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3192 H2TU-C Transceiver Unit Central Office (HDSL2) Installation and Maintenance

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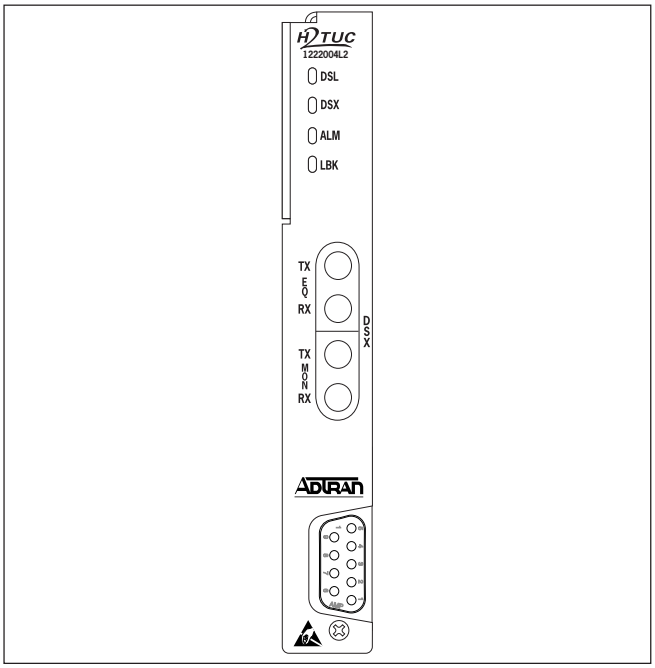


Figure 1. ADTRAN 3192 H2TU-C

1. GENERAL

The ADTRAN 3192 HDSL2 Transceiver Unit for the Central Office (H2TU-C), P/N 1222004L2, is the Central Office (CO) unit used to deploy an HDSL2 T1 circuit using 2-wire metallic facilities. The unit occupies one slot in a CI Wescom® 3192 Office Repeater Bay. The unit is illustrated in **Figure 1**.

DSX-1 signals are provided to and received from the network while HDSL2 signals are provided to the local loop. The ADTRAN H2TU-C works in conjunction with the ADTRAN H2TU-R to provide a DS1 service up to 12,000 feet on the local loop.

This H2TU-C works with multiple list versions of the HDSL2 Unit for the Remote end (H2TU-R) some of which are listed as follows:

Part Number	Description
1221026LX	T200 H2TU-R
1221026L6#L	T200 H2TU-R MON, Local Power
1222026LX	2nd Gen T200 H2TU-R

The H2TU-C can be deployed in circuits consisting of one H2TU-C and one H2TU-R.

System power and alarm bus connections are made through the backplane of the STS 3192 shelf. DSX-1 and HDSL2 signals are connected through the wire-wrap pins or the 64-pin shelf connectors related to each individual slot.

The H2TU-C contains an onboard fuse. If the fuse opens, it supplies a -48 VDC voltage to the fuse alarm bus and all faceplate indicators turn *off*. The fuse is not designed to be replaced in the field.

The H2TU-C uses a DC-to-DC converter to derive its internal logic and span powering voltages from the -48 VDC office supply. Span powering voltages meet all requirements of Class A2 voltages as specified by Bellcore GR-1089-CORE.

Revision History

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

2. INSTALLATION

CAUTION!
SUBJECT TO ELECTROSTATIC DAMAGE OR DECREASE IN RELIABILITY.
HANDLING PRECAUTIONS REQUIRED.

After unpacking the unit, inspect it for damage. If damage is noted, file a claim with the carrier, then contact ADTRAN. See *Warranty and Customer Service*.

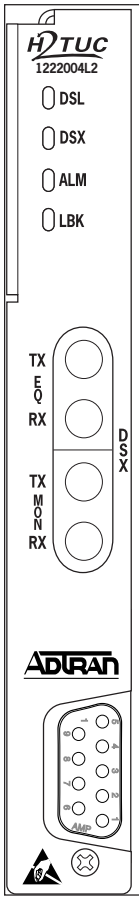
The H2TU-C plugs directly into standard CI Wescom 3192 office repeater shelves. The unit may be plugged into any of the first 28 slots of the 3192 shelf. No installation wiring is required.

Faceplate Indicators

The H2TU-C has four faceplate LEDs which indicate operational status. **Table 1** defines these LEDs.

Configuration is performed by manually selecting the appropriate option switch or switches. One six-position DIP switch (SW1) and one eight-position rotary switch (SW5) are used to configure the mode of operation. Switch functions are detailed in **Table 2** and **Table 3**. **Figure 2** shows the location of these switches.

Table 1. Faceplate Indicators



Indicator	Description
DSL	Indicates five possible states of the quality of the HDSL2 signals on the Loop:
	Off ..... No synchronization of H2TU-C and H2TU-R on the Loop
	Red ..... Poor signal quality on the Loop (> 10^{-7} BER)
	Yellow ..... Marginal signal quality on the Loop (≤ 2 dB margin above 10^{-7} BER)
	Green ..... Good signal quality on the Loop (> 2 dB margin above 10^{-7} BER)
	Blinking ..... An error detected on either end of the Loop will cause this LED to blink briefly
DSX	Indicates the following three conditions:
	Off ..... Network-side DSX-1 signal is absent or is of a format that does not match the provisioning of the HDSL2 circuit
	Blinking ..... Bipolar Violation (BPV), frame bit error (SF mode), or CRC error (ESF mode) detected at DSX-1 signal
	On Solid ..... Network-side DSX-1 signal is present and synchronized
ALM	Indicates the following three conditions:
	Off ..... No alarm condition detected
	Red ..... Alarm condition detected either locally (H2TU-C), or locally and remotely (H2TU-C and H2TU-R)
	Yellow ..... Remote alarm condition detected
LBK	Indicates the following three conditions:
	Off ..... Unit is not in loopback or armed state
	Yellow ..... Active loopback at the H2TU-C
	Blinking ..... Unit is armed but not in active loopback condition

CAUTION

While the H2TU-C is powered up, changes to any hardware setting using SW2 will change only that particular option. All options, which are being overridden by software settings through the terminal interface, will remain intact. Alternatively, while the H2TU-C is powered down, any hardware setting change will cause all options to revert to match the hardware settings. This includes DSX-1 Line Build Out, Framing, Line Code, NIU Loopback, Loopback Time Out, and Shelf Alarm settings.

Table 2. SW2 Option Settings [1]
(Default settings are indicated in **bold** typeface.)

Switch	Function	Description
SW2-1	Manual Code Select	
	AMI	Alternate Mark Inversion (AMI) is selected
	B8ZS	**B8ZS line code is selected**
SW2-2	T1 Framing[2]	Selects the T1 framing mode
	Unframed	Selects Unframed (UFRM) operation; SW2-3 is ignored
	Framed	**Selects Framed operation**
SW2-3	Manual Frame Select	
	SF	Selects Superframe (SF) format
	ESF	**Selects Extended Superframe (ESF) format**
SW2-4	NIU Loopback	Programs the ADTRAN HDSL2 system to respond to traditional T1 network interface unit (NIU) loop up and loop down codes. For more information, refer to Appendix A
	Enabled	
	Disabled	
SW2-5	Loopback Time Out	
	Enabled	Loopback Time out is Enabled [3, 4]
	Disabled	**Loopback Time out is Disabled**
SW2-6	Shelf Alarm	
	Enabled	If a CI Wescom 3192-9F Alarm Module is present in slot 29 of the 3192 shelf, the LOS LED on the module will be *On* when the ALM LED on the H2TU-C is red or amber
	Disabled	**The LOS LED on the module will not be activated by this H2TU-C. Other H2TU-Cs in the shelf may still activate the LOS LED independently of this one [5]**

[1] The H2TU-C transfers the local configuration to the H2TU-R when circuit synchronization is achieved. The H2TU-R then sets its configuration to match the H2TU-C.

[2] The ADTRAN H2TU-R (1221026L6) supports AIS-CI per the definition in ANSI T1.403.CORE-1997. The H2TU-R will generate an AIS-CI signal toward the network upon receiving unframed all ones from the customer. AIS-CI is not supported when the HDSL2 system is provisioned for unframed. The purpose of AIS-CI is to indicate that a defect or failure has been detected in the signal from the customer installation (CI) which would normally lead to the transmission of ANSI AIS. Since AIS-CI meets the definition of AIS, it may be detected and used for alarm suppression, the initiation of carrier group alarm (CGA) trunk processing and the development of DS1 performance parameters exactly as ANSI AIS.

[3] Loopback time out must be selected prior to initiating a loopback.

[4] 20-minute time out is the default for Loopback Time out Enabled. 60-minute and 120-minute time outs are also available from the craft interface.

[5] The LOS alarm will be activated if and only if sealing current has been present on the HDSL2 loop.

Table 3. Rotary Switch (SW1) Option Settings
(Default Setting is in **Bold** Typeface)

Function	Description
DSX-1 Line Build Out	This rotary switch is used to select operation of the line build out equalizer in series with the DSX-1 output.
0	**Line length from 0-133 feet of ABAM cable**
133	Line length from 133-266 feet of ABAM cable
266	Line length from 266-399 feet of ABAM cable
399	Line length from 399-533 feet of ABAM cable
533	Line length from 533-655 feet of ABAM cable
Positions 5-7 on the rotary switch are not used.	

Compliance Codes

Table 4 shows the Compliance Codes for the 3192 H2TU-C. The 3192 H2TU-C complies with the requirements covered under UL 60950, Third Edition, and is intended to be installed in an enclosure with an Installation Code (IC) of "B" or "E."

Table 4. Compliance Codes

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

CAUTION

Voltages up to –200 VDC may be present on the telecommunications wiring.

CAUTION

The DSX-1 connections should be connected to intra-building wiring only.

NOTES

This product is intended for installation in restricted access locations only.

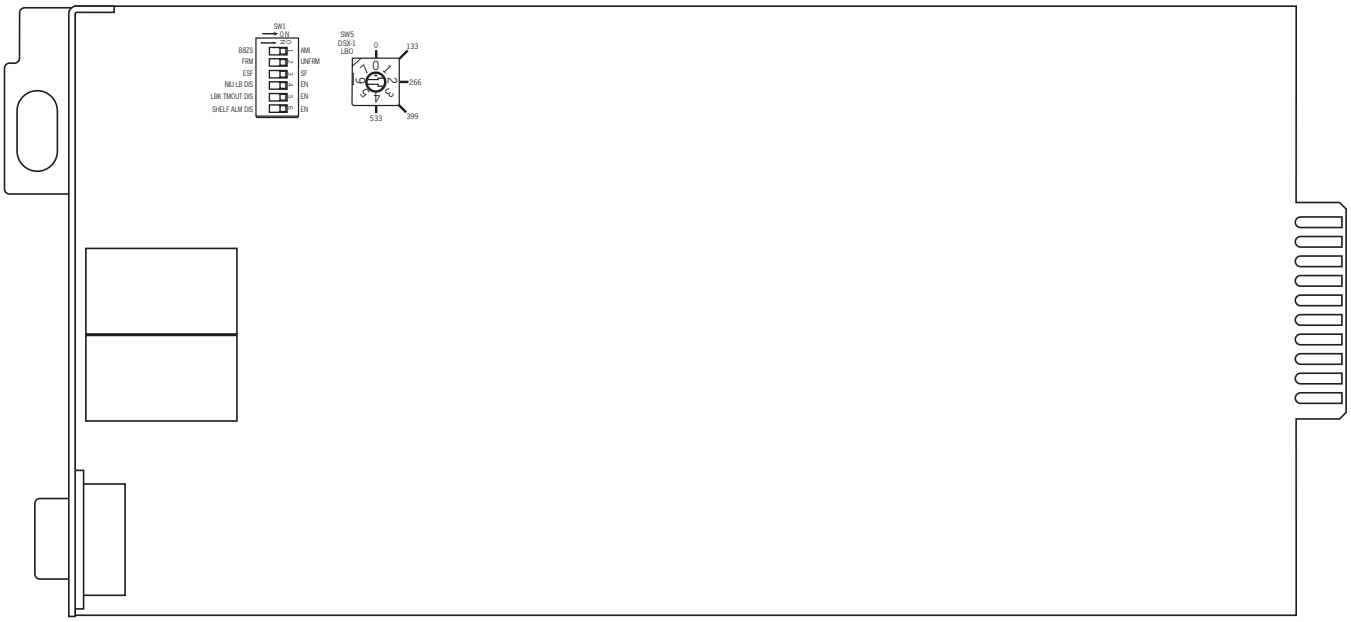


Figure 2. Option Switches

Powering Modes

The H2TU-C will automatically provide span powering voltage. No voltage settings are required, regardless of the presence of a H2R.

3. CONNECTIONS

The 3192 H2TU-C occupies one card slot in a CI Wescom 3192 Office Repeater Bay. Power and alarm signals are provided to the card through the backplane of the shelf. DSX-1 and HDSL2 loop signals are connected to the wire-wrap pins or mass termination shelf connectors corresponding to the slot the unit occupies. See **Figure 3** for H2TU-C edge connector wiring.

The H2TU-C is capable of span powering the H2TU-R by applying simplex current to the local loop. From 10 to 150 *m*A of current is coupled onto the HDSL2 span to power the H2TU-R when deployed (see **Figure 4**).

H2TU-C Alarm Outputs

Pin 10 of the H2TU-C edge connector interface provides a fuse alarm signal that connects -48 VDC to this pin in the presence of a blown fuse. This indicates the card has malfunctioned and should be replaced.

Pin H of the H2TU-C edge connector interface provides a receive loss of signal (RCV LOS) indication that connects -48 VDC to this pin when RCV LOS is detected.

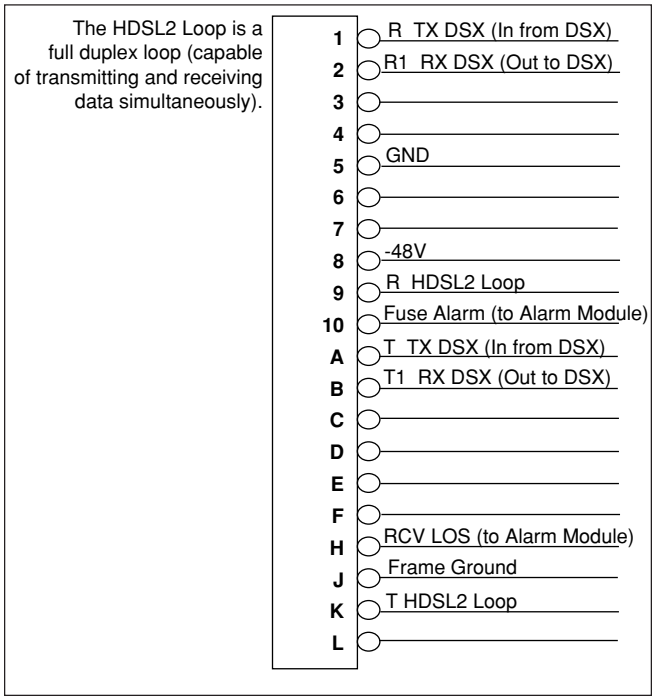


Figure 3. H2TU-C Edge Connector Wiring

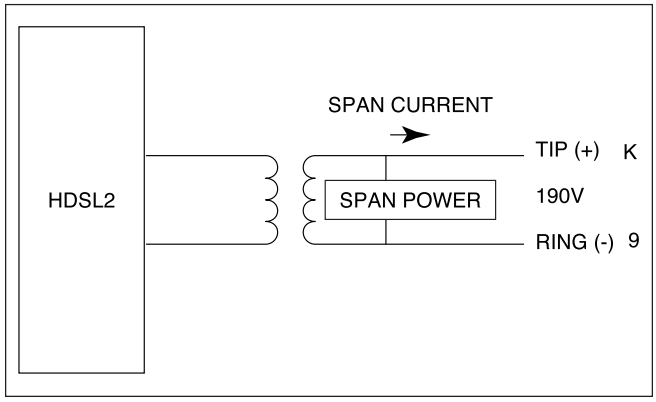


Figure 4. H2TU-C Span Powering Diagram

4. HDSL2 SYSTEM TESTING

The ADTRAN HDSL2 system provides the ability to monitor the status and performance of the DSX-1 signals, DS1 signals, and HDSL2 loop signals. Detailed performance monitoring is provided by the faceplate mounted RS-232 Control Port. These features are valuable in troubleshooting and isolating any system level problems that may occur at installation or during operation of the HDSL2 system. The following subsections describe additional testing features.

H2TU-C Bantam Jacks

The faceplate of the H2TU-C contains both monitoring and metallic splitting Bantam jacks. In general, the monitoring jacks provide a nonintrusive tap onto a signal line that permits the connection of test equipment to monitor the characteristics of that signal. For example, the DSX-1 monitor jack can be used to connect to a bit T1 Test Set to monitor for synchronization, test patterns, etc. The jacks provide an intrusive, signal interrupting access to the line.

Figure 5 illustrates the complete Bantam jack arrangement and details for specific jacks.

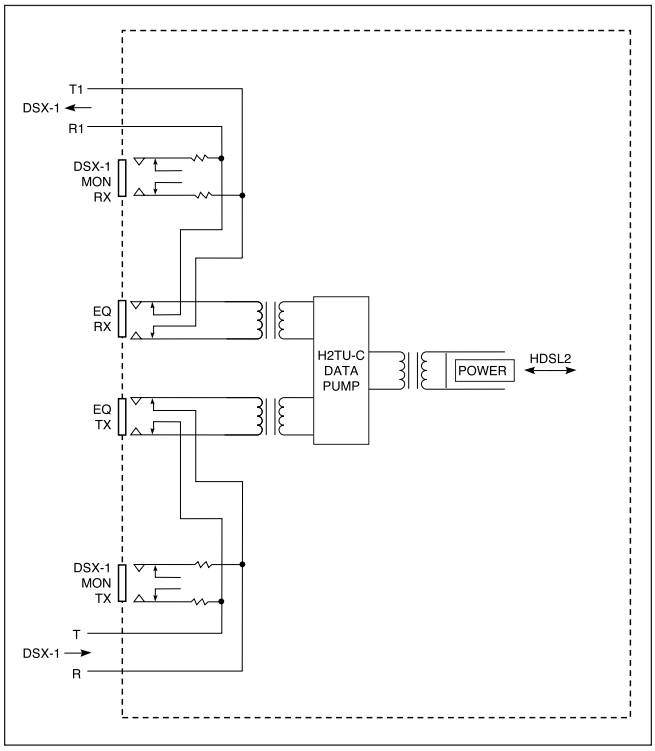


Figure 5. H2TU-C Bantam Jack Arrangement

H2TU-C Loopbacks

The H2TU-C responds to two different loopback activation processes. First, loopbacks may be activated using the craft interface. The Loopback Options Screen which provides for the H2TU-C and H2TU-R loopbacks, is described in Section 5 of this practice.

Second, the H2TU-C responds to the industry *defacto* standard for HDSL loopbacks. A detailed description of these loopback sequences is given in Appendix A.

The loopback condition imposed in both cases is a logic level loopback at the point within the H2TU-C where the DSX-1 signal passes into the HDSL2 modulators. **Figure 6** depicts all of the loopback locations possible with ADTRAN HDSL2 equipment.

In addition to network-side loopbacks, the H2TU-C provides customer-side loopbacks initiated by using the terminal control port (see Appendix A). In this mode, an AIS signal is supplied to the network.

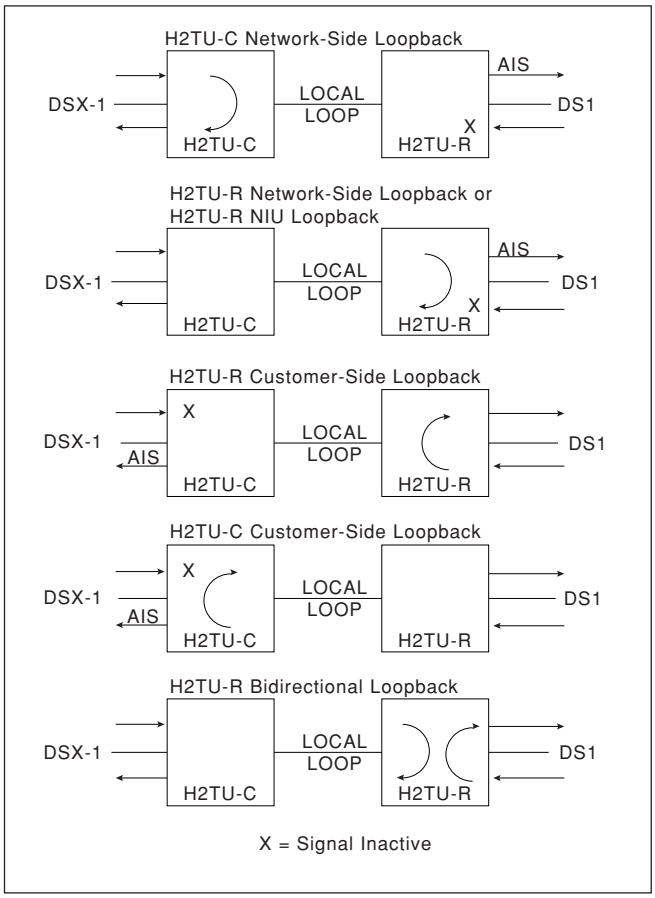


Figure 6. HDSL2 Loopbacks

5. CONTROL PORT OPERATION

The H2TU-C provides a faceplate-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 7**.

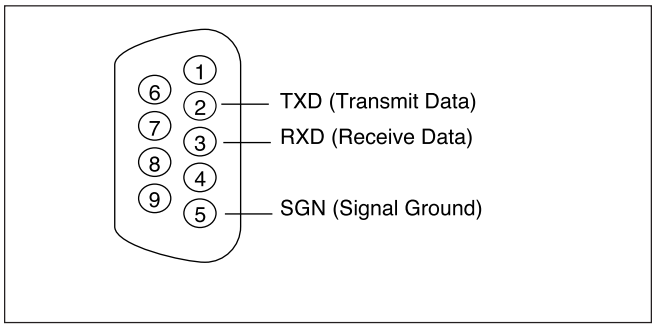


Figure 7. RS-232 (DB-9) Pin Assignment

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

The H2TU-C supports two types of terminal emulation modes. The Manual Update Mode is a dumb terminal mode, where the user can use print screen and log files commands easily. This mode also includes a "3 SPACES TO UPDATE" message on the top of the terminal screen (press the space bar three times to update the screen).

The Real Time Update Mode is a VT100 terminal mode. This mode enables all screen highlighting and cursor placement. Print screen and log file commands are not available in this mode.

The default Terminal Mode is Real Time Update.

NOTE

If you are using a personal computer (PC) with terminal emulation capability, be sure to disable any power saving programs. Otherwise, communication between the PC and the HDSL2 unit may be disrupted, resulting in misplaced characters or screen time outs.

Operation

For abbreviations used in the screen diagrams, see **Table 5**. The HTU-C also provides a "Performance Data Definitions Screen" which gives performance monitoring related abbreviations, see Figure 16.

Table 5. Screen Abbreviations

Abbreviation	Definition
NET	Network (DSX-1)
CUST	Customer (DS1)
LOS	Loss of Signal
SF	Superframe Format
ESF	Extended Superframe Format
B8ZS	Bipolar with 8 Zero Substitution
AMI	Alternate Mark Inversion
ATTEN	Pulse attenuation on HDSL2 loop
MARGIN	Signal-to-noise margin in dB above 10^{-7} Bit Error rate
LBO	Line Build Out
BPV	Bipolar Violations DSX/DS1.....Second in which a bipolar violation occurs
NIU	T1 Network Interface Unit
S/N	Serial Number
15M	Fifteen-minute period
24H	Twenty-four-hour period

The screens illustrated in Figure 8 through Figure 21 apply to an HDSL2 circuit deployed with ADTRAN's HDSL2 technology. The circuit includes an H2TU-C and an H2TU-R. Other configurations are possible (i.e. other vendor's equipment), and their displays will vary slightly from those shown in this section.

A terminal session is initiated by entering multiple space bar characters, which are used by the H2TU-C to determine the speed of the terminal. Once the speed has been determined, an HDSL2 Main Menu is presented, as illustrated in **Figure 8**.

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

1. HDSL2 Unit Information
2. Provisioning
3. Span Status
4. Loopbacks and Test
5. Performance History
6. Circuit ID, Time/Date
7. Terminal Modes
8. Alarm History
9. Event History

```
CIRCUIT ID:                                          01/01/00 00:00:40


                          Adtran HDSL2 Main Menu

                      1.  HDSL2 Unit Information
                      2.  Provisioning
                      3.  Span Status
                      4.  Loopbacks and Test
                      5.  Performance History
                      6.  Circuit ID,Time/Date
                      7.  Terminal Modes
                      8.  Alarm History
                      9.  Event History




                      Selection:
```

Figure 8. HDSL2 Main Menu

The HDSL2 Unit Information Screen, illustrated in **Figure 9**, provides detailed product information on each component in the HDSL2 circuit. This Screen also displays contact information for ADTRAN Technical Support, Internet Site, and address.

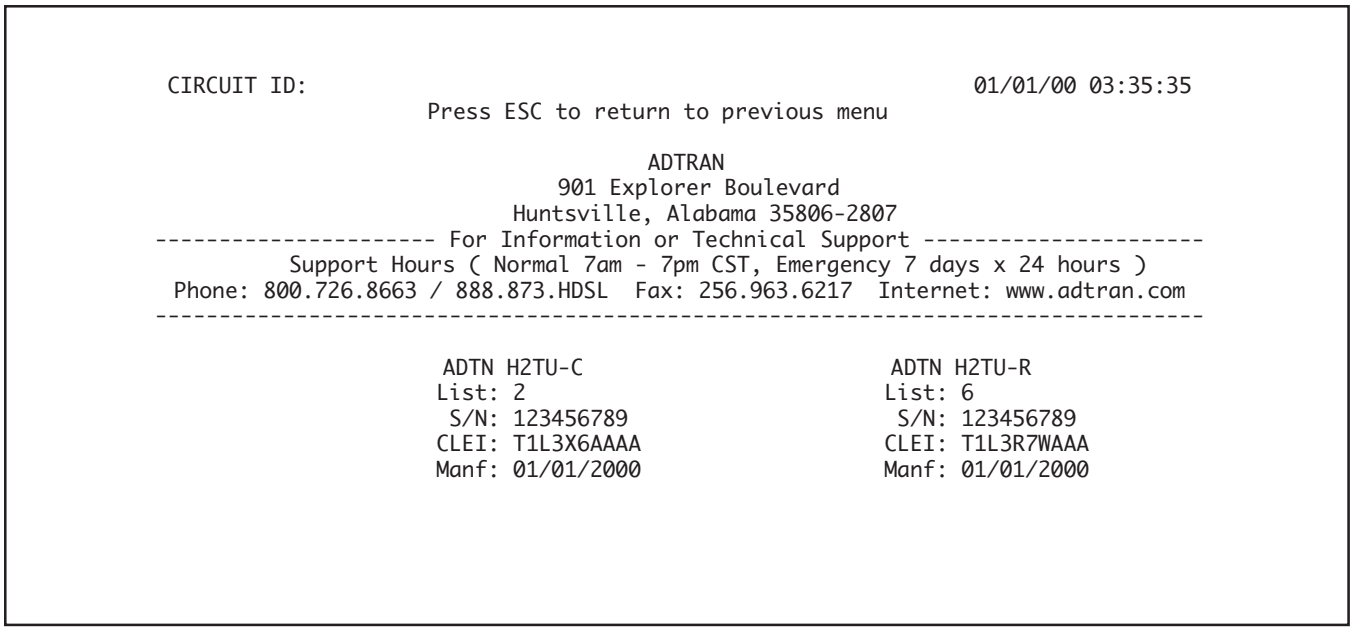


Figure 9. HDSL2 Unit Information Screen

The Provisioning Screen, illustrated in **Figure 10**, displays the current provisioning settings for the HDSL2 circuit. Options that can be changed from this screen are labeled with a number (e.g., "1" for DSX-1 Line Buildout). To change a particular option setting, select the appropriate number and a new menu will appear with a list of the available settings.

An asterisk will appear on the Provisioning Screen when a software setting conflicts with a hardware setting.

The Span Status Screen, illustrated in **Figure 11**, provides quick access to status information for each HDSL2 receiver in the circuit.

```
CIRCUIT ID:                                              01/01/00 00:02:15
                    Press ESC to return to previous menu


                          Provisioning

                    1.  DSX-1 Line Buildout     =  0-133 Feet
                    2.  DSX-1/DS1 Line Code     =  B8ZS
                    3.  DSX-1/DS1 Framing       =  ESF
                    4.  NIU Loopback            =  Enabled
                    5.  Loopback Timeout        =  20 Minutes
                    6.  DS1 TX Level            =  0 dB
                    7.  Shelf Alarm             =  Disabled




                         Selection:
```

Figure 10. Provisioning Screen

```
CIRCUIT ID:                                              01/01/00 00:02:56
                    Press ESC to return to previous menu

                          Span Status Screen
                               ATTEN
                          _____  <-03dB->  _____
                         |H2TUC |          |H2TUR |
                  <------|      |          |      |------>
                         |      |          |      |
                         |      |          |      |
                         |      |          |      |
                  NET    |      |<-------->|      |   CUST
                         |      |15dB   14dB|      |
                         |      |  MARGIN  |      |
                         |      |          |      |
                 --LOS-->|      |          |      |<-AIS-
                         |______|          |______|
                  DSX-1                             DS1

                           1.  Legend
                           2.  Detailed Status

                           Selection:
```

Figure 11. Span Status Screen

The Detailed Status selection from the System Status Menu, illustrated in **Figure 12**, displays the T1 and HDSL2 status for each receiver point. The Legend selection provides a description of the messages that are used on the Status Screens. There is also a Zero Registers selection, which applies only to error indicators displayed on the Status Screen.

Figure 13 illustrates the Loopback and Test Commands Screen, which provides the user with the ability to evoke or terminate all available HDSL2 loopbacks. Each HDSL2 circuit component can be looped toward the network or customer from this screen. It also provides a self-test option to perform a self-diagnostic of the H2TU-C and H2TU-R. A Loop down ALL units command is available in lieu of the Self-Test option when any loopback is active.

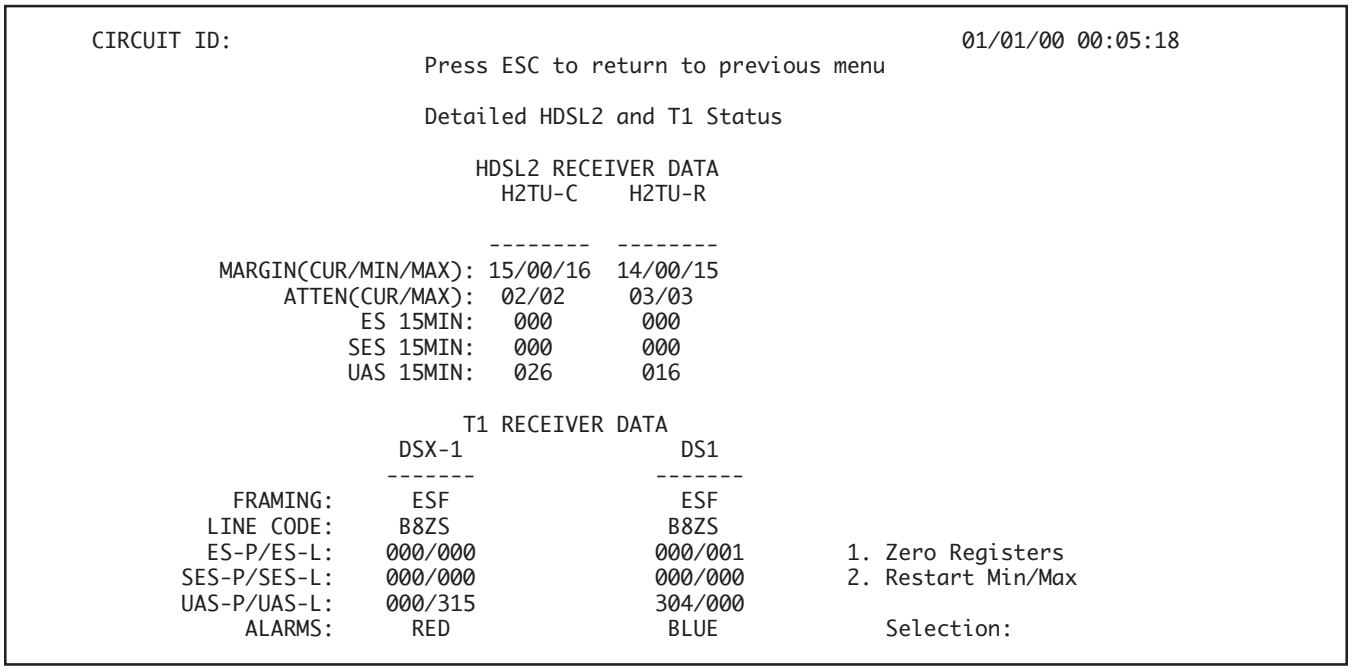


Figure 12. Detailed Status Screen

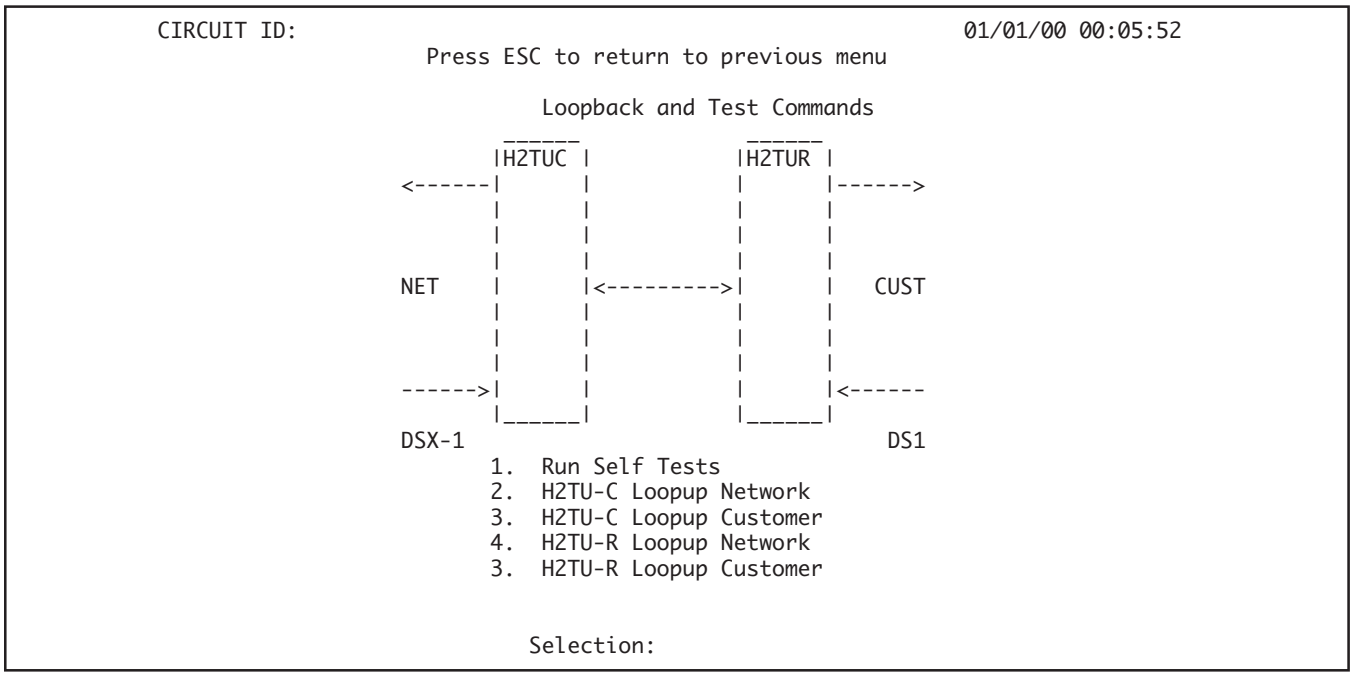


Figure 13. Loopback and Test Commands Screen

The Performance History Screens, illustrated in **Figure 14** and **Figure 15**, display the historical HDSL2 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 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 7 days of 24-hour interval data.

The user is prompted to select a module and interface to view the corresponding performance data. Line (L) and path (P) data can be viewed.

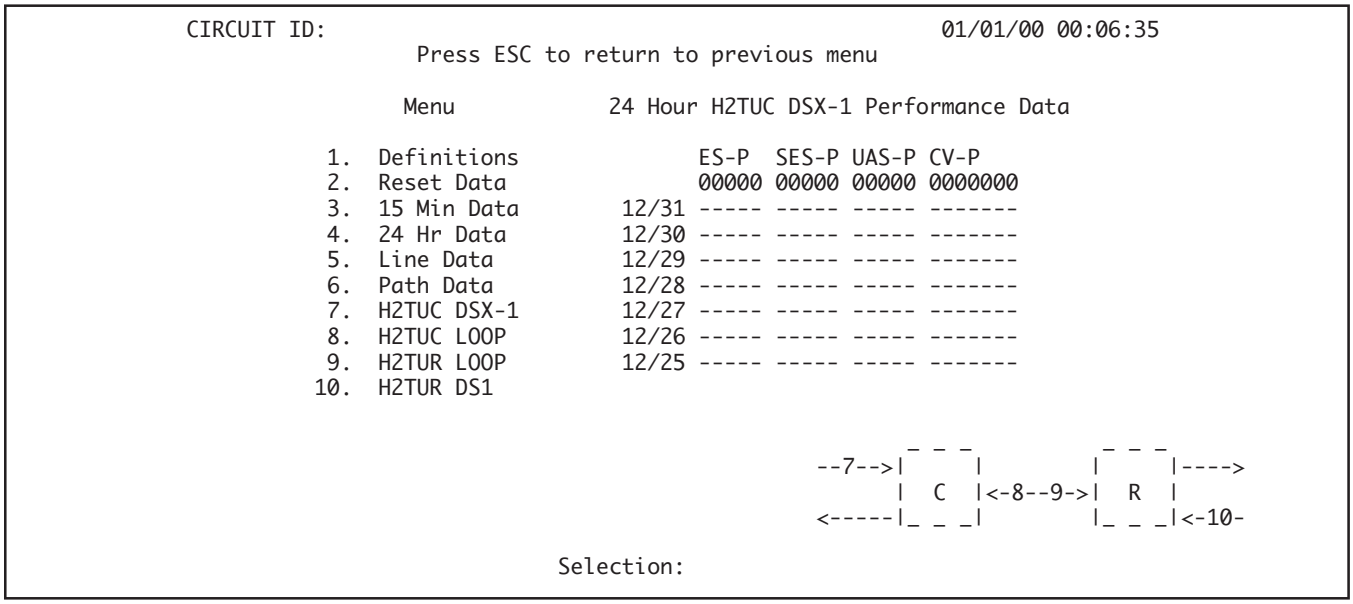


Figure 14. 24 Hour Performance History Path Data Screen

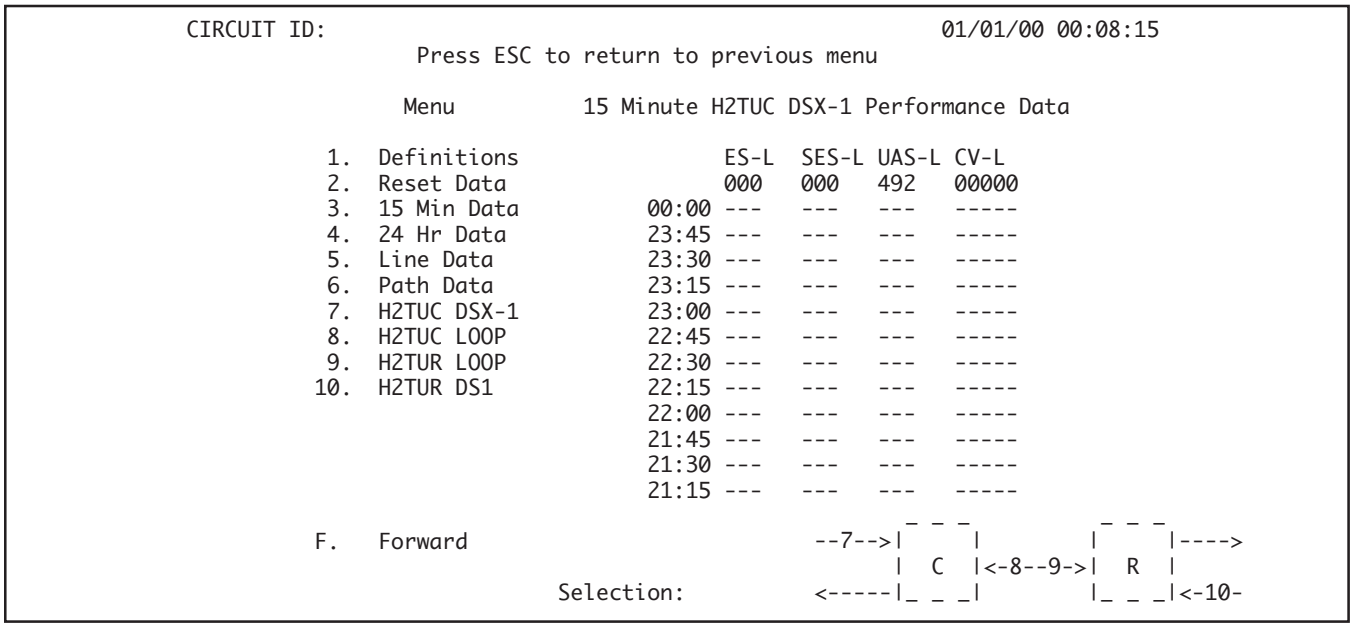


Figure 15. 15 Minute Performance History Line Data Screen

Figure 16 and **Figure 17** display the Performance Data Definitions Screens.

```
CIRCUIT ID:                                                  01/01/00 03:38:08


                          Performance Data Definitions

H2TUC, H2TUR, and H2R LOOP Related:     HDSL2 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
  UAS-L   Unavailable Seconds             >10 cont. SES-Ls
  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 16. Performance Data Definitions Screen, Loop Related

```
CIRCUIT ID:                                                  01/01/00 03:38:27


                          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
  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 17. Performance Data Definitions Screen, Path Related

Figure 18 illustrates the Circuit ID and Time/Date Screen. 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 31, 2000, as “013100”).

This unit includes two terminal emulation modes. The desired terminal mode can be selected from the Terminal Modes Screen, illustrated in **Figure 19**.

Additionally, pressing “CTRL” and “T” while on any screen can toggle the two terminal modes.

The default terminal emulation mode is the Real-Time Update Mode (VT100). This mode provides real time updating of HDSL2 circuit conditions and provisioning options as changes occur. While in Real- Time Update mode, the unit is anticipating baud poll responses from the terminal.

```
CIRCUIT ID:                                                  01/01/00 03:39:40
                        Press ESC to return to previous menu



         New Circuit ID =


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



                     Press TAB to skip to next entry field.

                        Press ENTER to set new Circuit ID.
```

Figure 18. Circuit ID, Time/Date Screen

```
         CIRCUIT ID:                                          01/01/00 00:40:53

                                TERMINAL MODES MENU

             MANUAL UPDATE MODE:

             * You can print or log screens
             * No text is highlighted
             * “3 SPACES TO UPDATE” appears at the top of each screen,
                reminding you to press the spacebar 3 times to update the screen
             * There is a delay between screen changes & updates
             * After 30 min. of no interaction, a new baud rate search is begun
             * Ignores input until screen is finished printing.

             REAL-TIME UPDATE MODE:

             * Faster of the two modes
             * You cannot print screens to a log file
             * Highlighting is enabled
             * Recommended for daily operation


                       Press CTRL+T to toggle update modes on any screen.
```

Figure 19. Terminal Modes Screen

The second terminal emulation mode is Manual Update Mode which 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. By pressing the space bar 3 times, the screen will be refreshed and will reflect the most current circuit conditions and provisioning options.

The Alarm History Screen, illustrated in **Figure 20**, provides the user with a detailed alarm history and events log for the HDSL2 and T1 spans.
This screen includes a time, date, first/last occurrence, and count for each type of HDSL2 or T1 alarm.

```
CIRCUIT ID:                                                  01/01/00 00:41:34

                              T1 Alarm History
LOCATION   ALARM       FIRST                LAST                CURRENT   COUNT
-------------------------------------------------------------------------------
H2TU-C     RED(LOS/LOF) 01/01/00  00:00:04   01/01/00  00:00:04   Alarm      001
 (DSX-1)   YELLOW(RAI)                                            OK         000
           BLUE(AIS)                                              OK         000

H2TU-R     RED(LOS/LOF)                                           OK         000
 (DS1)     YELLOW(RAI)                                            OK         000
           BLUE(AIS)    01/01/00  00:00:31   01/01/00  00:00:31   Alarm      001









-------------------------------------------------------------------------------
 1. T1 Alarm       2. HDSL2 Span                      C. Clear T1 Alarm
                            Selection:
```

Figure 20. Alarm History Screen

The Event History Screen, illustrated in **Figure 21**, provides a log history of HDSL2 circuit events. The following is a summary list of possible events:

- Circuit ID Change
- DS1 Transmit Level Option Change
- DSX/DS1 Alarm Type Active/Inactive
- DSX-1 Line Build Out Option Changes
- Element Network/Customer Loop up/Loop down
- Event Log Reset
- Framing Option Change
- H2TU-C/H2TU-R Powered Up
- HDSL/T1 PM Registers Reset
- Line Code Option Change
- Loopback Time Out Option Change
- NIU Loopback Option Change
- Shelf Alarm Option Change
- Time/Date Change From/To

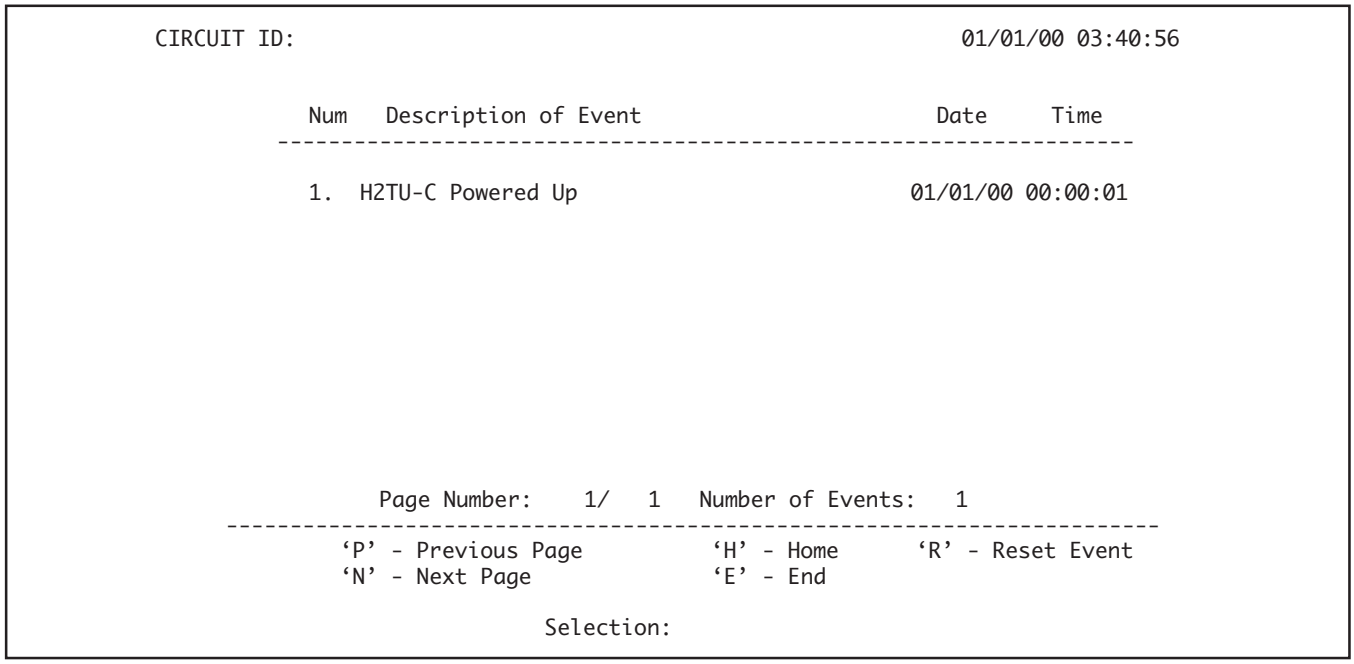


Figure 21. Event History Screen

6. HDSL2 DEPLOYMENT GUIDELINES

The ADTRAN HDSL2 system provides DS1-based services over loops designed to comply with the Carrier Service Area (CSA) guidelines given below.

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

   $12 - \{(3*L_{26})/(9-L_{BTAP})\}$ (in kft)

   L_{26} = Total length of 26-AWG cable excluding bridged taps (in kft)

   L_{BTAP} = Total length of all bridged taps (in kft)

This deployment criteria is summarized in **Figure 22**.

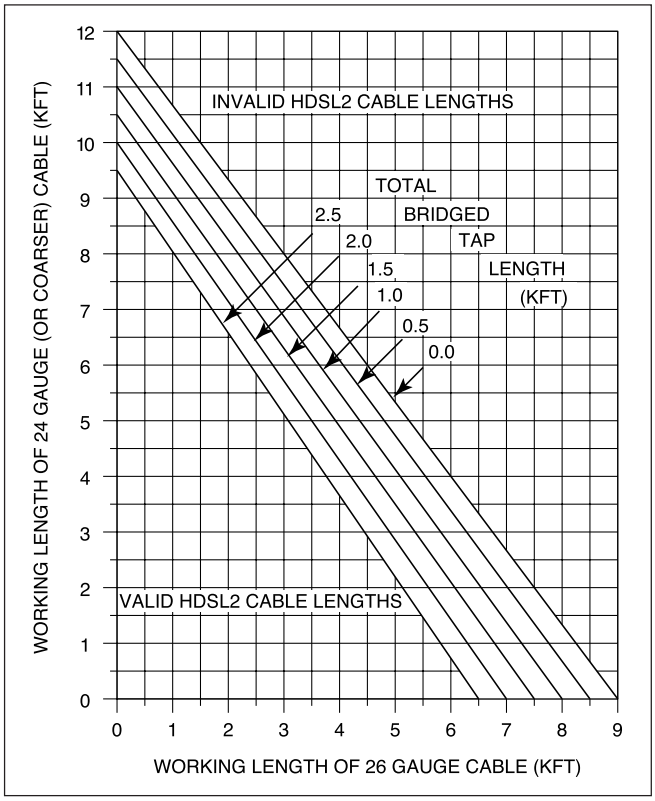


Figure 22. HDSL2 Deployment Guidelines

For more information regarding deployment guidelines and applications, reference ADTRAN's *Supplemental Deployment Information for HDSL/HDSL2*, P/N 61221HDSLL1-10.

Loop loss per kft for other wire is summarized in **Table 6**.

Table 6. HDSL2 Loss Values
(200 kHz cable loss in dB/kft at 135 Ω)

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

Recommended maximum local loop loss information for PIC cable at 70°F, 135 Ω, resistive termination is provided in **Table 7**.

Table 7. Loop Insertion Loss Data

Frequency (Hz)	Maximum Loss (dB)
3,000	12.0
10,000	15.0
50,000	25.5
100,000	30.0
150,000	32.75
200,000	35.25
250,000	37.50
325,000	42.00

An approximation for the maximum amount of wideband noise on an HDSL2 local loop as measured by a 50 kbps filter is ≤ 31 dBrn.

An approximation for the maximum level of impulse noise as measured using a 50 kbps filter on an HDSL2 loop is ≤ 50 dBrn.

NOTE

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

7. TROUBLESHOOTING PROCEDURES

Table 8 is a troubleshooting guide for the 3192 H2TU-C.

Table 8. Troubleshooting Guide

Condition	Solution
All faceplate indicators are *off*.	1. Verify that -48 VDC power is properly connected to the shelf. 2. Insert the H2TU-C into an operational slot. When the unit is powered, at least one LED will be *on*. 3. If Step 1 passes, but Step 2 fails, replace the H2TU-C.

8. MAINTENANCE

The ADTRAN 3192 H2TU-C requires no routine maintenance. In case of equipment malfunction, use the faceplate Bantam jack connectors 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 ADTRAN. See *Warranty and Customer Service* section of this Practice.

9. PRODUCT SPECIFICATIONS

Product specifications are detailed in **Table 9**.

10. WARRANTY AND CUSTOMER SERVICE

ADTRAN will replace or repair this product within ten (10) years from the date of shipment if it does not meet its published specifications or fails while in service. Refer to ADTRAN *U.S. and Canada Carrier Networks Equipment Warranty,* document 60000087-10.

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

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

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

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

Table 9. 3192 H2TU-C Specifications

Loop Interface

Modulation Type	16-TC PAM
Mode	Full Duplex, Partially Overlapped, Echo Cancelling
Number of Pairs	One
Line Rate	1.552 mbps
Baud Rate	517.333 K baud
Service Range	Defined by Carrier Service Area Guidelines
Loop Loss	35 dB maximum @ 196 kHz
Bridged Taps	Single Taps < 2000 feet, Total Taps < 2500 feet
Performance	Compliant with ANSI T1.418-2000 (HDSL2 Draft Standard)
H2TU-C Transmit Power (Data) Level	16.6 ±0.5 dBm (0 to 450 kHz)
H2TU-C Transmit Power (Activation) Level	16.3 ±0.5 dBm (0 to 350 kHz)
Input Impedance	135 Ω
Maximum Loop Resistance	900 Ω per span
Return Loss	12 dB (50 kHz to 200 kHz)

Network Interface

DSX-1 Output Level	0 dB
DSX-1 Line Buildout	0-133 feet ABAM 134-266 feet ABAM 267-399 feet ABAM 400-533 feet ABAM 534-655 feet ABAM
DSX-1 Line Code	AMI, B8ZS
DSX-1 Format	SF, ESF, Unframed

Power

Tested with the ADTRAN H2R (P/N 1221045L1) and the ADTRAN H2TU-R (1222026L6).

Total Power	worst case input voltage @ 160 *m*A with H2TU-R
HTU-C Power Dissipation	4.25 watts with H2TU-R
Span Power	-190 VDC (Internally Generated) Class A2 compliant; current limited at 150 *m*A
Fusing	1.00 A (not field replaceable)

Clock

Clock Sources	Internal, DSX-1 Derived (with HDSL2 frame bit stuffing)
Internal Clock Accuracy	± 25 ppm (exceeds Stratum 4). Meets T1.101 timing requirements.

Tests

Diagnostics	Self-Test, Local Loopback (H2TU-C), Remote Loopback (H2TU-R)

Physical

CI / Wescom 3192 STS-1 Office Repeater Shelf-Mounted

Dimensions	4.75 in. High x 0.69 in. Wide x 10.25 in. Deep
Weight	Approximately 6.5 oz.

Environment

Temperature	Operating (Standard) -40°C to +70°C Storage -40°C to +85°C

Compliance

UL Listed
Bellcore NEBS Level 3 (SR-3580)
FCC47CFR Part 15, Class A

Part Number

3192 H2TU-C	1222004L2

Appendix A
HDSL2 Loopbacks

HDSL2 MAINTENANCE MODES

This appendix describes operation of the HDSL2 system with regard to detection of in-band and ESF facility data link loopback codes. The operation of the loopback commands in the ADTRAN HDSL2 system is compliant with the recommendation to ANSI recorded in T1E1.4/92. The HDSL2 network loopback points described below are shown in **Figures A-1** and **A-2**.

H2TU-C Loopback: A regenerative loopback of the DSX-1 signal toward the network.

H2TU-R Loopback: A regenerative loopback of the DS1 signal toward the network. This loopback is in addition to a separate Smartjack loopback. Separate activation sequences are provided for the H2TU-R and the Smartjack loopback initiation.

Upon deactivation of a loopback, the HDSL2 system will synchronize automatically.

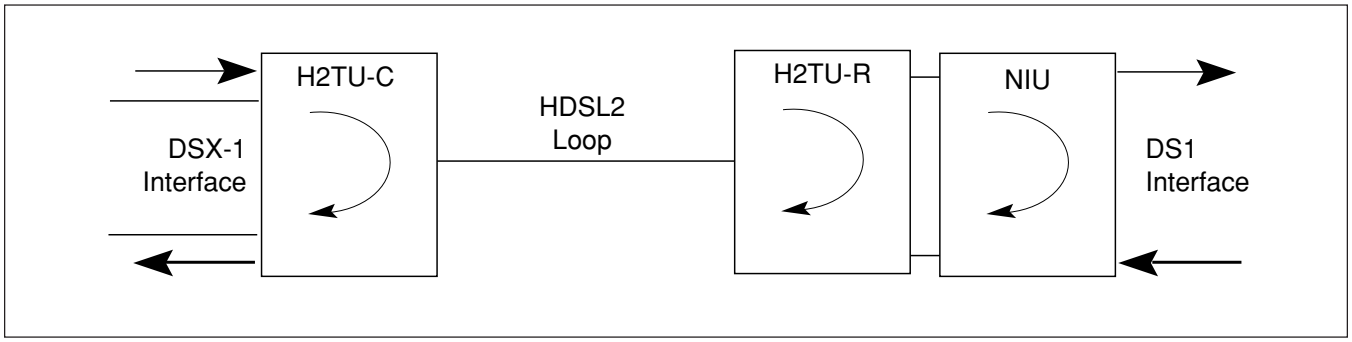


Figure A-1. HDSL2 Loopback Points

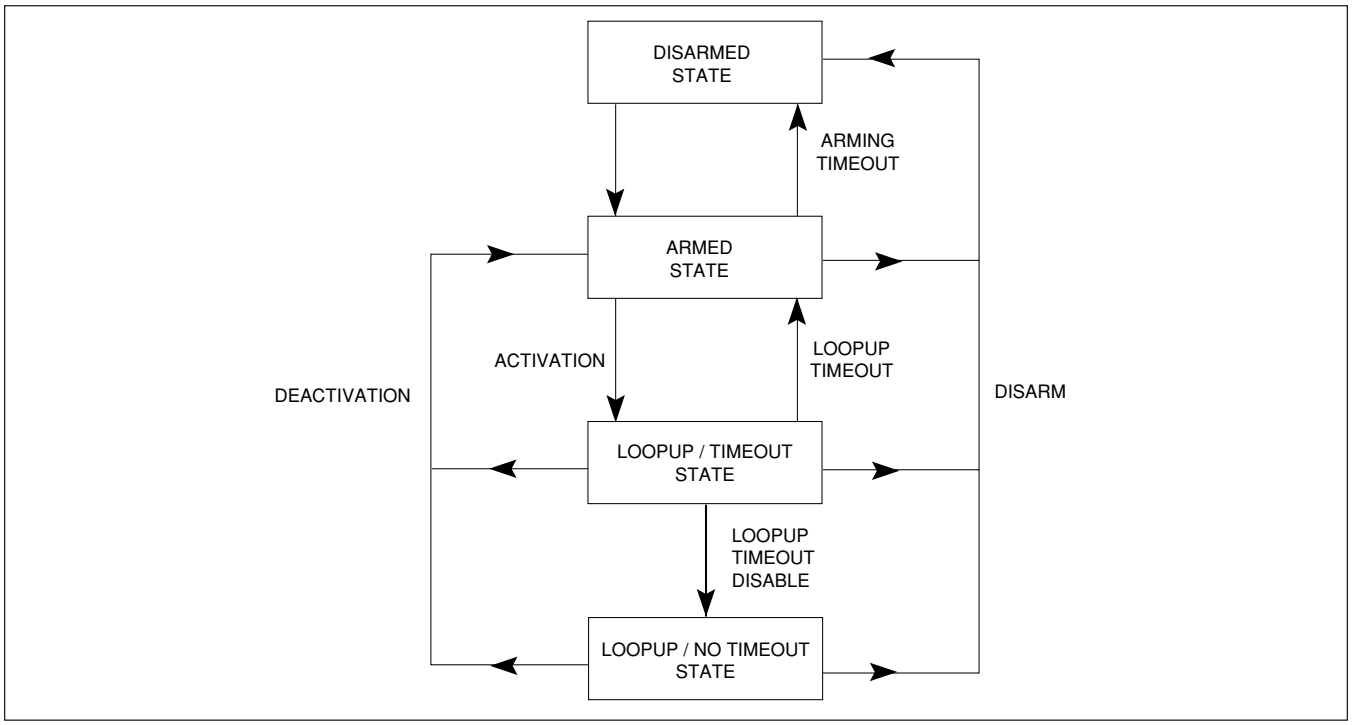


Figure A-2. HDSL2 Element State Diagram

Loopback Process Description

In general, the loopback process for the HDSL2 system elements is modeled on the corresponding DS1 system process. Specifically, the H2TU-C loopback is similar to an Intelligent Office Repeater loopback and the H2TU-R loopbacks are similar to an inline T1 Repeater loopback.

Each HDSL2 system element is independently described by the state diagram shown in Figure 17. The four states are disarmed, loop up, armed, and loop up/time out disable.

State transitions result from in-band and ESF Data Link sequences as well as time out operations. The sequences and time out values are as follows:

1. Arming Sequence (In-band and ESF)
2. Activation Sequence
3. Deactivation Sequence
4. Disarming Sequence (In-band and ESF)
5. Loop Up Time Out
6. Arming Time Out

In-band control code sequences are transmitted over the DS1 link by either the *unframed* or *overwrite* method. The HDSL2 elements respond to either method.

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

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

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

States and State Transitions

A summary of time out and control sequences is given in **Table A-1**.

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.

The **Disarmed State** is the normal mode of operation. Each HDSL2 element is transparent to the data flow. However, the in-band data flow and the ESF data link are monitored for the arming sequence.

The in-band control code sequence used to simultaneously arm the loopback capability of all of the HDSL2 elements is the following 5-bit pattern:

Arm Sequence 11000

Note that this sequence is the standard NIU loop up code. If the NIU loopback feature for the HDSL2 circuit is enabled (see *H2TU-C Switch Options*), the arming sequence will activate the NIU loopback in the H2TU-R. If the NIU loopback feature is disabled and an external Smartjack NIU is present, the HDSL2 arming process will not interfere with NIU detection of the loop up code.

All other in-band sequences are ignored in the disarmed state.

The ESF Data Link sequence used to simultaneously arm the loopback capability of all of the HDSL2 elements is the following 16-bit pattern ESF data link sequence:

ESF Arm Sequence 0001 0010 1111 1111
for four repetitions

HDSL2 element arming and NIU loop up is performed as described for the in-band arming sequence.

All other ESF patterns are ignored in the disarmed state.

In the **Armed State**, the HDSL2 system element continues to be transparent to the data flow. However, the in-band data flow and ESF data link is monitored for disarming and activation codes. An arming time out value causes the automatic return of the HDSL2 element to the disarmed state.

Transition from Armed to Loop Up State: An in-band control code sequence is used to command a specific HDSL2 element to move from the armed state into the loop up state. Each HDSL2 element has a unique 16-bit activation control code sequence as shown in the following example.

H2TU-C Activation Sequence 1101 0011 1101 0011
H2TU-R Activation Sequence 1100 0111 0100 0010

Table A-1. HDSL2 Loopback Control Codes

Name	Code	Detection Time	Comments
Arming (In-band) Arming (ESF)	11000 0001 0010 1111 1111	5 Seconds 4 Repetitions	Signal sent in-band or over ESF data link. HDSL2 elements in disarmed state make transition to armed state. Detection of either code results in Smartjack loop up, if NIU loopback is enabled.
Activation (H2TU-C)	1101 0011 1101 0011	> 4 Seconds	Signal sent in-band. HDSL2 elements in armed state make transition to loop up state. Loop up state time out is programmable from the H2TU-C.
Activation (H2TU-R)	1100 0111 0100 0010	> 4 Seconds	
Deactivation (all HDSL2 elements)	1001 0011 1001 0011	> 5 Seconds	Signal sent in-band. HDSL2 element in loop up state makes transition to armed state.
Disarming (In-band) Disarming (ESF)	11100 0010 0100 1111 1111	5 Seconds 4 Repetitions	Signal sent in-band or over ESF data link. HDSL2 elements in any state make transition to disarmed state.
Arming Time out	N/A	2 Hours	
Loop up Time out	N/A	Programmable from H2TU-C: None, 20, 60, or 120 minutes	HDSL2 element in loop up makes transition to armed state.
Loopback Time out Override	1101 0101 1101 0110	>5 Seconds	Signal sent in-band. Sets Loopback Time out to NONE. Time out will return to previous value when pattern is removed. Arming pattern (11000) must precede this pattern.
Span Power Disable	0110 0111 0110 0111	>5 Seconds	Signal sent in-band. Disables span powering of remotes. Span power will return when pattern is removed. Arming pattern (11000) must precede this pattern.

The designated HDSL2 element will loop up after receiving the proper activation sequence.

If the NIU loopback feature for the HDSL2 circuit is enabled (see *H2TU-C Switch Options*), the 5-bit in-band arming sequence (11000) or the 16-bit ESF data link sequence (0001 0010 1111 1111) will activate the NIU loopback in the H2TU-R.

Transition from Armed to Disarmed State: All HDSL2 elements can be commanded to move from the armed state into the disarmed state by the standard 5-bit in-band disarming sequence used for NIU Smartjack loop down. Each HDSL2 element must disarm after receiving the following code for five seconds per element:

Disarm Sequence 11100

The disarming process ensures race-free operation of HDSL2 element disarming and Smartjack loop down. Duration of the disarm sequence may need to exceed 24 seconds to allow detection and loop down of up to three HDSL2 elements and the Smartjack.

All HDSL2 elements can be commanded to move from the armed state into the disarmed state by the ESF DATA LINK disarming sequence used for NIU Smartjack loop down as follows:

ESF Disarm Sequence ..... 0010 0100 1111 1111 for four repetitions per element in loopback

The disarming process ensures race-free operation of HDSL2 element disarming and Smartjack loop down. Duration of the disarm sequence may need to exceed 16 repetitions to allow detection and loop down of up

to three HDSL2 elements and the Smartjack. This sequence will loop down the Smartjack and the HDSL2 element.

All HDSL2 elements will automatically move from the armed state into the disarmed state when a default time out value of two hours is reached.

Arming Time Out ..... 2 Hours

Overriding Loopback Time Out:
If the units are armed and this pattern is sent, the loopback time out will be disabled. The time out option will be updated on the Provisioning Menu of the HTU-R (viewable through the RS-232 port) to "None". As long as the units remain armed, the time out will remain disabled. When the units are disarmed, the loopback time out will return to the value it had before the D5D6 code was sent.

Loopback Time Out Override 1101 0101 1101 0110

Disabling Span Power:
If the units are armed and this pattern is sent, the HTU-C will deactivate its span power supply, turning off the HTU-R and HRE (if present). As long as the pattern continues to be sent, the span power supply will remain disabled. When the pattern is no longer being sent, the HTU-C will reactivate its span power supply, turning the remote unit(s) on. All units will retrain and return to the disarmed and unlooped state.

Span Power Disable 0110 0111 0110 0111

In the **Loop Up State**, the selected HDSL2 element provides continuous loop up of the DS1 signal. However, the data flow is monitored for the in-band deactivation sequence, the in-band disarming sequence, and the ESF data link disarming sequence. Also, a loop up time out value causes automatic return to the armed state. All other control code sequences are ignored in the loop up state.

Transition from Loop Up to Armed State: Any HDSL2 element can be commanded to move from the loop up state into the armed state by a single in-band 16-bit deactivate control code sequence. The same deactivation sequence as shown is used for all HDSL2 elements.

Deactivation Sequence 1001 0011 1001 0011

An HDSL2 element must loop down after receiving this deactivation sequence for at least five seconds.

Deactivation After Receiving Sequence for > 5 seconds

Duration of the deactivation sequence may need to exceed 18 seconds to allow detection and loop down of up to three HDSL2 elements. The deactivation sequence does not disarm the HDSL2 elements. They can still respond to activation sequence control codes.

All HDSL2 elements automatically move from the loop up state into the armed state when the selected loop up time out value is reached.

Loop Up Time Out ..... programmable from the H2TU-C at None, 20, 60, or 120 minutes

Transition from Loop Up to Disarmed State: All HDSL2 elements can be simultaneously commanded to move from the loop up state into the disarmed state by either the standard 5-bit in-band disarming sequence used for NIU Smartjack loop down, or by the ESF DATA LINK command, as described in *Transition from Armed to Disarmed State*.