HDSL4 T200 H4TU-R
Installation and Maintenance Practice

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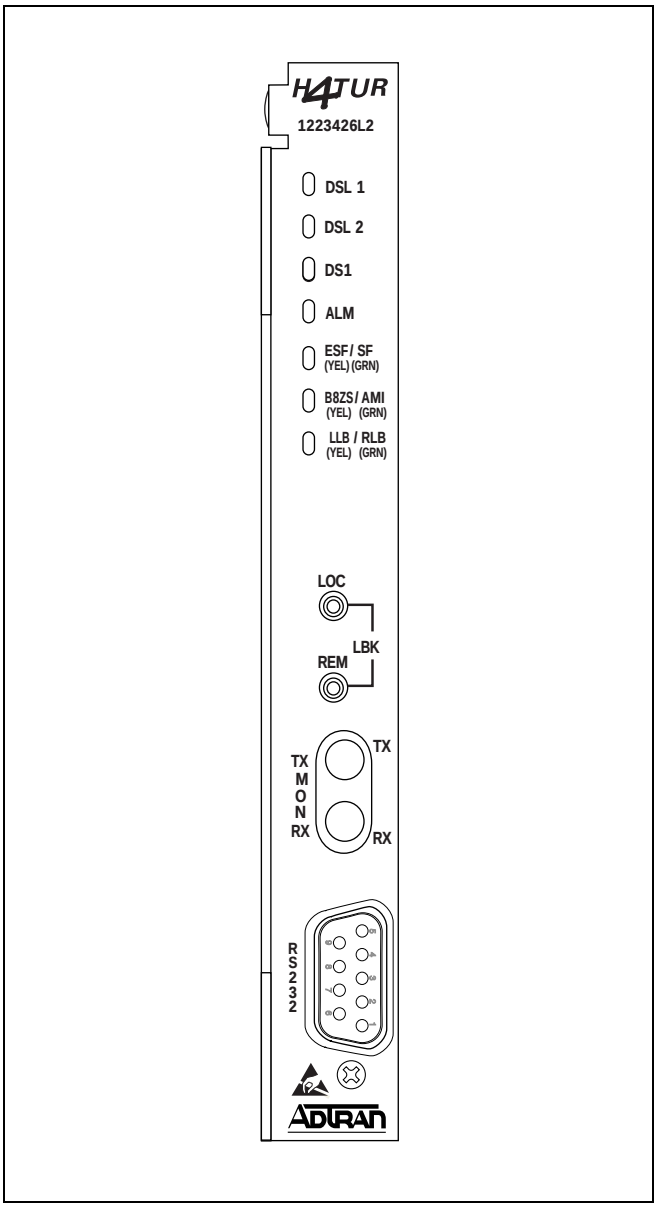


Figure 1. ADTRAN HDSL4 T200 H4TU-R

1. GENERAL

The ADTRAN 4-wire T200 HDSL4 transceiver unit for the remote end (H4TU-R), P/N 1223426L2, is a network terminating unit used to deploy an HDSL4 T1 circuit using 4-wire metallic facilities. See **Figure 1**. The H4TU-R is a T200 mechanics card, which will fit Type 200 or Type 400 mechanic enclosures. The H4TU-R can be housed in the ADTRAN standalone metal enclosures (P/N 1242034LX or P/N 1245034L1). Refer to the appropriate ADTRAN practice for more information. The T200 H4TU-R card can also plug into the ADTRAN HR12 HDSL4 remote shelf (P/N 1242007LX), or the ADTRAN HR4 HDSL4 remote shelf (P/N 1242008L1).

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 in **Table 1**.

Table 1. ADTRAN Unit Compatability

Unit Number	Description
122x401L1 or L2	220/E220 H2TU-C (G2)
122x003L1 or L2	DDM+ H2TU-C (G2)
122x004L1 or L2	3192 H2TU-R (G2)
118141xL1	Total Access H2TU-C
122x441L1	T200 H4R
122x445L1	239 H4R

NOTE: x = any generic release number

The T200 H4TU-R can be deployed in circuits using one H4TU-C, one H4TU-R, and up to two H4Rs.

The T200 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 T200 H4TU-R can be used with any H4TU-C to complete a fully span-powered HDSL4 circuit with up to two H4Rs. Span power is provided from the H4TU-C.

NOTE

This unit is intended for Span Power Only. If a locally powered unit is needed, refer to P/N 122x424L2.

Revision History

This is the initial release of this document. Future revisions to this document will be explained in this subsection.

2. INSTALLATION

After unpacking the unit, inspect it for damage. If damage is discovered, file a claim with the carrier, then contact ADTRAN. Refer to the *Warranty and Customer Service* section in this practice. The settings on the H4TU-C are encoded and transmitted to the T200 H4TU-R once the circuit has achieved synchronization. There are no switch settings on the T200 H4TU-R.

To install the T200 H4TU-R, perform the following steps:

1. If present, remove the Access Module Blank from the appropriate access module slot of the chassis.
2. Hold the T200 H4TU-R by the front panel while supporting the bottom edge of the module.
3. Align the module edges to fit in the lower and upper guide grooves for the access module slot.
4. Slide the module into the access module slot. Simultaneous thumb pressure at the top and at the bottom of the module will ensure that the module is firmly positioned against the backplane of the chassis.

WARNING

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

Compliance

Table 2 shows the compliance codes for the T200 H4TU-R. This product is intended for installation in equipment with a Type “B” or “E” enclosure.

This product meets all requirements of Bellcore GR-1089-CORE (Class A2), ANSI T1.418-2002 and is NRTL listed to the applicable UL standards.

Table 2. Compliance Codes

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

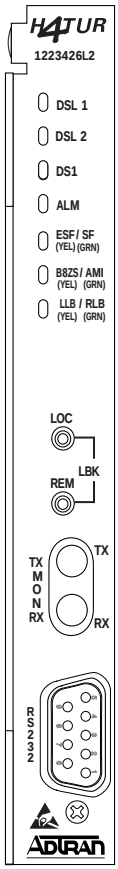
Front Panel LED Indicators

There are seven front panel mounted status LED indicators. Each indicator is described in **Table 3**.

Front Panel DS1 Monitor Jack

The T200 H4TU-R provides DS1 monitor bantam jacks. These jacks provide a test point for DS1 traffic to and from the customer. Refer to the *HDSL4 System Testing* section for details.

Table 3. Front Panel Indicators

Front Panel	Name	Indication	Description
	**DSL 1**	Green	DSL Loop 1 sync, no errors currently detected, and signal margin ≥3dB
		Red	No DSL Loop 1 sync, errors being detected, or signal margin <3dB
	DSL 2	Green	DSL Loop 2 sync, no errors currently detected, and signal margin ≥3dB
		Red	No DSL Loop 2 sync, errors being detected, or signal margin <3dB
	DS1	Green	DSX-1 signal is present and no errors currently being detected
		Red	No DSX-1 signal or signal is present with errors
	ALM	OFF	No active alarm present
		Red	Loss of DSX-1 signal to the unit
		Yellow	Loss of DS1 signal to the remote
	ESF/SF	OFF	Unit is provisioned for UNFRAMED data
		Yellow	Unit is provisioned for ESF data
		Green	Unit is provisioned for SF data
	B8ZS/AMI	Yellow	Unit is provisioned for B8ZS coded data
		Green	Unit is provisioned for AMI data
	LLB/RLB	OFF	Unit is NOT in loopback
		Yellow	Unit is in loopback (network and/or customer)
		Green	H4TU-C is in loopback toward this unit

Remote Provisioning

There are no configuration switches for the T200 H4TU-R. Configuration is performed via software discussed in the *Control Port Operation* section of this practice.

The provisioning settings can be viewed and manipulated through management access via the front panel RS-232 port. **Table 4** lists the available provisioning options and their factory default settings.

Table 4. Provisioning Options

Provisioning Option	Option Settings	Default Settings
1. DSX-1 Line Build Out	0-133 ft. 133-266 ft. 266-399 ft. 399-533 ft. 533-655 ft.	0 to 133 ft.
2. DSX-1/DS1 Line Code	B8ZS AMI	B8ZS
3. DSX-1/DS1 Framing	SF ESF Unframed Auto	ESF
4. Force Frame Conversion	Disabled Enabled	Disabled
5. Smartjack Loopback	Disabled Enabled	Enabled
6. Loopback Time Out	None 120 Min	120 Minutes
7. Latching Loopback Mode	T1 (Disabled) FT1 (Enabled)	T1 (Disabled)
8. DS1 Tx Level	0 dB -7.5 dB -15 dB	0 dB
9. Customer Loss Indicator	AIS Loopback AIS/CI	AIS/CI
10. Performance Reporting Messages	None SPRM NPRM AUTO (both)	AUTO
11. Loop Attenuation Alarm Threshold	0 (Disabled) 1-99 dB	34 dB
12. SNR Margin Alarm Threshold	0 (Disabled) 1-15 dB	04 dB
13. Remote Provisioning	Disabled Enabled	Enabled

3. CONNECTIONS

All connections of the T200 H4TU-R are made through card edge connectors. **Figure 2** gives the card edge pin assignments for the T200 H4TU-R circuit pack.

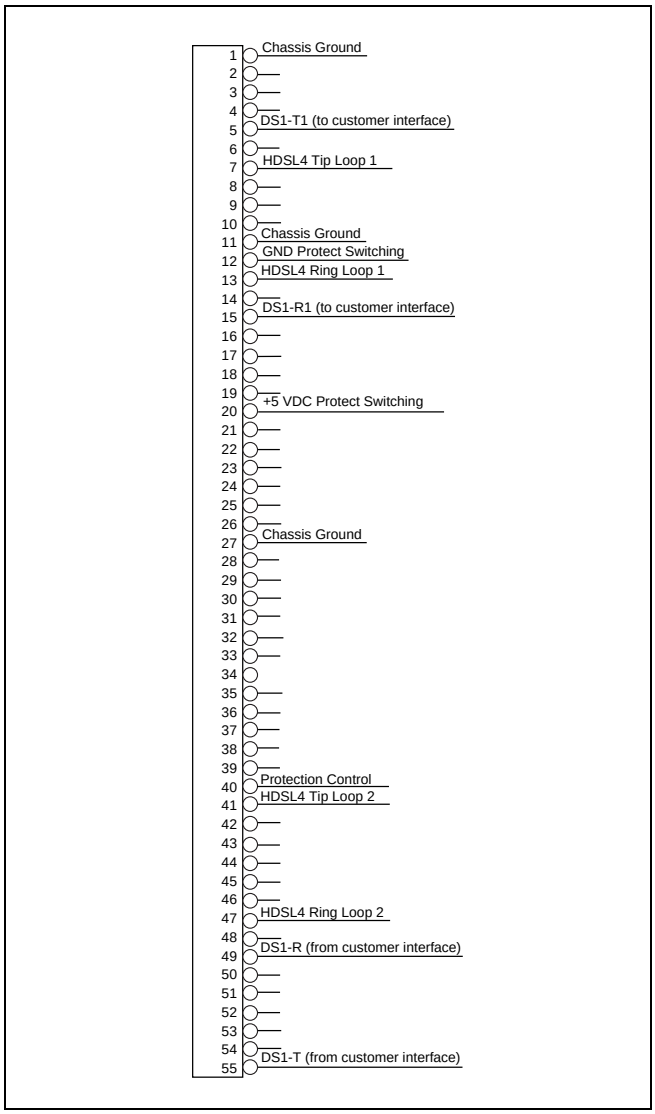


Figure 2. H4TU-R Edge Connector Wiring

When the circuit pack is installed in any H4TU-R enclosure, all connections are made through the enclosure backplanes. See the following ADTRAN documents for more information:

Document No.	Description
61242007Lx-5	HR12 I&M
61242008L1-5	HR4 I&M
61242034L2-5	T400 Single Mount I&M
61242034L3-5	T400 Single Mount HV I&M
61245034L1-5	T200 Dual Mount I&M

NOTE: x = any generic number

CAUTION

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

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. Refer to the *Installation* section for details.

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* sections for more details.

DS1 MON Bantam Jacks

The MON jack provides a non intrusive 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 3 is an illustration of specific jack detail.

NOTE

For the MON jacks, the TX and RX indications relate to the direction of the signal to/from the CPE.

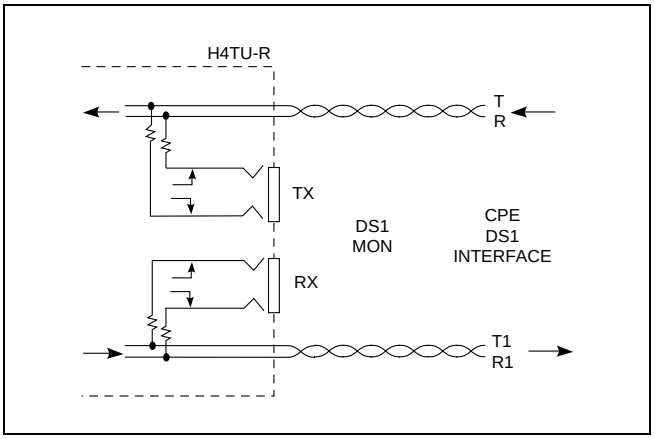


Figure 3. H4TU-R MON Diagram

H4TU-R Network Loopbacks

The loopback position is a logic loopback located within the H4TU-R internal HDSL4 transceiver. See **Figure 4**.

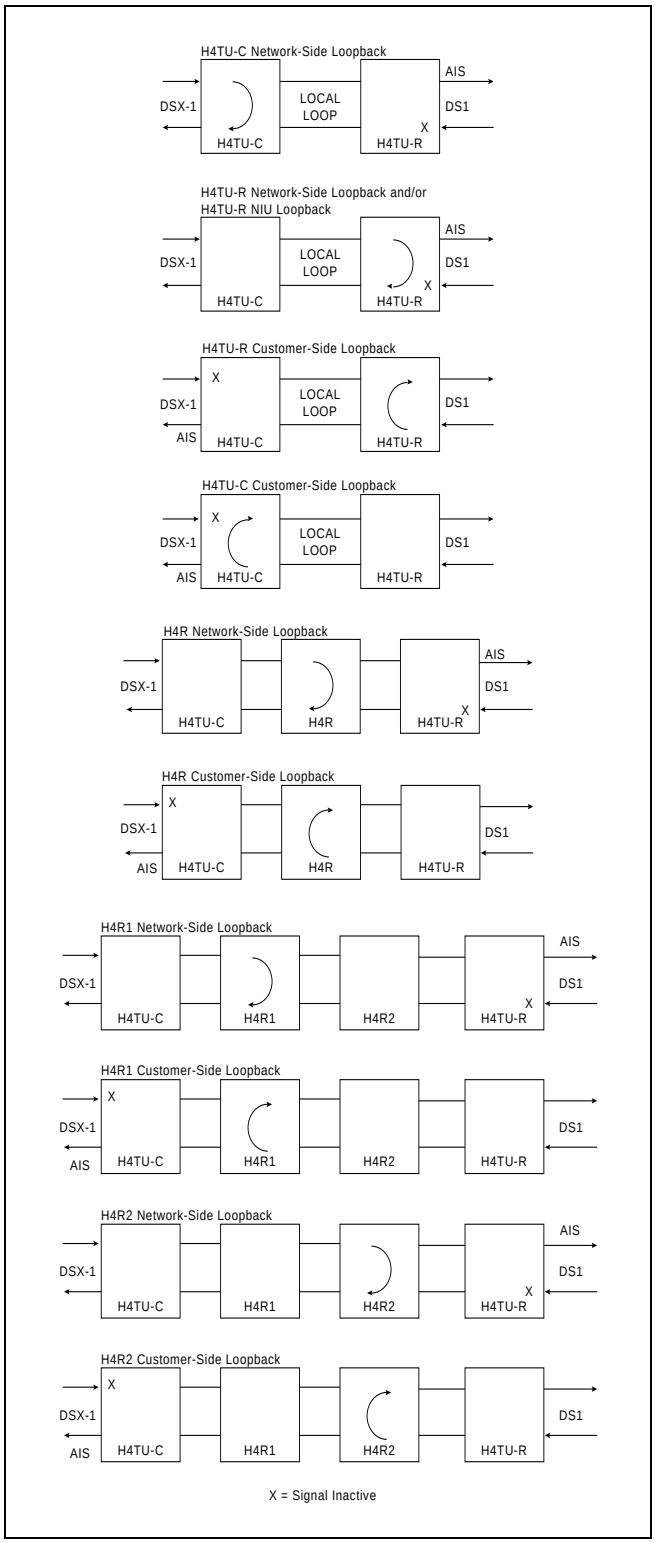


Figure 4. HDSL4 Loopbacks

The H4TU-R responds to multiple loopback activation processes.

- First, manual loopback on the H4TU-R and/or the H4TU-C unit may be controlled from the front panel. Refer to the *Front Panel Operation* section of this practice for more detail.
- Second, loopback activation may be accomplished using the control port of the H4TU-R.
- Third, the H4TU-R will respond to the industry standard HDSL loopback codes as designated in the ANSI document T1E1.4/92. These are described in *Appendix A*, *HDSL4 Loopbacks*.
- Fourth, the H4TU-R responds to T1 Network Interface Unit (NIU) loopback codes as described in Bellcore TR-TSY-000312. These 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 (FF 48)
Loop down	1111 1111 0010 0100 (FF 24)

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 loopback codes by activating the NIU loopback from either the disarmed or armed state. The loop down codes will return the H4TU-R to the disarmed or de-activated state depending upon the code utilized.

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 4.

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. These are 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 loopback toward the H4TU-R and network 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 5**.

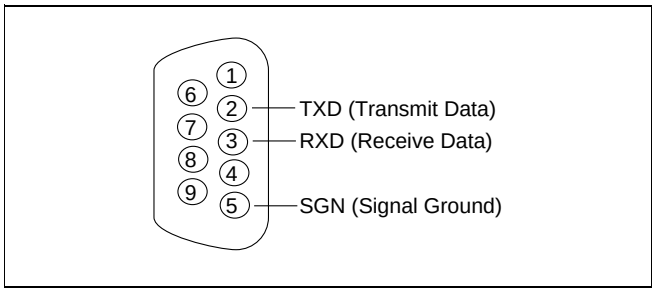


Figure 5. RS-232 (DB-9) Connector Pinout

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 a personal computer with terminal emulation capability is being used, 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

The screens illustrated in the following section apply to an HDSL4 circuit deployed with the ADTRAN HDSL4 technology. The circuit includes an H4TU-C, up to two H4Rs and an H4TU-R. Other configurations are possible (such as use of another vendor's equipment) and their displays will vary slightly from those shown in this section.

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 is presented as illustrated in **Figure 6**.

This ADTRAN HDSL4 Main Menu provides access to detailed performance and configuration information. The OAM&P (Operation, Administration, Maintenance, and Provisioning) screens are available as listed on the Main Menu (Figure 6). To access a particular menu item, press the number associated with that item, and press ENTER.

The HDSL4 Unit Information Screen (**Figure 7**) 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.

```
Circuit ID:                                                  10/01/03 09:29:45

                            Adtran HDSL4 Main Menu


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




                         Selection:
```

Figure 6. HDSL4 Main Menu

```
Circuit ID:                                                  10/01/03 09:29:45
                    Press ESC to return to previous menu

                                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: 1223403L2                     P/N: 1222426L1
             S/N: 123456789                     S/N: 123456789
            CLEI: T1L7PODAAA                   CLEI: T1L5JZTCAAA
            Manf: 01/01/2000                   Manf: 01/01/2000
             Ver: 24  1 A00000                  Ver: 27  2 A00000

             ADTN H4R1                          ADTN H4R2
             P/N: 1221445L1                     P/N: 1221445L1
             S/N: BB50A8343                     S/N: BB50A8353
            CLEI: T1R5YP3DAA                   CLEI: T1R5YP3DAA
            Manf: 02/12/2002                   Manf: 02/12/2002
             Ver: 21  1 A00001                  Ver: 21  1 A00001
```

Figure 7. Unit Information Screen

The Provisioning menu (**Figure 8**) displays current provisioning settings for the HDSL4 circuit. Options that can be changed from this screen are labeled with a number (for example, "1" for DSX-1 Line Build Out). To change a particular option setting, select the appropriate number, and a new menu will appear with a list of the available settings.

The options shown in Table 4 are available with the T200 H4TU-R (P/N 1223426L2). Some settings may differ when using different H4TU-Rs.

The Span Status Screen (**Figure 9**) provides quick access to status information for each HDSL4 receiver in the circuit.

```
Circuit ID:                                              10/01/03 09:29:45
                    Press ESC to return to previous menu


                              Provisioning

                    1.  DSX-1 Line Buildout     =  0-133 ft
                    2.  DSX-1/DS1 Line Code     =  B8ZS
                    3.  DSX-1/DS1 Framing       =  ESF
                    4.  Forced Frame Conversion =  Disabled
                    5.  Smartjack Loopback      =  Enabled
                    6.  Loopback Timeout        =  120 Min
                    7.  Latching Loopback Mode  =  T1 (Disabled)
                    8.  DS1 TX Level            =  0 dB
                    9.  Span Power              =  Enabled
                   10.  Customer Loss Indicator =  AIS/CI
                   11.  PRM Setting             =  AUTO
                   12.  Loop Atten Alarm Thres  =  34dB
                   13.  SNR Margin Alarm Thres  =  04dB
                   14.  Remote Provisioning     =  Enabled
                    D.  Restore Factory Defaults


                                  Selection:
```

Figure 8. Provisioning Menu

```
Circuit ID:                                              10/01/03 09:29:45
                    Press ESC to return to previous menu

                              Span Status Screen

      ______          ______          ______                      ______
NET  |      |        |      |        |      |                    |      |  CUST
     |      |        |      |        |      |                    |      |
----->|      |--------|      |--------|      |--------------------|      |----->
     |      |        |      |        |      |                    |      |
     |      |        |      |        |      |                    |      |
<-----|      |--------|      |--------|      |--------------------|      |<-----
     |      |        |      |        |      |                    |      |
DSX-1|______|        |______|        |______|                    |______|   DS1
      H4TUC           H4R 1           H4R 2                       H4TUR


                                  1.  View Detailed Status


                                  Selection:
```

Figure 9. Span Status Screen

The Detailed Status Screen from the Span Status menu (**Figure 10**), displays the HDSL4 status for each receiver point.

The Loopbacks and Test Commands menu (**Figure 11**) provides 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. Unit self tests can also be initiated from this screen.

```
Circuit ID:                                                  10/01/03 09:29:45
                        Press ESC to return to previous menu

                              Detailed Status Screen

                    LOOP 1                              LOOP 2
                 MARGIN       ATTEN                  MARGIN       ATTEN
Interface    (CUR/MIN/MAX)  (CUR/MAX)            (CUR/MIN/MAX)  (CUR/MAX)
---------    -------------- ---------            ------------- ---------
H4TUC          17/00/17      00/00                 17/00/17      00/00
H4R1 NETW      17/00/17      00/00                 17/13/17      00/00
H4R1 CUST      17/17/17      00/00                 17/00/17      00/00
H4R2 NETW      17/00/17      00/00                 17/13/17      00/00
H4R2 CUST      17/17/17      00/00                 17/00/17      00/00
H4TUR          17/00/17      00/00                 17/00/17      00/00




                                     1. Reset Min/Max
                                     2. View Performance History
                                     Selection:
```

Figure 10. Detailed Status Screen

```
Circuit ID:                                                  10/01/03 09:29:45
                        Press ESC to return to previous menu

                              Loopbacks and Test Commands


       ______          ______          ______                        ______
NET   |      |        |      |        |      |                      |      |  CUST
      |      |        |      |        |      |                      |      |
----->|      |--------|      |--------|      |----------------------|      |----->
      |      |        |      |        |      |                      |      |
      |      |        |      |        |      |                      |      |
<-----|      |--------|      |--------|      |----------------------|      |<-----
      |      |        |      |        |      |                      |      |
DSX-1 |______|        |______|        |______|                      |______|   DS1
       H4TUC           H4R 1           H4R 2                         H4TUR

        1.  Run Self Tests                    7.  H4R1  Loopup  Cust
        2.  H4TU-C  Loopup  Net               8.  H4R1  Loopup  Net
        3.  H4TU-C  Loopup  Cust              9.  H4R2  Loopup  Cust
        4.  H4TU-R  Loopup  Net
        5.  H4TU-R  Loopup  Cust
        6.  H4R1  Loopup  Net

                            Selection:
```

Figure 11. Loopbacks and Test Commands Menu

The Performance History screens (**Figure 12** and **Figure 13**) are used to select and display the historical HDSL4 and T1 performance data in several different registers. 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 previous 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. Line Data or Path Data results are available by selecting the appropriate menu item.

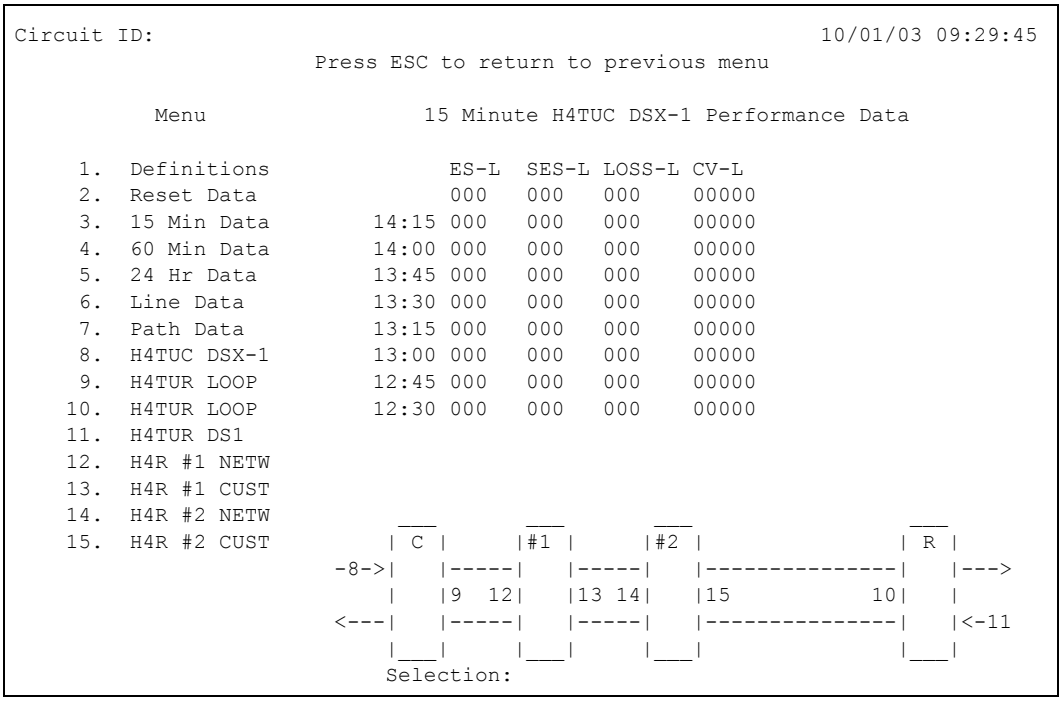


Figure 12. 15-Minute Performance Data Screen

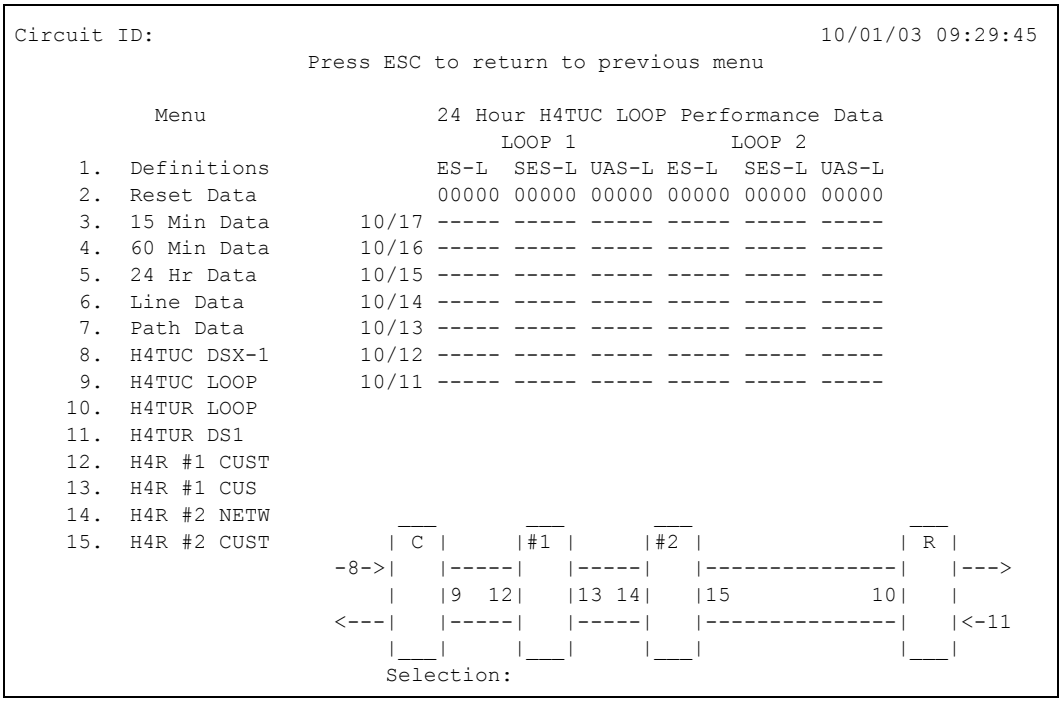


Figure 13. 24-Hour Performance Data Screen

Abbreviations used in the Performance History screens are defined in Performance Data Definitions screens (**Figure 14** and **Figure 15**).

Line related definitions are shown in Figure 14 while Path related definitions are provided in Figure 15.

```
Circuit ID:                                                  10/01/03 09:29:45


                          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 14. Performance Data Definitions

```
Circuit ID:                                                  10/01/03 09:29:45


                          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 15. Performance Data Definitions (Continued)

The Scratch Pad, Circuit ID, and Time/Date Screen (**Figure 16**) provides a Scratch Pad for user-defined information and 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 in the MMDDYY format. (For example, enter January 02, 2003, as “010203”.)

The T1 Alarm History menu (**Figure 17**) and HDSL4 Span History menu (**Figure 18**) provide a detailed alarm history and events log for the HDSL4 and T1 spans. These screens include a time, date, first and last occurrence, and count for each type of HDSL4 or T1 alarm. A historical alarm log is also available in the System Alarm menu.

```
Circuit ID:                                                  10/01/03 09:29:45




    Current Scratch Pad:
       New Scratch Pad =



        New Circuit ID =



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



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

Figure 16. Scratch Pad, Circuit ID, and Time/Date Screen

```
Circuit ID:                                                  10/01/03 09:29:45
Press ESC to return to previous menu

                                   T1 Alarm History
 LOCATION   ALARM       FIRST                LAST              CURRENT   COUNT
 ------------------------------------------------------------------------------

 H4TU-C    RED(LOS/LOF) 01/01/00  00:00:05   01/01/00  00:00:05 Alarm      001
  (DSX-1)  YELLOW(RAI)                                          OK       000
           BLUE(AIS)                                            OK       000
 H4TU-R    RED(LOS/LOF) 06/01/03  23:46:22   06/01/03  23:46:22  Alarm     001
  (DS1)    YELLOW(RAI)                                         OK       000
           BLUE(AIS)                                           OK       000









 ------------------------------------------------------------------------------
        1. T1 Alarm             4. Span H4R1 to H4R2
        2. Facility Alarm       5. Span H4R2 to H4TU-R
        3. Span H4TUC to H4R1   C. Clear T1 Alarms
```

Figure 17. T1 Alarm History Menu

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

```
Circuit ID:                                                    10/01/03 09:29:45
                      Press ESC to return to previous menu

                              HDSL4 Span History
LOCATION    ALARM       FIRST                LAST               CURRENT   COUNT
-------------------------------------------------------------------------------
SPAN C-H1   L1  LOS                                              OK          000
            L2  LOS                                              OK          000

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

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 H4R2
    2. Facility Alarm        5. Span H4R2 to H4TU-R
    3. Span H4TUC to H4R1    C. Clear Span Alarms
                             Selection:
```

Figure 18. HDSL4 Span History Screen

```
Circuit ID:                                                    10/01/03 09:29:45
                      Press ESC to return to previous menu

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

   1.  H4TU-C Powered Up                                01/25/02 11:52:00









        Page Number:   1/  1   Number of Events:   1
     ------------------------------------------------------------------
      'P' - Previous Page  'H' - Home      'R' - Reset Events
      'N' - Next Page      'E' - End

                           Selection:
```

Figure 19. Event History Screen

The System PM/Screen Report option (**Figure 20**) 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.

The Clear PM and Alarm Histories screen (**Figure 21**) initializes data from performance monitoring and alarm histories. Selecting this option from the Main Menu displays the prompt, "This will clear the history data for all elements in the circuit. Are you sure (Y/N)?"

```
                              1.  HDSL4 Unit Information
                              2.  Provisioning
                              3.  Span Status
                              4.  Loopbacks and Test
                              5.  Performance History
                              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

```
Circuit ID:                                                  10/01/03 09:29:45

                               Adtran HDSL4 Main Menu


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

                  This will clear the PM, Alarm, Span Status, and
                 Troubleshooting Histories for all circuit elements.
                              Are you sure (Y/N)?

                               Selection: 11
```

Figure 21. Clear PM and Alarm Histories

Item 12 on the Main Menu displays the Troubleshooting screen (**Figure 22**). Helpful ADTRAN contact information along with two menu items appear on the bottom of this screen.

Selecting option 1 from the Troubleshooting screen causes the H2TU-C to read the operational status of the card and return Troubleshooting Guidance, or hints, as to the probable cause of the trouble, as shown in **Figure 23**.

```
Circuit ID:                                                  10/01/03 09:29:45
                      Press ESC to return to previous menu
                                Troubleshooting

For HELP based on detected problems, select Troubleshooting Guidance from the
list below. If further assistance is needed, contact ADTRAN Tech Support.









Hours: Normal 7am - 7pm CST                      1. Troubleshooting Guidance
       Emergency 7 days x 24 hours               2. General Information
Phone: 800.726.8663 / 888.873.HDSL
  Fax: 256.963.6217

                                          Selection:
```

Figure 22. Troubleshooting Screen

```
Circuit ID:                                                  10/01/03 09:29:45
                      Press ESC to return to previous menu
                        DSX-1 Loss of Signal (Red Alarm)

- Patch test set REC jack into H4TUC MON TX jack to verify integrity of
signal to the H4TUC from the network (verify test set in MON mode).

- If signal to H4TUC is missing, insert test set at DSX panel IN Jack connecting
toward H4TUC (to verify wiring between DSX and H4TUC shelf). Check H4TUC to
verify DSX-1 LOS alarm is cleared. This verifies TX(out) and RX(in) pairs are
not swapped.

- If signal from DSX OK, verify cross-connect wiring at DSX panel is turned over
(OUT to IN) and (IN to OUT).

-If DSX wiring OK, connect test set REC to the DSX MON, network side equipment,
to verify signal from network (verify test set to MON). If no signal,
troubleshoot office problems.

For Total Access cards verify the following:
- Provisioning>Network Source is configured correctly for Mux or DSX operation.
- Provisioning>Service State is not configured for OOS-Unassigned.
- Mux card is mapped correctly.
- Mux card is functioning correctly.
```

Figure 23. Troubleshooting Guidance

Selecting option 2 from the Troubleshooting screen accesses the General Information Screen (**Figure 24**) that summarizes the deployment guidelines necessary to provision this HDSL4 circuit.

The Virtual Terminal Session Screen (**Figure 25**) allows control of the Remote card provisioning from the H4TU-C. Press 1 from this screen to begin a user-initiated session with the Remote card. When the remote session is completed, Press CTRL+X to terminate the session.

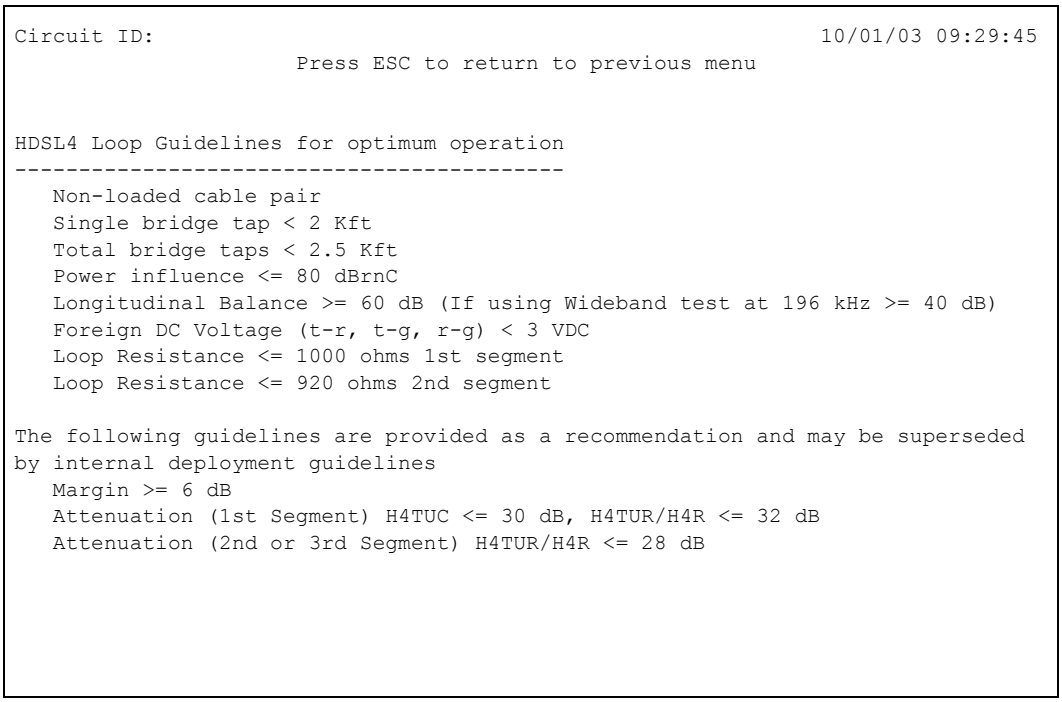


Figure 24. General Information Screen

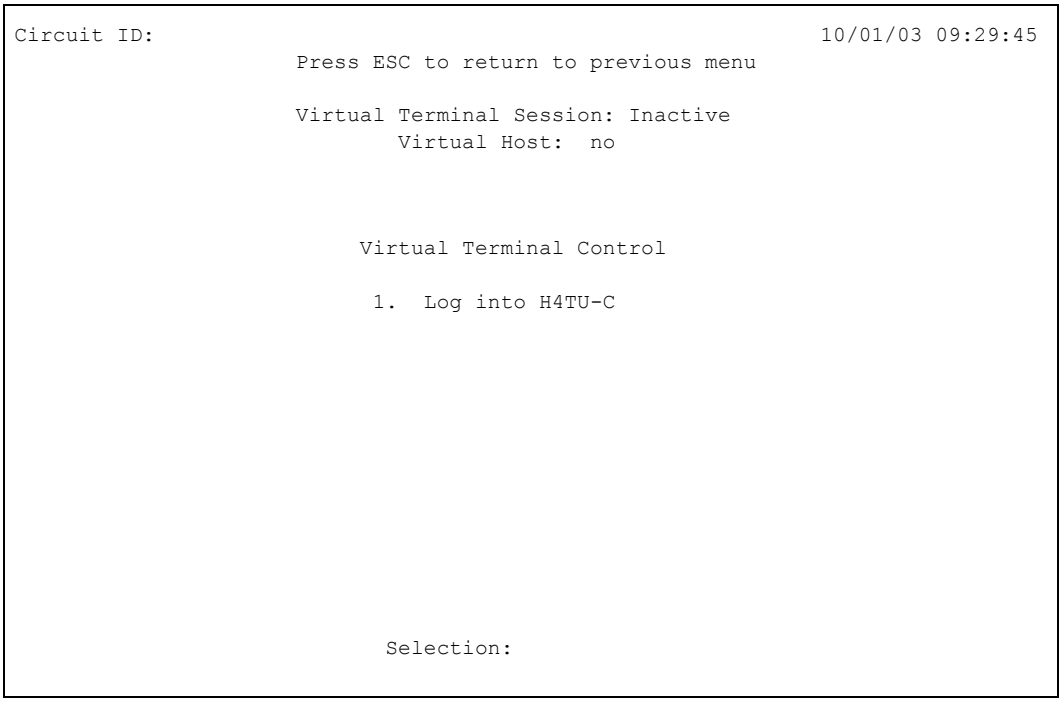


Figure 25. Virtual Terminal Session Screen

7. HDSL4 DEPLOYMENT GUIDELINES

The different segments of an HDSL4 circuit are defined in **Figure 26.**

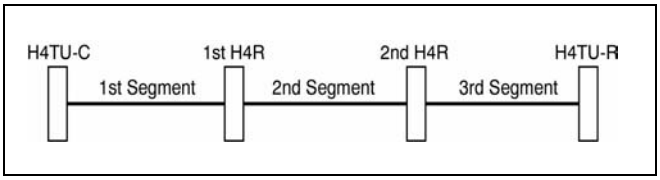


Figure 26. HDSL4 Circuit Segments

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 three 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 on an as-necessary basis to ensure optimum performance.

Designing a circuit with loop attenuation greater than the recommended maximum loss may result in compromised reliability of that loop. Follow the guidelines in in this section to ensure that the circuit meets basic requirements:

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 5.**
6. DSL-Recommended Range Limits. See **Table 6** and **Table 7**.

NOTE

In three segment circuits (two H4Rs), individual segment resistance values *must be verified*. See step 8 below.

Table 5. Attenuation limits

	Recommended Maximum	
	Upstream	**Downstream**
1st segment	30 dB	32 dB
2nd and 3rd segment	28 dB	28 dB

Table 6. Range Limits: 26 Gauge / 70°F / PIC

26 Gauge	Recommended Maximum
1st segment	10,470 ft.
2nd segment	9,865 ft.
3rd segment	9,865 ft. (see note)

Table 7. Range Limits: 24 Gauge / 70°F / PIC

26 Gauge	Recommended Maximum
1st segment	14,770 ft.
2nd segment	14,050 ft.
3rd segment	14,050 ft. (see note)

7. Resistance Values. See **Table 8**.

   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 bridged taps) and Ω_{26} is the DC resistance of #AWG cable.

Table 8. Single Pair DC Resistance Value

Resistance (ohms/kft)				
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

Note: Interpolated between 70°F and 120°F data. Extrapolated from 70°F and 120°F data.

Once the resistance of each segment is confirmed, refer to **Figure 27** to decide if the H4TU-C is capable of span powering two H4Rs and one H4TU-R. Alternatively, the DSL Assistant program will automatically calculate this and report any violations.

To utilize the graph shown in Figure 27, perform the following steps:

a. Find the line on the graph that 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 step b and step c meet on the graph.

The point found in step d must be below the upper limit line defined by the third segment measurement in 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.

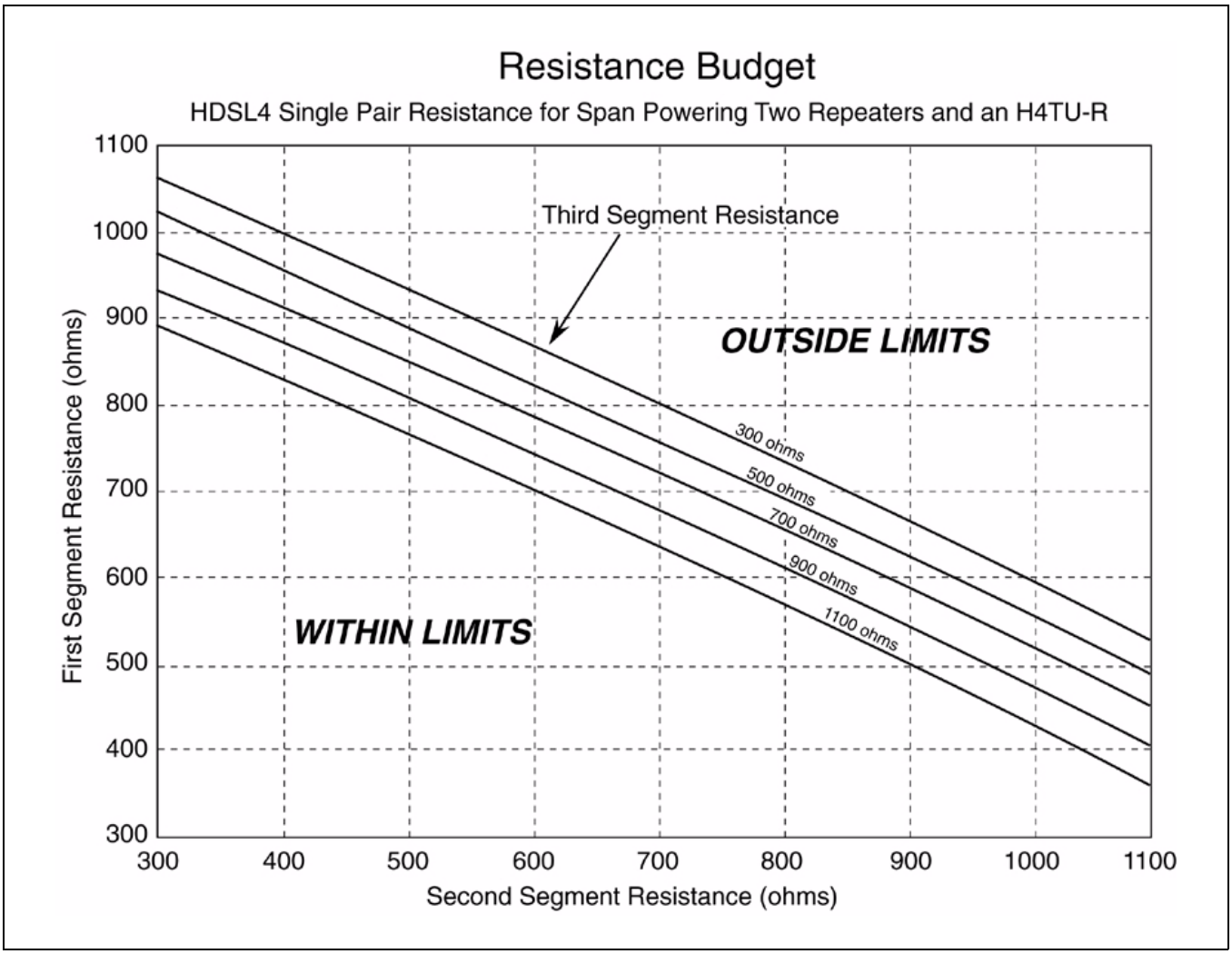


Figure 27. Resistance Budget Span Powering Two Repeaters

An example problem is illustrated in **Figure 28**. For this example, begin with three known measurements: 600 ohms first segment resistance, 700 ohms second segment resistance, and 900 ohms third segment resistance.

Refer to Figure 28 and the following steps to solve the example problem:

a. Find the 900 ohms third segment resistance line on the graph. This line is depicted in bold in Figure 28. This line is the upper span power limit.

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

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

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

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

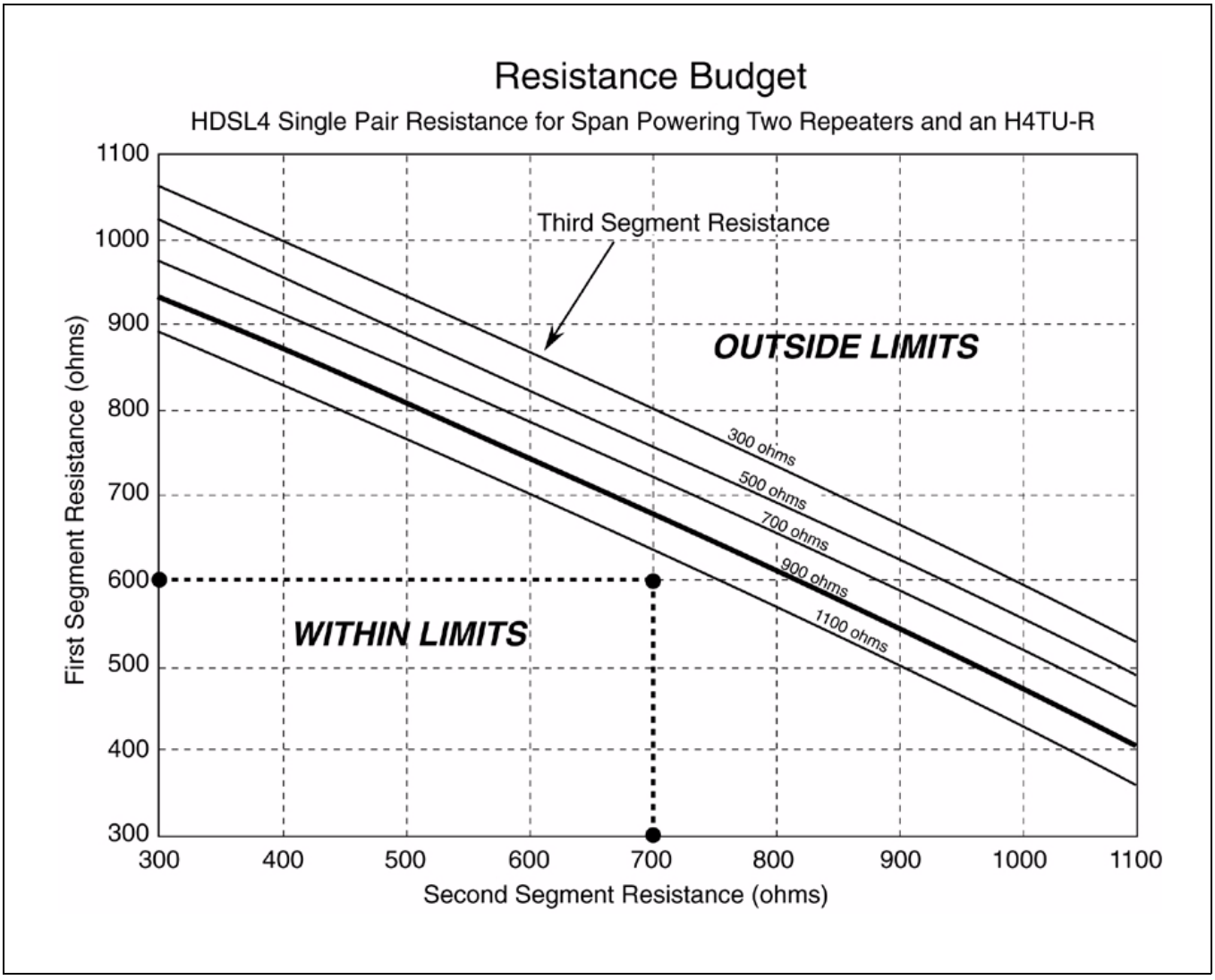


Figure 28. Resistance Budget Span Powering (Example)

8. Insertion Loss limits. See **Table 9.**

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

9. Field Technician Simplified Loop Qualification Procedure. See **Table 10** and **Table 11**.

   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 9. HDSL4 Insertion Loss Values (Based upon 26 AWG cable)

Frequency (KHz)	1st Segment Loss (dB)	2nd/3rd Segment Loss (dB)
50	29.8	28.0
80	34.2	32.2
130	37.0	34.8
196	40.8	N/A

Table 10. 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 minus Meas)
50	29.8		
80	34.2		
130	37.0		
196	40.8		
		[1]Sum Delta Loss =	

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

Table 11. Second or Third 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	28.0		
80	32.2		
130	34.8		
50	28.0		
		[1]Sum Delta Loss =	

1. If any single frequency insertion loss exceeds the maximum loss (delta loss < 0), then the sum of the three delta loss values must be > 1.0 dB.

8. MAINTENANCE

The T200 H4TU-R requires no routine maintenance for normal operation. In case of equipment malfunction, use the front panel bantam jack connectors to help locate the source of the problem. Verification of possible trouble indications may be accomplished using the Troubleshooting Guide in **Table 12**.

ADTRAN does not recommend that repairs be attempted in the field. Repair services may be obtained by returning the defective unit to ADTRAN. Refer to the *Warranty and Customer Service* section for further information.

9. SPECIFICATIONS

Specifications for the T200 H4TU-R are detailed in **Table 13**.

10. 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 12. Troubleshooting Guide

Condition: All front panel indicators are off. Solutions: 1. Make sure the H4TU-R is properly seated in the housing. 2. Verify that the H4TU-C is delivering sufficient simplex voltage to the loops. If steps 1 and 2 pass and front panel indicators remain off, replace the H4TU-R.
Condition: DSL 1/DSL 2 LED is red. Solutions: 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 of the circuit. 2. Verify that the loop meets requirement stated in the *HDSL4 Deployment Guidelines* section of this practice. 3. Verify that noise on the HDSL4 loops is within acceptable limits. If steps 1-3 pass and LED is red, replace the H4TU-R.

Table 13. HDSL4 T200 H4TU-R Specifications

Specification	Description
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 *HDSL4 Deployment Guidelines* section for additional measurements.
Bridged Taps	Single Taps < 2000 ft., Total Taps < 2500 ft.
Performance	Compliant with T1.418-2000 (HDSL4 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 Impedance	135 ohms
Maximum Loop Resistance	1150 ohms (nonrepeatered circuit)
Return Loss	12 dB (50 kHz to 200 kHz)
Network Interface	
DS1 Transmit Level	0 dB (default), –7.5 dB, –15 dB
DSX-1 Line Buildout	0-133 ft. ABAM (default) 133-266 ft. ABAM 266-399 ft. ABAM 399-533 ft. ABAM 533-655 ft. ABAM
DSX-1 Line Code	B8ZS (default), AMI
Power	
Tested with the ADTRAN H4TU-C (P/N 1223401L2) and H4R (P/N 1223445L1)	
H4TU-R Power Dissipation	3.8 watts
Span Power	190 VDC (from H4TU-C) Class A2 Compliant, GFI Current Limited at <5 mA, Loop Current Limited at 150 mA
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) Storage Temperature	–40°C to + 70°C –40°C to + 85°C
Compliance	
UL 60950; GR-1089-CORE; GR-63-CORE; ANSI T1.418-2001, Issue 2; ANSI T1.102 (DS1 Interface)	
Part Number	
T200 H4TU-R	1223426L2

Appendix A
HDSL4 Loopbacks

HDSL4 MAINTENANCE MODES

This appendix describes operation of the HDSL4 system with regard to detection of inband 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 an in-line T1 Repeater loopback.

In-band control code sequences are transmitted over the DS1 link by either the insert or overwrite method. The HDSL4 elements respond to either method. The insert method produces periodic control sequences that are not overwritten by the DS1 framing bits.

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 greater is present.

Loopback Control Codes

A summary of 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 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 (1111 1111 0001 1110)	Loopback data from network toward network at HTU-C.
	(C)	3F1E (0011 1111 0001 1110)	Loopback data from customer toward customer at HTU-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 HTU-R.
	(C)	3F02 (0011 1111 0000 0010)	Loopback data from customer toward customer at HTU-R.
	(C)	FF48 (1111 1111 0100 1000)	Loopback data from customer toward customer at HTU-R.(FDL)
	(N)	FF48 (1111 1111 0100 1000)	Loopback data from network toward network at HTU-R. (FDL)
	(N/C)	1 in 3 (100)	Loopdown everything.
	(N/C)	FF24 (1111 1111 0010 0100)	Loopdown everything. (ESF-DL)

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.
2. All codes are in-band unless labeled ESF-DL.
3. All codes listed above must be sent for a minimum of 5 seconds to be detected and acted upon.

Table A-2. Loopback Control Codes

Function	Code (Hex / Binary)	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 or 1111 1111 0100 1000 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. When sent from the customer, the units will arm.
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 or 1111 1111 0010 0100 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 or 1101 0011 1101 0011	If armed, the H4TU-C will loop up, 2 seconds of AIS (all ones) 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 reinstated, the injection of 231 logic errors will continue every 20 seconds.
Loop Down w/o Disarm	9393 or 1001 0011 1001 0011	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 or 1101 0101 1101 0101)	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: H4TU-C 231 errors H4R1 10 errors H4R2 200 errors H4TU-R 20 errors
Loopback Time Out Override[1]	D5D6 or 1101 0101 1101 0110	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. H4TU-C 231 bps H4R1 110 bps H4R2 2200 bps H4TU-R 20 bps

Table A-2. Loopback Control Codes (Continued)

Function	Code (Hex / Binary)	Response
Span Power Disable[1]	6767 or 0110 0111 0110 0111	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 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 reinstated, the injection of 10 logic errors will continue every 20 seconds.
Second H4R Loop Up [1,2]	C754 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 reinstated, the injection of 200 logic errors will continue every 20 seconds.
H4TU-R Address 20 for Extended Demarc [1,2]	C742 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 reinstated, 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

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