX-1 Line Related:             Superframe and Extended Superframe
  ES-L    Errored Seconds                 (BPV+EXZ)>=1 or LOS>= 1
  SES-L   Severely Errored Seconds        (BPV+EXZ)>=1544 or LOS>=1
  LOSS-L  Loss of Signal Seconds          LOS>= 1
  PDVS-L  Pulse Density Violation Secs    EXZ>=1; >7 zeros if B8ZS, >15 if AMI
  B8ZS-L  B8ZS Seconds                    B8ZS coded signal received
  CV-L    Code Violation Count            (BPV+EXZ) count

NOTE: Reverse video indicates invalid data due to a terminal restart (or power
      cycle), a data register reset, or a system date or time change.


    N.  Next
    P.  Previous            Selection:
```

**Figure 13. Performance Data Definitions Screen**

**Figure 15** illustrates the Scratch Pad, Circuit ID, and Time/Date screen. The Scratch Pad data can be any alphanumeric string up to 50 characters in length. The Circuit ID can be any alphanumeric string up to 25 characters in length.

The time should be entered using military time. (For example, enter 3:15 p.m. as “151500”.)

The date should be entered as MMDDYY. (For example, enter January 02, 2003, as “010203”.)

```
C Ircuit ID:TOPKKSSLD0932                                    09/21/02 00:43:47

                          Performance Data Definitions

DS1 and DSX-1 Path Related:          Superframe          Extended Superframe
  ES-P    Errored Seconds              FE>=1 or            CRC>=1 or
                                        SEF>=1 or AIS>=1     SEF>=1 or AIS>=1
  SES-P   Severely Errored Seconds     FE>=8 or            CRC>=320 or
                                        SEF>=1 or AIS>=1     SEF>=1 or AIS>=1
  UAS-P   Unavailable Seconds          >10 cont. SES-Ps    >10 cont. SES-Ps
  SAS-P   SEF/AIS Seconds              SEF>=1 or AIS>=1    SEF>=1 or AIS>=1
  ES-PFE  Far End Errored Seconds      n/a                 PRM bits G1-G6,SE,
                                                            or SL=1, or RAI
  CV-P    Code Violation Count         FE count            CRC error count

NOTE: Under a UAS-P condition, ES-P and SES-P counts are inhibited.
      Under a SES-L or SES-P condition, the respective CV-L or CV-P count is
      inhibited.



    P.  Previous            Selection:
```

**Figure 14. Performance Data Definitions Screen (Continued)**

```
 Circuit ID:TOPKKSSLD0932                                    09/21/02 00:49:31




   Current Scratch Pad: RJ45 jack in broom closet
      New Scratch Pad = RJ45 jack in broom closet


       New Circuit ID =


             New Date =   /  /    (MM/DD/YY)
             New Time =   :  :    (HH:MM:SS)


                    Press TAB to skip to next entry field.
```

**Figure 15. Scratch Pad, Circuit ID, Time/Date Screen**

This unit includes two terminal emulation modes. These modes are described on the Terminal Modes Menu (**Figure 16**).

**NOTE**

Pressing CTRL T while on any screen will toggle between Manual and Real Time Terminal Modes.

The Manual Update Mode allows the user to manually update the provisioning option screens. This mode supports efficient print screen and log file utilities for storage of key provisioning parameters, alarm or performance history, and current system status. "3 SPACES TO UPDATE" appears at the top of each screen. Pressing the spacebar 3 times will cause the screen to refresh and reflect the most current circuit conditions and provisioning options.

The default terminal emulation mode is the Real Time Update Mode (VT100). This mode provides real time updating of HDSL4 circuit conditions and provisioning options as changes occur. While in Real Time Update Mode, the unit is anticipating baud poll responses from the terminal.

**NOTE**

When operating in Virtual Terminal Mode, the terminal baud rate should be 4.8 kbps or higher. The remote terminal session is automatically initiated if a terminal is connected to the H4TU-R, and the HDSL4 loops are in sync with the H4TU-C. When a remote terminal session is in progress, the screens are not accessible from the H4TU-C. Once a remote terminal session is terminated, the screens are available at the H4TU-C. The remote terminal session is terminated by typing CTRL X on the terminal at the H4TU-R. Alternatively, if there is no keyboard input at the H4TU-R's terminal for a period of 5 minutes, the remote session will time out, and the screens will once again be available at the H4TU-C. After the 5-minute time out, the remote terminal session can be reinstated at the H4TU-R by pressing the space bar several times.

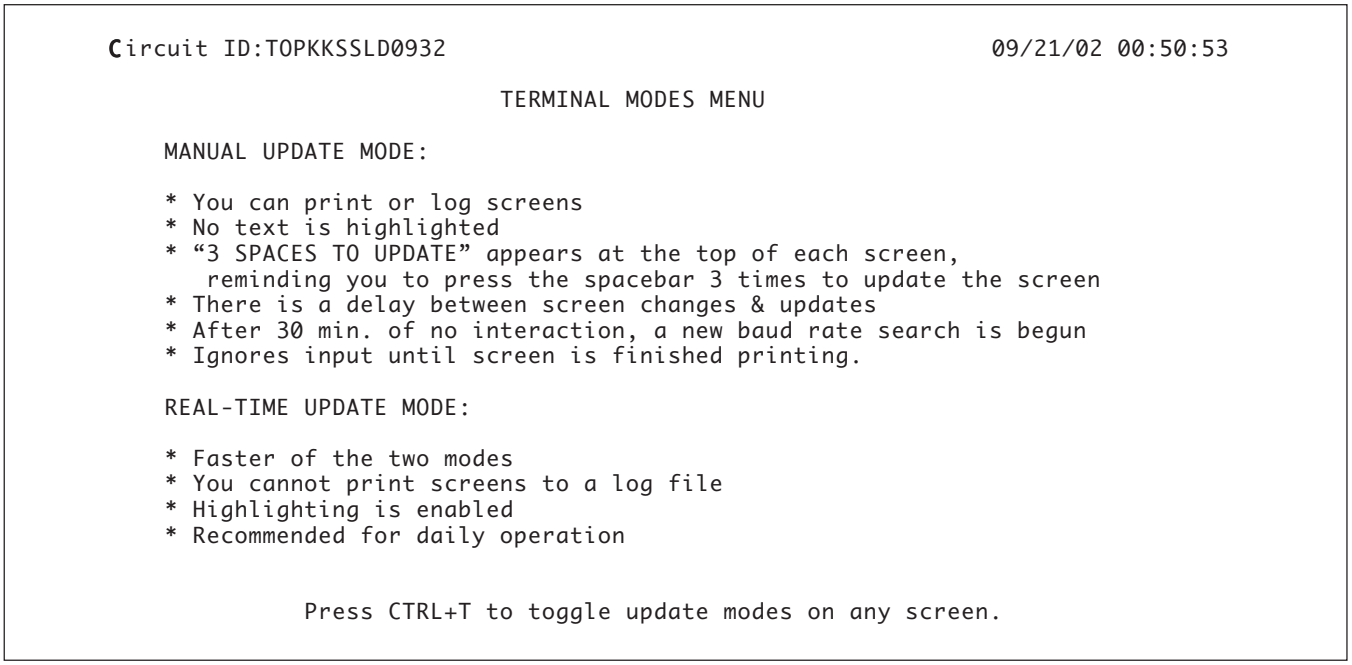



**Figure 16. Terminal Modes Menu**

The T1 Alarm History screen (**Figure 17)** provides the user with a detailed alarm history and events log for the T1 circuit. This screen includes a time, date, first/ last occurrence, and count for each type of HDSL4 or T1 alarm. The HDSL4 Span History screen **(Figure 18)** lists alarms that have occurred on the span between the H4TU-C and H4TU-R.

```
CIrcuit ID:TOPKKSSLD0932                                        09/21/02 00:51:30


                              T1 Alarm History
LOCATION   ALARM       FIRST                LAST                 CURRENT   COUNT
-------------------------------------------------------------------------------
H4TU-C     RED(LOS/LOF) 01/01/00  00:00:34   09/20/02  18:45:32   Alarm      018
 (DSX-1)   YELLOW(RAI)                                           OK         000
           BLUE(AIS)                                             OK         000

H4TU-R     RED(LOS/LOF) 08/11/02  19:31:25   09/14/02  11:31:03   OK         016
 (DS1)     YELLOW(RAI)                                           OK         000
           BLUE(AIS)    01/01/00  00:00:03   09/21/02  00:17:02   Alarm      067









-------------------------------------------------------------------------------
    1. T1 Alarm             4. Span H4R1 to H4TUR
    2. Facility Alarm       C. Clear T1 Alarms
    3. Span H4TUC to H4R1
                             Selection:
```

**Figure 17. T1 Alarm History Screen**

```
Circuit ID:TOPKKSSLD0932                                        09/21/02 04:02:52


                            HDSL4 Span History
LOCATION   ALARM       FIRST                LAST                 CURRENT   COUNT
-------------------------------------------------------------------------------
SPAN C-H1  L1  LOS     08/13/02  18:41:09   08/24/02  02:28:24   OK         004
           L2  LOS     08/11/02  19:31:26   09/07/02  21:01:38   OK         036

H4TU-C     L1  MRGN    08/13/02  18:40:35   09/19/02  04:00:45   OK         040
           L2  MRGN    08/11/02  19:31:20   09/20/02  18:45:31   OK         061
H4R1 NET   L1  MRGN    08/13/02  18:40:34   09/19/02  04:00:45   OK         049
           L2  MRGN    08/11/02  19:31:24   09/21/02  00:16:29   OK         050

H4TU-C     L1  ATTEN                                             OK         000
           L2  ATTEN                                             OK         000
H4R1 NET   L1  ATTEN                                             OK         000
           L2  ATTEN                                             OK         000

-------------------------------------------------------------------------------
    1. T1 Alarm             4. Span H4R1 to H4TUR
    2. Facility Alarm       C. Clear Span Alarms
    3. Span H4TUC to H4R1
                             Selection
```

**Figure 18. HDSL4 Span History Screen**

The Event History screen (**Figure 19)** provides a log history of HDSL4 circuit events.

The System PM/Screen Report option from the Main Menu offers four types of reports on performance monitoring. Selecting a report type will then display all the reports for that category on the screen at once, which is more efficient than stepping through the menus individually. See **Figure 20**.

```
Circuit ID:TOPKKSSLD0932                                    09/21/02 04:03:29

 Num   Description of Event                          Date     Time      Source
 ------------------------------------------------------------------------------

  41.  H4TU-C Powered Up                            09/18/02 20:45:44  H4TU-C
  42.  H4TU-R Powered Up                            09/19/02 04:00:01  H4TU-R
  43.  H4TU-C Powered Up                            09/19/02 04:00:44  H4TU-C
  44.  H4TU-R Powered Up                            09/19/02 10:45:01  H4TU-R
  45.  H4TU-C Powered Up                            09/19/02 10:45:43  H4TU-C
  46.  H4TU-R Powered Up                            09/20/02 11:15:01  H4TU-R
  47.  H4TU-C Powered Up                            09/20/02 11:15:41  H4TU-C
  48.  H4TU-R Powered Up                            09/20/02 18:45:01  H4TU-R
  49.  H4TU-C Powered Up                            09/20/02 18:45:43  H4TU-C


        Page Number:   5/  5   Number of Events:  49
 ------------------------------------------------------------------------------
      'P' - Previous Page  'H' - Home      'R' - Reset Events
      'N' - Next Page      'E' - End

                             Selection:
```

**Figure 19. Event History Screen**

```
                                    6.  SCRATCH PAD, CKT ID, TIME/DATE
                                    7.  TERMINAL MODES
                                    8.  ALARM HISTORY
                                    9.  EVENT HISTORY
                                   10.  SYSTEM PM/SCREEN REPORT
                                   11.  VIRTUAL TERMINAL CONTROL









                                    SELECTION: 10


            ENABLE DATA LOGGING NOW.
          SELECT REPORT TYPE OR PRESS ESCAPE TO CANCEL:
            1)  FULL SYSTEM/HISTORY REPORT
            2)  CURRENT STATUS REPORT
            3)  SYSTEM CONFIGURATION REPORT
            4)  ALARM/EVENT HISTORY
```

**Figure 20. System PM/Screen Report Option**

**Figure 21** illustrates the Virtual Terminal Control screen. Use this screen to log onto the H4TU unit at the opposite end of the circuit.

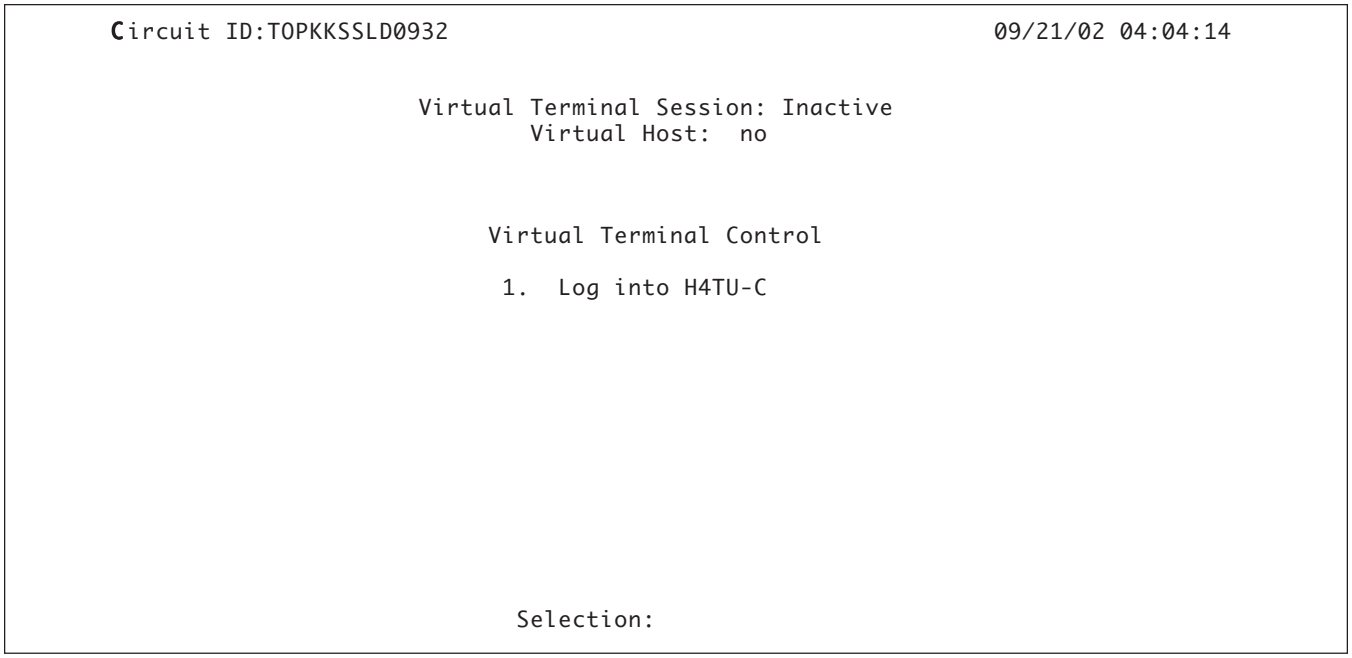



**Figure 21. Virtual Terminal Control Screen**

## 7. HDSL4 DEPLOYMENT GUIDELINES

The different segments of an HDSL4 circuit are illustrated in **Figure 22.**


**Figure 22. HDSL4 Circuit Segments**

The ADTRAN HDSL4 system provides DS1-based services over loops designed to comply with the guidelines given below. These guidelines apply to the following circuit configurations:

- A single segment or an HDSL4 circuit with no H4Rs.
- A circuit having two segments (with one H4R), or
- A circuit having 3 segments (with two H4Rs).

The guidelines reflected herein are for worst-case scenarios (that is, for loops that contain a maximum amount of disturbers, noise, etc). Actual deployment guidelines may vary based on local policy. Please refer to those guidelines to ensure optimum performance.

Designing a circuit with loop attenuation greater than the recommended maximum loss (yellow zone) may result in compromised reliability of that loop. The guidelines are provided in numbers 1 through 9, which follow:

1. All loops are nonloaded only
2. Any single bridged tap is limited to 2 kft.
3. Total bridged tap length is limited to 2.5 kft.
4. Bridge tap within 1000 feet of units may affect performance of the circuit.
5. Loop Attenuation Limits. See **Table 6**.
6. DSL-Recommended Range Limits. See **Table 7** and **Table 8**.

**Table 6. Attenuation Limits from DSL Assistant**

| | **Recommended Maximum (DSL Assistant Green Zone)** | |
|---|---|---|
| | Upstream | Downstream |
| 1st Segment | 31 dB | 33 dB |
| 2nd/3rd Segment | 30 dB | 30 dB |

**Table 7. Range Limits: 26 Gauge/70°F/PIC**

| **26 Gauge** | **Recommended Maximum (DSL Assistant Green Zone)** |
|---|---|
| 1st Segment | 10.8 kft |
| 2nd/3rd Segment | 10.55 kft |
| 3rd Segment | 10.55 kft (see note) |

**Table 8. Range Limits: 24 Gauge/70°F/PIC**

| **24 Gauge** | **Recommended Maximum (DSL Assistant Green Zone)** |
|---|---|
| 1st Segment | 15.25 kft |
| 2nd/3rd Segment | 15.05 kft |
| 3rd Segment | 15.05 kft (see note) |

ADTRAN provides an excellent computer-aided loop design tool called DSL Assistant that provides these loop loss design criteria automatically. The color-coded loop attenuation results provide green when the loss is at or below the recommended maximum loss, yellow if the loss is more than recommended but below the absolute maximum and red if the loss exceeds the T1.418 standard based absolute maximum.

**NOTE**

In three segment circuits (two H4Rs), individual segment resistance values must be verified. See paragraph Number 7 below.

7. Resistance Values. See **Table 9**.

   Each of the three segments associated with span powering two H4Rs and a H4TU-R must satisfy the DC resistance budgets in addition to the recommended insertion loss and loop attenuation requirements. In general, 22 and 19 AWG segments will be restricted by their loop attenuation while the DC resistance will restrict the segment reach for 26 and 24 AWG. When designing a dual H4R loop, the first segment should have lower DC resistance than the second segment.

   Single H4R spans do not require any restriction due to DC resistance.

**NOTE**

A circuit that otherwise meets attenuation and insertion loss requirements for cable reach will encounter span powering problems if resistance values are excessive.

The segment resistance ($\Omega_{segment}$) is determined using this equation:

$$\Omega_{segment} = L_{26} * \Omega_{26} + L_{24} * \Omega_{24} + L_{22} * \Omega_{22} + L_{19} * \Omega_{19}$$

where : $L_{\#}$ is the length of # AWG cable (kft, excluding bridge taps), $\Omega_{\#}$ is the D.C. Resistance of # AWG cable

Table 9 lists single pair cable DC resistance values to be used in the equation above.

**Table 9. Single Pair Cable DC Resistance Value (Ω)**

| Resistance (Ohms/kft) | | | | |
|---|---|---|---|---|
| **AWG** | **70ºF** | **90ºFº*** | **120ºF** | **140ºF**** |
| 19 | 16.465 | 17.183 | 18.261 | 18.979 |
| 22 | 33.006 | 34.446 | 36.606 | 38.046 |
| 24 | 52.498 | 54.789 | 58.225 | 60.516 |
| 26 | 83.475 | 87.117 | 92.581 | 96.223 |
| * Interpolated between 70ºF and 120ºF data<br>** Extrapolated from 70ºF and 120ºF data | | | | |

Once the resistance of each segment is confirmed, refer to **Figure 23** to decide if the H4TU-C is capable of span powering two H4Rs and one H4TU-R. Follow these steps to utilize the graph shown in Figure 23:

a) Find the line on the graph which represents the known third segment resistance. These are the lines running diagonally across the graph labeled 300 - 1100 ohms. This line represents the upper limit for two H4Rs plus H4TU-R span powering.

b) Find the first segment resistance on the vertical axis.

c) Find the second segment resistance on the horizontal axis.

d) Find the instance where the two points from Steps b and c meet on the graph.

e) The point found in step d must be below the upper limit line defined by the third segment measurement (Step a). If the instance where these two points is above this line, the H4TU-C cannot span power two H4Rs and the H4TU-R.

Note that these measurements represent only one of the two HDSL4 pairs.

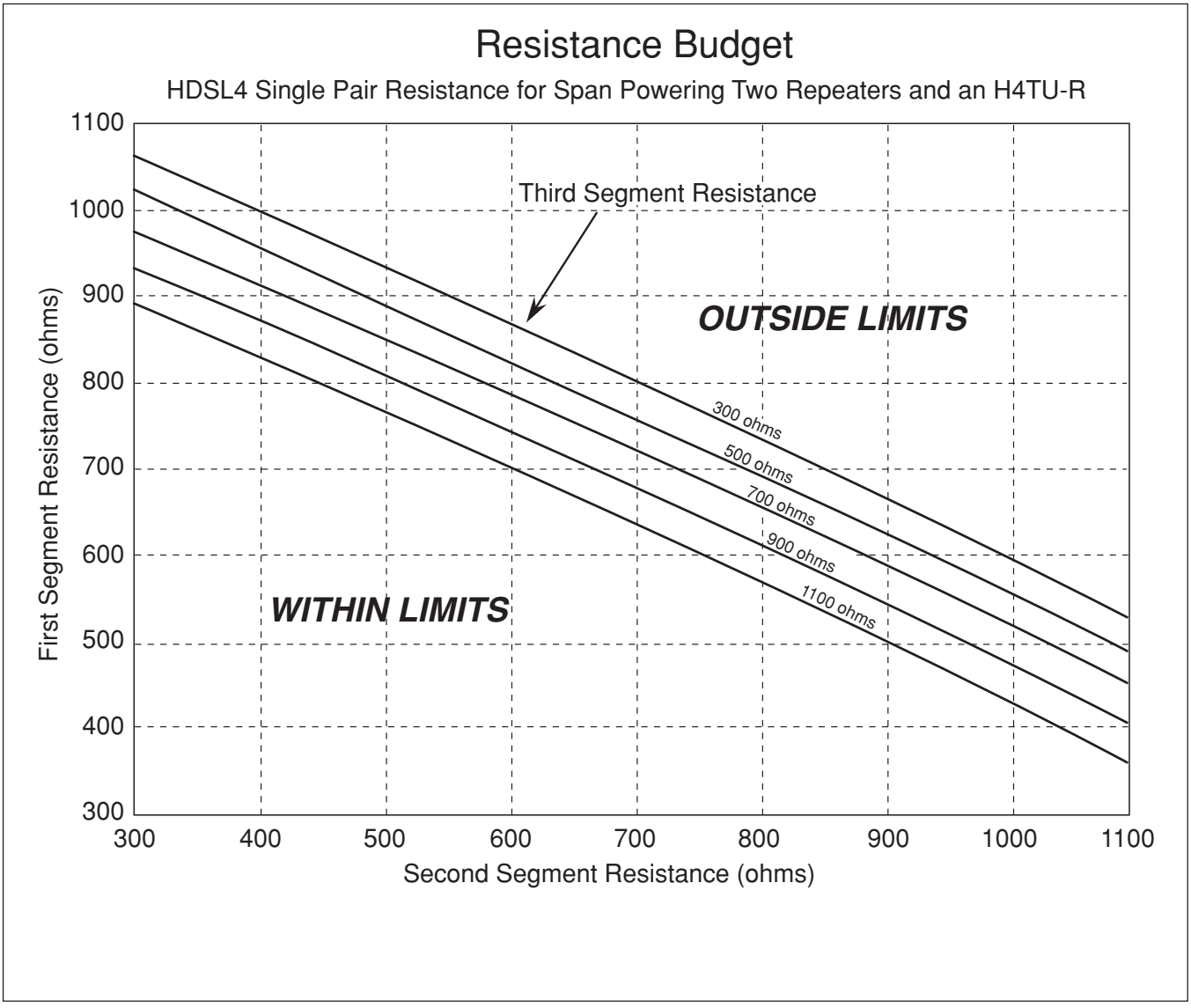



**Figure 23. Resistance Budget Span Powering Two Repeaters**

An example problem is illustrated in **Figure 24**. For this example, begin with three known measurements: 600 ohm first segment resistance, 700 ohm second segment resistance, and 900 ohm third segment resistance. Refer to Figure 24 and the following steps to solve the example problem:

a) Find the 900 ohm third segment resistance line on the graph. This line is depicted in bold in Figure 24. This line is the upper span power limit.

b) Find the 600 ohm first segment resistance point on the vertical axis.

c) Find the 700 ohm second segment resistance point on the horizontal axis.

d) Find the instance on the graph where the points from Steps b and c meet.

e) If this point is below the bold line defined in Step a, the circuit is capable of span powering two H4Rs and one H4TU-R.

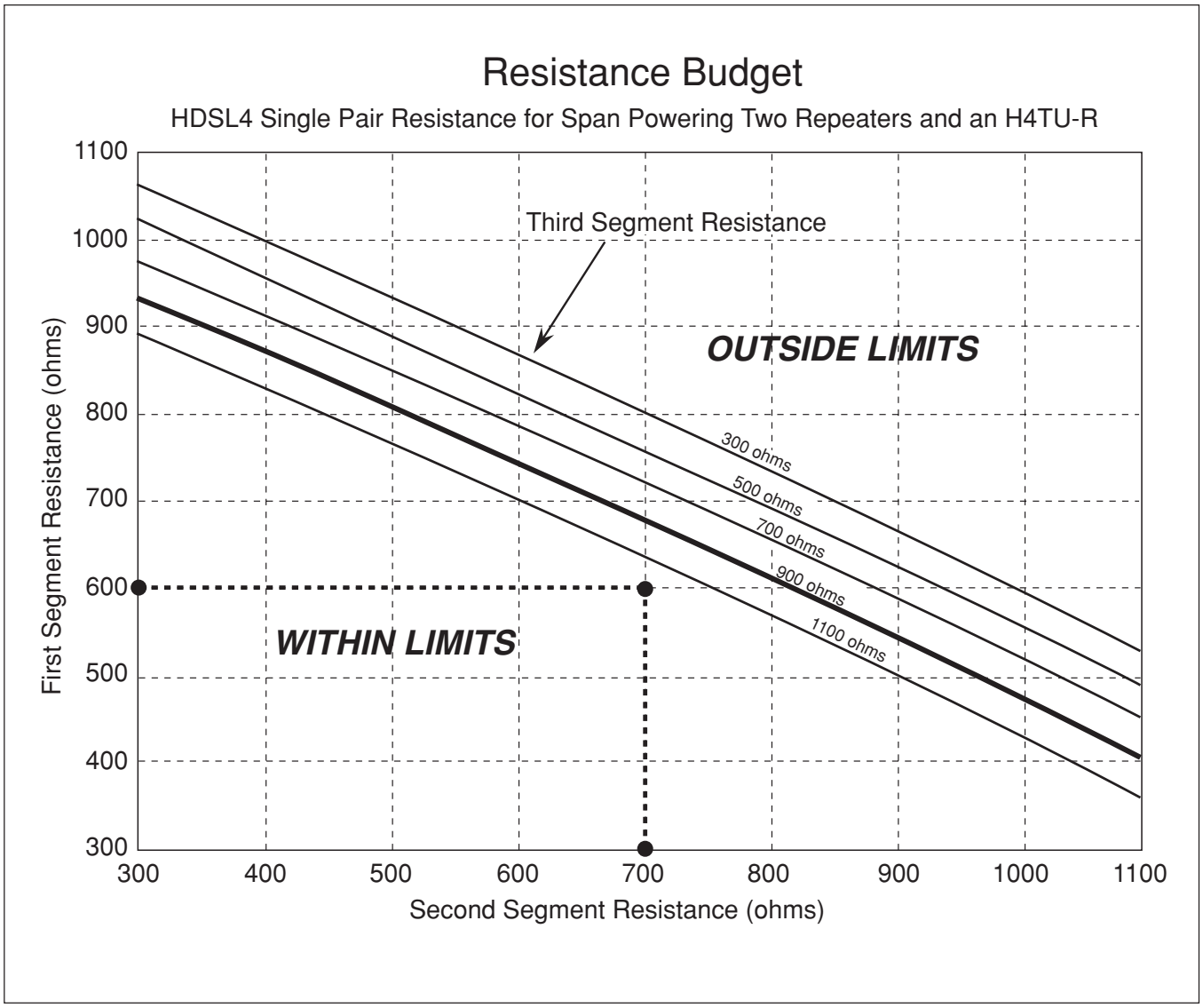



**Figure 24. Resistance Budget Span Powering Two Repeaters (Example)**

8. Insertion Loss limits. See **Table 10**.

   The asymmetric nature of the HDSL4 TC PAM line code necessitates that insertion loss be verified at 4 separate frequencies. Verifying at only 196 kHz will not insure proper circuit performance.

9. Field Technician Simplified Loop Qualification Procedure. See **Table 11** and **Table 12**.

For each of the four (or three for second and third segment) measured insertion loss values, compute the difference between the recommended maximum loss and the measured loss (rec minus measured). If all differences are positive, then the loop meets the performance criteria. If any one of the difference values is negative (measured loss is more than rec maximum loss), then the sum of the differences must be at least +3dB for 1st segment or +1 dB for 2nd/3rd segment. If neither of these criteria is satisfied, then the loop is suspect and may not provide robust HDSL4 deployment.

### Table 10. HDSL4 Loop Insertion Loss Values
**(Based upon 26 AWG cable)**

| | Recommended Maximum | |
|---|---|---|
| **Frequency (KHz)** | **1st Segment Loss (dB)** | **2nd/3rd Segment Loss (dB)** |
| 50 | 31.5 | 29.9 |
| 80 | 35.3 | 33.5 |
| 130 | 39.1 | 37.1 |
| 196 | 43.0 | N/A |

### Table 11. Single Span and First Segment of Repeatered Loop
**(Based upon 11.1 kft. of 26 AWG cable)**

| Frequency (kHz) | Recommended Maximum Loss (dB) | Measured Loss (dB) | Delta Loss (dB) (Max-Meas) |
|---|---|---|---|
| 50 | 31.5 | | |
| 80 | 35.3 | | |
| 130 | 39.1 | | |
| 196 | 43.0 | | |
| | | [1]Sum Delta Loss = | |

[1] If any single frequency insertion loss exceeds the maximum loss (delta loss < 0), then the sum of the four delta loss values must be > 3.0 dB

### Table 12. Second or Third Segment of Repeatered Loop
**(Based upon 10.5 kft. of 26 AWG cable)**

| Frequency (kHz) | Recommended Maximum Loss (dB) | Measured Loss (dB) | Delta Loss (dB) (Max-Meas) |
|---|---|---|---|
| 50 | 29.9 | | |
| 80 | 33.5 | | |
| 130 | 37.1 | | |
| | | [1]Sum Delta Loss = | |

[1] If any single frequency insertion loss exceeds the maximum loss (delta loss < 0), then the sum of the four delta loss values must be > 3.0 dB

## 8. TROUBLESHOOTING PROCEDURES

Use **Table 13** to troubleshoot the ADTRAN H4TU-R.

## 9. MAINTENANCE

The ADTRAN H4TU-R requires no routine maintenance. In case of equipment malfunction, use the front panel bantam jack and/or DB-9 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 and Product Service (CAPS) Department.

## 10. PRODUCT SPECIFICATIONS

**Table 14** lists the H4TU-R specifications.

## 11. WARRANTY AND CUSTOMER SERVICE

ADTRAN will replace or repair this product within the warranty period if it does not meet its published specifications or fails while in service. Warranty information can be found at www.adtran.com/warranty.

U.S. and Canada customers can also receive a copy of the warranty via ADTRAN's toll-free faxback server at 877-457-5007.

- Request Document 414 for the *U.S. and Canada Carrier Networks Equipment Warranty*.
- Request Document 901 for the *U.S. and Canada Enterprise Networks Equipment Warranty*.

Refer to the following subsections for sales, support, CAPS requests, or further information.

### ADTRAN Sales

Pricing/Availability:

800-827-0807

### ADTRAN Technical Support

Pre-Sales Applications/Post-Sales Technical Assistance:

800-726-8663

Standard hours: Monday - Friday, 7 a.m. - 7 p.m. CST
Emergency hours: 7 days/week, 24 hours/day

### ADTRAN Repair/CAPS

Return for Repair/Upgrade:

(256) 963-8722

### Repair and Return Address

Contact Customer and Product Service (CAPS) prior to returning equipment to ADTRAN.

ADTRAN, Inc.
CAPS Department
901 Explorer Boulevard
Huntsville, Alabama 35806-2807

**Table 13. Troubleshooting Guide**

| |
|---|
| Condition: All front panel indicators are *off*.<br><br>Solutions:<br>1. Make sure the H4TU-R is properly seated in the housing.<br>2. Verify that the local power of –48 VDC (±24 VDC) is available at the housing.<br>3. If Steps 1 and 2 pass, but indicators are still off, replace the H4TU-R. |
| Condition: DSL 1/DSL 2 LED is *red*.<br><br>Solutions:<br>1. Verify that loss (attenuation) on Detailed System Status screen is < 35 dB on the first segment of the circuit and < 31 dB on the second and third segments.<br>2. Verify that the loops conform with HDSL4 Deployment Guidelines. See *Section 7*.<br>3. Verify that noise on the HDSL4 loops is within acceptable limits.<br>4. If Steps 1 through 3 pass and LED is *red*, replace the H4TU-R. |

## Table 14. ADTRAN T200 H4TU-R Specifications

| Specifications | Descriptions |
|---|---|
| **Loop Interface** | |
| Modulation Type | 16 TC PAM |
| Mode | Full duplex, partially overlapped echo canceling |
| Number of Pairs | 2 |
| Line Rate | 1.552 Mbps |
| Baud Rate | 261.333 k baud |
| Loop Loss | Refer to the *Deployment Guidelines* section of this practice |
| Bridged Taps | Single Taps < 2000 ft., Total Taps < 2500 ft. |
| Performance | Compliant with T1.418-2002 (HDSL2 Standard, issue 2) |
| H4TU-C Transmit Power (Data) Level | 14.1 ±0.5 dBm (0 to 400 kHz) |
| H4TU-C Transmit Power (Activation) Level | 14.1 ±0.5 dBm (0 to 307 kHz) |
| Input Impedence | 135 Ω |
| Maximum Loop Resistance | 1150 Ω (nonrepeatered circuit) |
| Return Loss | 12 dB (50 kHz to 200 kHz) |
| **Network Interface** | |
| DS1 Transmit Level | 0 dB, –7.5 dB (default), –15 dB |
| DSX-1 Line Buildout | 0-133 ft ABAM (default)<br>133-266 ft ABAM<br>266-399 ft ABAM<br>399-533 ft ABAM<br>533-655 ft ABAM |
| DSX-1 Line Code | B8ZS (default), AMI |
| **Power**<br>Tested with the ADTRAN H4TU-C (1221401L1) and H4R (1221445L1) | |
| H4TU-R Power Dissipation | 5.0 watts |
| Local Power | –48 VDC/±24 VDC |
| Fusing | 1.00 A (not field-replaceable) |
| **Clock** | |
| Clock Sources | DSX-1 derived (with HDSL4 frame bit stuffing) |
| Internal Clock Accuracy | ±25 ppm (exceeds Stratum 4), Meets T1.101 timing requirements |
| **Tests** | |
| Diagnostics | Self-Test, Local Loopback (H4TU-C), Remote Loopback (H4TU-R) |
| **Physical** | |
| T200 Office Repeater Shelf-Mounted | |
| Dimensions | 5.5 in. high, x 0.7 in. wide, x 6.0 in. deep |
| Weight | < 1 lb. |
| **Environment** | |
| Operating Temperature (Standard) | –40ºC to +70ºC |
| Storage Temperature | –40ºC to +85ºC |
| **Compliance** | |
| UL 60950 Safety Listed<br>GR-1089-CORE<br>GR-63-CORE<br>ANSI T1.418-2001, Issue 2<br>ANSI T1.102 (DS1 Interface) | |
| **Part Number** | |
| T200 H4TU-R, Local Power | 1222424L1 |

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# Appendix A
# HDSL4 Loopbacks

## HDSL4 MAINTENANCE MODES

This appendix describes operation of the HDSL4 system with regard to detection of in-band and ESF facility data link loopback codes.

Upon deactivation of a loopback, the HDSL4 system will synchronize automatically.

### Loopback Process Description

In general, the loopback process for the HDSL4 system elements is modeled on the corresponding DS1 system process. Specifically, the H4TU-C loopback is similar to an Intelligent Office Repeater loopback, and the H4TU-R loopbacks are similar to a T1 Smart Jack loopback.

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

### Loopback Control Codes

A summary of network and customer control sequences is given in **Table A-1** and **Table 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. HDSL4 Loopback Control Codes

| Type | Source [1] | Code [2, 3] | Name |
|---|---|---|---|
| Abbreviated | (N) | 3in7 (1110000) | Loopback data from network toward network in the H4TU-R |
| | (N) | 4in7 (1111000) | Loopback data from network toward network in the H4TU-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 H4TU-C |
| | (C) | 5in7 (1111100) | Loopback data from customer toward customer in H4TU-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 (1111 1111 0001 1110) | Loopback data from network toward network at H4TU-C |
| | (C) | 3F1E (0011 1111 0001 1110) | Loopback data from customer toward customer at H4TU-C |
| | (N) | FF04 (1111 1111 0000 0100) | Loopback data from network toward network at HRE1 |
| | (N) | FF06 (1111 1111 0000 0110) | Loopback data from network toward network at HRE2 |
| | (C) | 3F04 (0011 1111 0000 0100) | Loopback data from customer toward customer at HRE1 |
| | (C) | 3F06 (0011 1111 0000 0110) | Loopback data from customer toward customer at HRE2 |
| | (N) | FF02 (1111 1111 0000 0010) | Loopback data from network toward network at H4TU-R |
| | (C) | 3F02 (0011 1111 0000 0010) | Loopback data from customer toward customer at H4TU-R |
| | (C) | FF48 (ESF-DL) (1111 1111 0100 1000) | Loopback data from customer toward customer at H4TU-R |
| | (N) | 1in6 (100000) | Loopback data from network toward network at H4TU-R |
| | (N) | FF48 (ESF-DL) (1111 1111 0100 1000) | Loopback data from network toward network at H4TU-R |
| | (N/C) | 1in3 (100) | Loopdown everything |
| | (N/C) | FF24 (ESF-DL) (1111 1111 0010 0100) | Loopdown everything |

[A-1] 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.

[A-2] All codes are inband unless labeled ESF-DL

[A-3] All codes listed above must be sent for a minimum of 5 seconds to be detected and acted upon.

## Table A-2. Loopback and Control Codes

| Function | Code | Response |
|---|---|---|
| ARM (in-band)–also known as 2-in-5 pattern | 11000 (binary) | If the pattern is sent from the network, the units will arm, and the H4TU-R will loop up if NIU Loopback is enabled. |
| ARM (ESF Data Link) | FF48 (hex) or 1111 1111 0100 1000 (binary) sent in the Facility Data Link | If the pattern is sent from the network, the units will arm, and the H4TU-R will loop up if NIU Loopback is enabled. This code has no functionality when sent from the customer. |
| Disarm (in-band)–also known as 3-in-5 pattern | 11100 (binary) | When sent from the network or customer, all units are removed from the armed state, and loopbacks will be released. |
| Disarm (ESF Data Link) | FF24 (hex) or 1111 1111 0010 0100 (binary) sent in the Facility Data Link | When sent from the network or customer, all units are removed from the armed state, and loopbacks will be released. |
| H4TU-C Loop Up[1,2] | D3D3 (hex) or 1101 0011 1101 0011 (binary) | If armed, the H4TU-C will loop up, 2 seconds of AIS (all 1s) will be transmitted, the looped data will be sent for 5 seconds, and then a burst of 231 logic errors will be injected. The burst of 231 logic errors will continue every 20 seconds as long as the D3D3 pattern is detected. When the pattern is removed, the unit will remain in loopback. If the pattern is re-instated, the injection of 231 logic errors will continue every 20 seconds. |
| Loop Down w/o Disarm | 9393 (hex) or 1001 0011 1001 0011 (binary) | When sent from the network, all units currently in loopback will loop down. Armed units will not disarm. In order to behave like a smartjack, the H4TU-R will not loop down from a network loopback in response to the 9393 pattern if NIU Loopback is enabled. |
| Loopback Query[1] | D5D5 (hex) or 1101 0101 1101 0101 (binary) | When the pattern is sent from the network, logic errors will be injected toward the network to indicate a loopback is present toward the network. The number of errors injected is determined by the nearest unit that is in loopback. As long as the pattern continues to be sent, errors are injected again every 20 seconds. 231 errors = H4TUC; 10 errors = H4R #1; 200 errors = H4R #2; 20 errors = H4TU-R. |

[1]Units must be armed with 11000b or FF48h before this code will work.
[2]Loopback and error injection will only occur if the in-band code is received by the unit that is to go into loopback. In other words, if another loopback blocks the in-band code from being transmitted to the unit that is to go into loopback, loopback and error injection will not occur.
Note: All codes listed above must be sent for a minimum of 5 seconds to be detected and acted upon.

## Table A-2. Loopback and Control Codes (continued)

| Function | Code | Response |
|---|---|---|
| Loopback Time Out Override[1] | D5D6 (hex) or 1101 0101 1101 0110 (binary) | If the units are armed or a unit is currently in loopback when this pattern is sent from the network, the loopback time out will be disabled. As long as the units remain armed, the time out will remain disabled. When the units are disarmed, the loopback time out will revert to the previous loopback time out setting. If any element is in network loopback, a bit error confirmation will be sent.<br>H4TU-C.....231 bps<br>H4R1.....110 bps<br>H4R2.....2200 bps<br>H4TU-R.....20 bps |
| Span Power Disable[1] | 6767 (hex) or 0110 0111 0110 0111 (binary) | If the units are armed and 6767 is sent from the network, the H4TU-C will disable span power. If the pattern is sent from the network, the span power will be disabled as long as 6767 pattern is detected. Once the pattern is no longer received, the H4TU-C will reactivate span power. All units will then retrain and return to the disarmed and unlooped state. |
| First H4R Loop Up[1,2] | C741<br>(1100 0111 0100 0001) | If one or more H4Rs are present, the H4R closest to the H4TU-C will loop up toward the network, 2 seconds of AIS (all ones) will be transmitted, the looped data will be sent for 5 seconds, and then a burst of 10 logic errors will be injected. The burst of 10 logic errors will continue every 20 seconds as long as the C741 pattern is detected. When the pattern is removed, the unit will remain in loopback. If the pattern is re-instated, the injection of 10 logic errors will continue every 20 seconds. |
| Second H4R Loop Up[1,2] | C754<br>(1100 0111 0101 0100) | If two H4Rs are present, the second H4R from the H4TU-C will loop up toward the network, 2 seconds of AIS (all ones) will be transmitted, the looped data will be sent for 5 seconds, and then a burst of 200 logic errors will be injected. The burst of 200 logic errors will continue every 20 seconds as long as the C754 pattern is detected. When the pattern is removed, the unit will remain in loopback. If the pattern is re-instated, the injection of 200 logic errors will continue every 20 seconds. |
| H4TU-R Address 20 for Extended Demarc[1,2] | C742<br>(1100 0111 0100 0010) | If armed, the H4TU-R will loop up toward the network, 2 seconds of AIS (all ones) will be transmitted, the looped data will be sent for 5 seconds, and then a burst of 20 logic errors will be injected. The burst of 20 logic errors will continue every 10 seconds as long as the C742 pattern is detected. When the pattern is removed, the unit will remain in loopback. If the pattern is re-instated, the injection of 20 logic errors will continue every 20 seconds. |

[1]Units must be armed with 11000b or FF48h before this code will work.
[2]Loopback and error injection will only occur if the in-band code is received by the unit that is to go into loopback. In other words, if another loopback blocks the in-band code from being transmitted to the unit that is to go into loopback, loopback and error injection will not occur.
Note: All codes listed above must be sent for a minimum of 5 seconds to be detected and acted upon.