

3192 HDSL4 Transceiver Unit for the Central Office Installation and Maintenance Practice

CONTENTS

1. General	1
2. Installation	2
3. Connections	4
4. HDSL4 System Testing	5
5. Control Port Operation (HDSL4)	6
6. HDSL4 Deployment Guidelines	15
7. Maintenance	19
8. Product Specifications	19
9. Warranty and Customer Service	19
Appendix A. HDSL4 Loopbacks	A-1

FIGURES

Figure 1. 3192 H4TU-C	1
Figure 2. H4TU-C Span Powering Diagram	5
Figure 3. H4TU-C Bantam Jack Arrangement	5
Figure 4. HDSL4 Loopbacks	6
Figure 5. RS-232 (DB-9) Pin Assignments	6
Figure 6. HDSL4 Main Menu	8
Figure 7. Unit Information Screen	8
Figure 8. Provisioning Screen	9
Figure 9. Span Status Screen	9
Figure 10. Detailed Status Screen	10
Figure 11. Loopbacks and Test Commands Screen	10
Figure 12. 15-Minute H4TU-C DSX-1 Performance Data Screen	11
Figure 13. 24-Hour H4TU-C Loop Performance Data Screen	11
Figure 14. Performance Data Definitions – HDSL4 Loop Related Screen	12
Figure 15. Performance Data Definitions – DS1 and DSX-1 Path Related Screen	12
Figure 16. Scratch Pad and Circuit ID Screen	13
Figure 17. T1 Alarm History Screen	13
Figure 18. HDSL4 Span History Screen	14
Figure 19. Event History Screen	14
Figure 20. System PM/Screen Report Option	15
Figure 21. Virtual Terminal Control Screen	15
Figure 22. HDSL4 Circuit Segments	16
Figure 23. Resistance Budget Span Powering Two Repeaters	18
Figure 24. Resistance Budget Span Powering Two Repeaters (Example)	19

TABLES

Table 1. Compliance Codes	2
Table 2. Front Panel Indicators	3
Table 3. Provisioning Options	4
Table 4. Screen Abbreviations	7
Table 5. HDSL4 Loop Insertion Loss Values	16
Table 6. Single Span and First Segment of Repeated Loop	16
Table 7. Second Segment of Repeated Loop	16
Table 8. Single Pair Cable DC Resistance Value (Ω)	17
Table 9. 3192 H4TU-C Specifications	21
Table A-1. HDSL4 Loopback Control Codes	A-2
Table A-2. Loopback and Control Codes	A-3,4

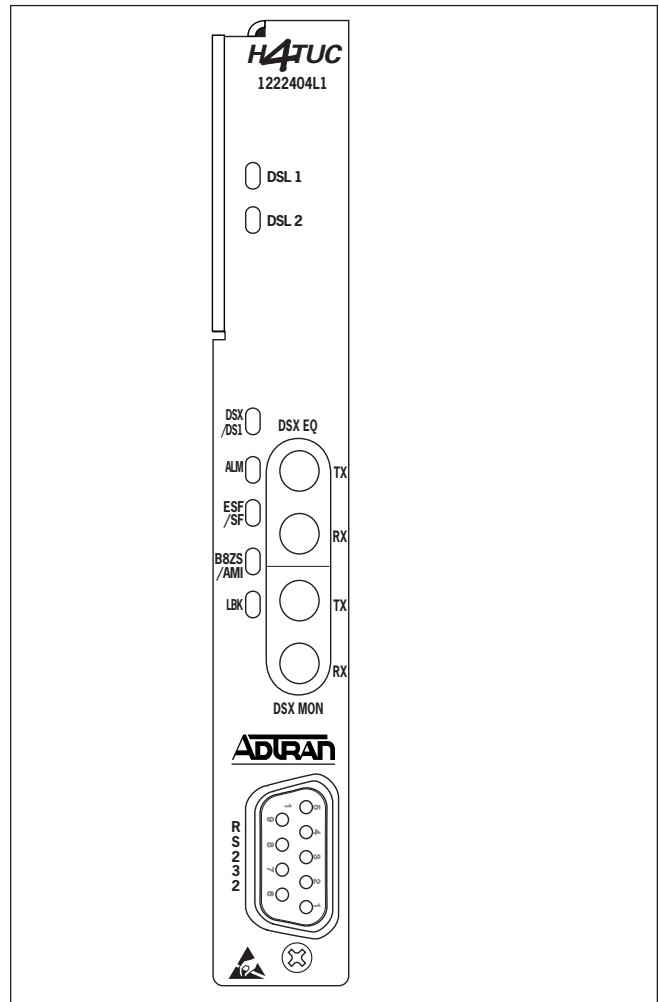


Figure 1. 3192 H4TU-C

1. GENERAL

The ADTRAN 3192 HDSL4 Transceiver Unit for the Central Office (H4TU-C) (ADTRAN P/N 1222404L1) is used to deploy an HDSL4 T1 circuit using 4-wire metallic facilities. See **Figure 1**. The unit occupies one slot in a 3192 shelf.

The DS1 or DSX-1 input signal is supplied from the network. The HDSL4 signals are provided to the local loop. The ADTRAN 3192 H4TU-C works in conjunction with the ADTRAN H4TU-R and up to two H4Rs to provide a DS1 service on the local loop.

This H4TU-C works with the following list versions of the HDSL4 unit for the remote end (H4TU-R) and the repeater (H4R):

Part Number	Description
122x424L1	T200 H4TU-R, Local Power
122x426L1	T200 H4TU-R, Span Power
122x441L1	T200 H4R
122x445L1	239 H4R

Note: *x* = any generic number

The 3192 H4TU-C can be deployed in circuits consisting of one H4TU-C, one H4TU-R, and up to two H4Rs. System power and alarm bus connections are made through the backplane of the 3192 shelf. The H4TU-C contains an onboard fuse. If the fuse opens, it supplies a -48 VDC voltage to the fuse alarm bus and all front panel indicators will be *off*. This fuse is not designed to be replaced in the field.

The 3192 H4TU-C uses a DC-to-DC converter to derive its internal logic and span powering voltages from the -48 VDC office supply. The H4TU-C can span power an H4TU-R and up to two H4Rs as listed above.

Revision History

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

2. INSTALLATION



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

Compliance

Table 1 lists compliance codes for the 3192 H4TU-C. This product is intended for installation in restricted access locations only and in equipment with a Type “B” or “E” enclosure.

WARNING

Up to -200 VDC may be present on telecommunications wiring. The DSX-1 interface is intended for connection to intra-building wiring only. Ensure chassis ground is properly connected.

Table 1. Compliance Codes

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

This product provides span powering voltage (negative only with respect to ground, -190 VDC nominal, GFI protection < 5 mA) and meets all requirements of Bellcore GR-1089-CORE (Class A2), ANSI T1.418-2002. This product is NRTL listed to the applicable UL standards.

Front Panel Indicators

The 3192 H4TU-C has seven front panel LEDs, illustrated in **Table 2**, which indicate operational status.

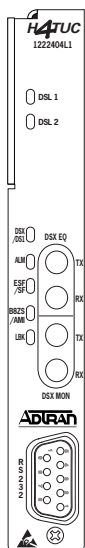
The 3192 H4TU-C plugs directly into the 3192 shelf. No installation wiring is required.

There are no configuration switches for the H4TU-C. Configuration is performed via software discussed in *Section 5* of this practice.

Powering Options

The H4TU-C is default enabled for span powering mode. The H4TU-C will power one, two, or three elements and can be set to span power Disabled when the H4TU-R is locally powered and there are no H4Rs on the circuit.

Table 2. Front Panel Indicators



Label	Condition	Description
DSL 1/ DSL 2	Green Red	DSL Loop 1/ Loop 2 sync, no errors currently detected, and signal margin \geq 3 dB. No DSL Loop 1/ Loop 2 sync, errors being detected, or signal margin $<$ 3 dB.
DSX/DS1	Green Red	DSX-1 signal is present and no errors are currently being detected. No DSX-1 signal, or signal is present with errors.
ALM	Off Red Yellow	No active alarm present. Loss of DSX-1 signal to the unit. Loss of DS1 signal to the remote.
ESF/SF	Off Yellow Green	Unit has detected unframed data. Unit has detected ESF data. Unit has detected SF data.
B8ZS/AMI	Yellow Green	Unit has detected B8ZS coded data. Unit has detected AMI coded data.
LBK	Off Yellow	Unit is not in loopback. Unit is in loopback (network and/or customer).

Provisioning

The provisioning settings can be viewed and manipulated through management access via the front panel RS-232 port. **Table 3** lists the available provisioning options and their factory default settings.

3. CONNECTIONS

The 3192 H4TU-C occupies one card slot in a 3192 shelf. Power and alarm signals are provided to the card through the backplane of the shelf. DSX-1 and HDSL4 loop signals are connected to the mass termination shelf connectors.

Table 3. 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.	0-133 ft.
2. DSX-1/DS1 Line Code	B8ZS, AMI	B8ZS
3. DSX-1/DS1 Framing	SF, ESF, Unframed, Auto	ESF
4. Forced Frame Conversion	Disabled, Enabled	Disabled
5. Smartjack Loopback	Disabled, Enabled	Enabled
6. Loopback Time Out	None, 120 Minutes	120 Minutes
7. Latching Loopback Mode	T1 (Disabled), FT1 (Enabled)	T1 (Disabled)
8. DS1 TX Level	0 dB, -7.5 dB, -15 dB	-7.5 dB
9. Span Power	Enabled, Disabled	Enabled
10. Customer Loss Indicator	AIS, Loopback, AIS/CI	AIS/CI
11. Performance Reporting Messages	None, SPRM, NPRM, AUTO (Both)	AUTO
12. Loop Attenuation Alarm Threshold	0 (Disabled), 1-99 dB	34 dB
13. SNR Margin Alarm Threshold	0 (Disabled), 1-15 dB	4 dB
14. Remote Provisioning	Disabled, Enabled	Enabled

The 3192 H4TU-C is capable of span powering the H4TU-R and two H4Rs by applying current to the local loop. From 30 to 155 mA of loop current is coupled onto the HDSL4 span to power the H4TU-R and two H4Rs when deployed. The span powering voltage is less than –190 volts with GFI protection to less than 5 mA. See **Figure 2**.

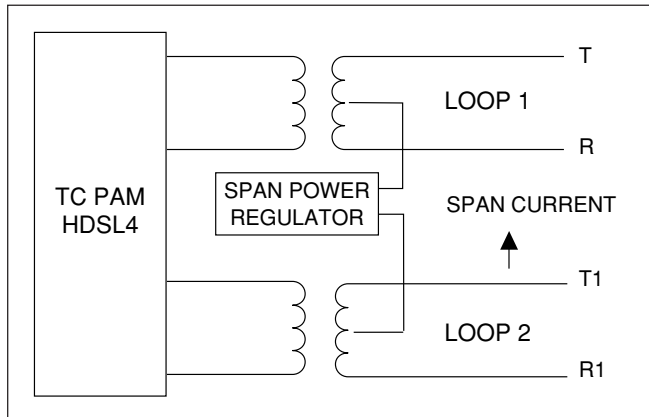


Figure 2. H4TU-C Span Powering Diagram

H4TU-C Alarm Outputs

Each H4TU-C has a built-in fuse for the –48 VDC power feed. A blown fuse indicates the card has malfunctioned and should be replaced.

In order to avoid a shelf alarm, the H4TU-C element can be provisioned to disable external alarms. This will disable all DSX and DS1 alarms.

4. HDSL4 SYSTEM TESTING

The ADTRAN HDSL4 system provides the ability to monitor the status and performance of the DSX-1 signals, DS1 signals, and HDSL4 loop signals.

Detailed performance monitoring is provided via management access of the front panel RS-232 port. These features are valuable in troubleshooting and isolating any system level problems that may occur at installation or during operation of the HDSL4 system. The following subsections describe additional testing features.

H4TU-C Bantam Jacks

The front panel of the H4TU-C contains metallic splitting bantam jacks for both nonintrusive (monitoring) and intrusive (terminating) DSX-1 test access.

Figure 3 illustrates the complete bantam jack arrangement and details for specific jacks.

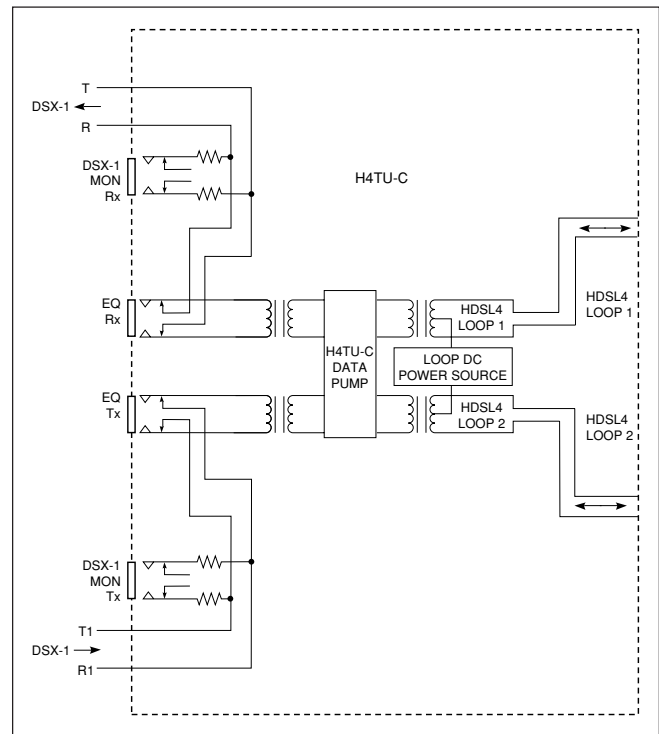


Figure 3. H4TU-C Bantam Jack Arrangement

H4TU-C Loopbacks

The H4TU-C responds to two different loopback activation processes. First, loopbacks may be activated using the craft interface of the 3192 H4TU-C. The Loopbacks and Test screen, which provides for the H4TU-C and H4TU-R loopbacks, is described in the Control Port Operation (HDSL4) Section 5 of this practice.

Second, the H4TU-C responds to the industry standard for HDSL4 loopbacks. A detailed description of these loopback sequences is given in *Appendix A*.

This unit is transparent to framing. If a framed or unframed loopback control sequence is sent, the unit will initiate the proper loopback command. (Refer to *Appendix A*, Table A-1.)

The loopback condition imposed in all cases is a logic level loopback at the point within the H4TU-C where the DSX-1 signal passes into the HDSL4 modulators. **Figure 4** depicts all of the loopback locations possible with ADTRAN HDSL4 equipment.

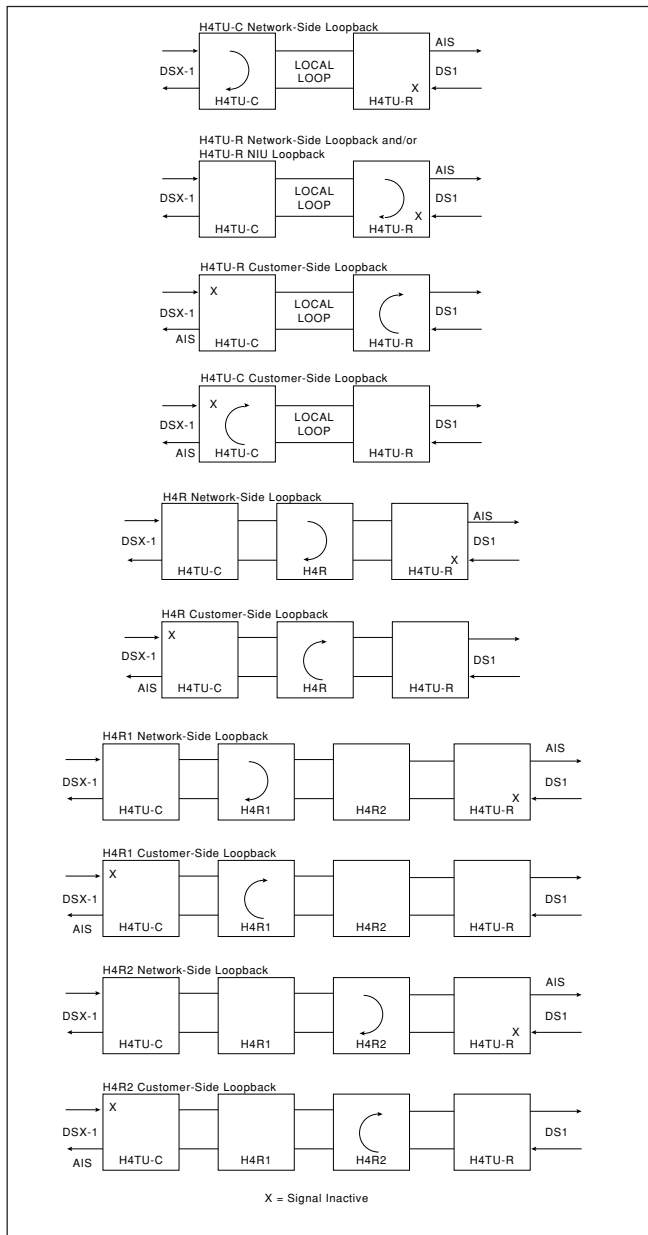


Figure 4. HDSL4 Loopbacks

In addition to network-side loopbacks, the H4TU-C provides customer-side loopbacks initiated by using either the terminal control port or in-band loop codes. (See *Appendix A*.) In this mode, an AIS signal is supplied to the network.

5. CONTROL PORT OPERATION (HDSL4)

The 3192 H4TU-C 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**.

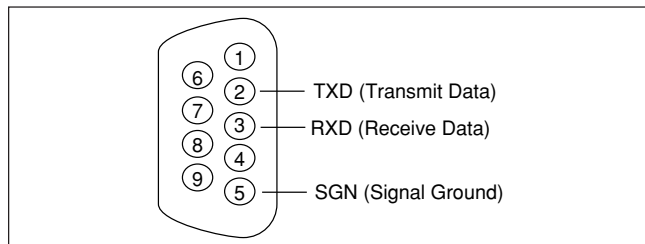


Figure 5. RS-232 (DB-9) Pin Assignments

The terminal interface can operate at data rates of 1.2, 2.4, 4.8, 9.6, and 19.2 kbps. The asynchronous data format is fixed at eight data bits, no parity, and one stop bit. The supported terminal type is VT100 or compatible.

The H4TU-C supports two types of terminal emulation modes. The Manual Update mode is a dumb terminal mode, where the print screen and log file commands can be used easily. This mode also includes a “3 SPACES TO UPDATE” message on the top of the terminal screen. (Press the spacebar three times to update the screen.)

The Real Time Update 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 mode.

NOTE

Pressing the CTRL T while on any screen will toggle between Manual and Real Time terminal modes.

NOTE

Pressing Esc while on any screen will go back to the previous screen.

NOTE

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

The screens illustrated in Figure 6 through Figure 21 are for an HDSL4 circuit deployed with ADTRAN's HDSL4 technology. The circuit includes an H4TU-C, up to two H4Rs and an H4TU-R. Other configurations are possible, and the displays will vary slightly from those shown in this section.

Operation

For abbreviations used in the screen diagrams, see **Table 4.** The Performance Data Definitions screen also offers a listing of screen definitions by selecting "1" from the Performance History screen.

Table 4. Screen Abbreviations

Abbreviation	Definition
ES	Errored Seconds DSX/DS1 SF Second in which a BPV or frame bit error occurs ESF Second in which a BPV or CRC error occurs HDSL4 Second in which a CRC error occurs
SES	Severely Errored Seconds DSX/DS1 SF Second in which 1544 BPVs or 8 frame bit errors occurs ESF Second in which 1544 BPVs or 320 CRC errors occur HDSL4 Second in which 50 CRC errors occur.
UAS	Unavailable Seconds DSX/DS1 .. Second in which there is a loss of signal or sync HDSL4 Second in which there is a loss of signal or sync
SF	Superframe Format
ESF	Extended Superframe Format
B8ZS	Bipolar with 8 Zero Substitution
AMI	Alternate Mark Inversion
LBO	Line Build Out
BPV	Bipolar Violation DSX/DS1 .. Second in which a bipolar violation occurs
NIU	T1 Network Interface Unit
S/N	Serial Number
15M.....	15-Minute Period
24H	24-Hour Period

From the ADTRAN HDSL4 Main Menu (**Figure 6**), the following screens can be accessed:

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

The Configuration screen illustrated in **Figure 7** provides detailed product information on each component in the HDSL4 circuit.

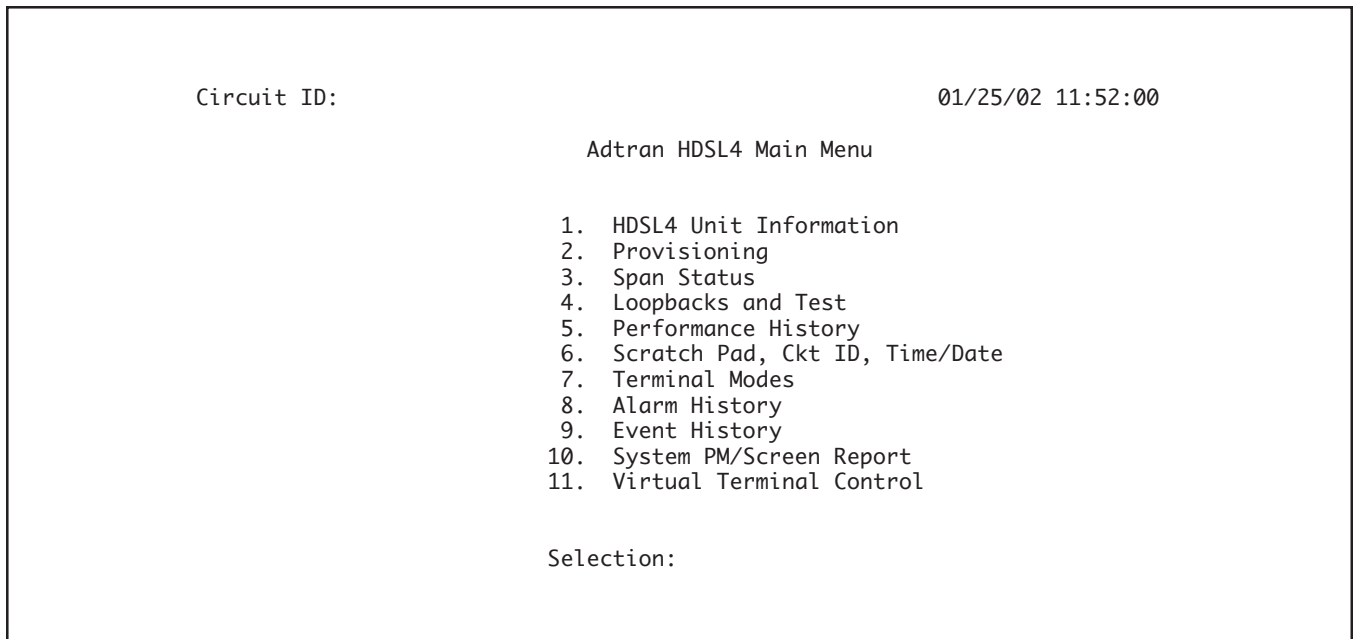


Figure 6. HDSL4 Main Menu

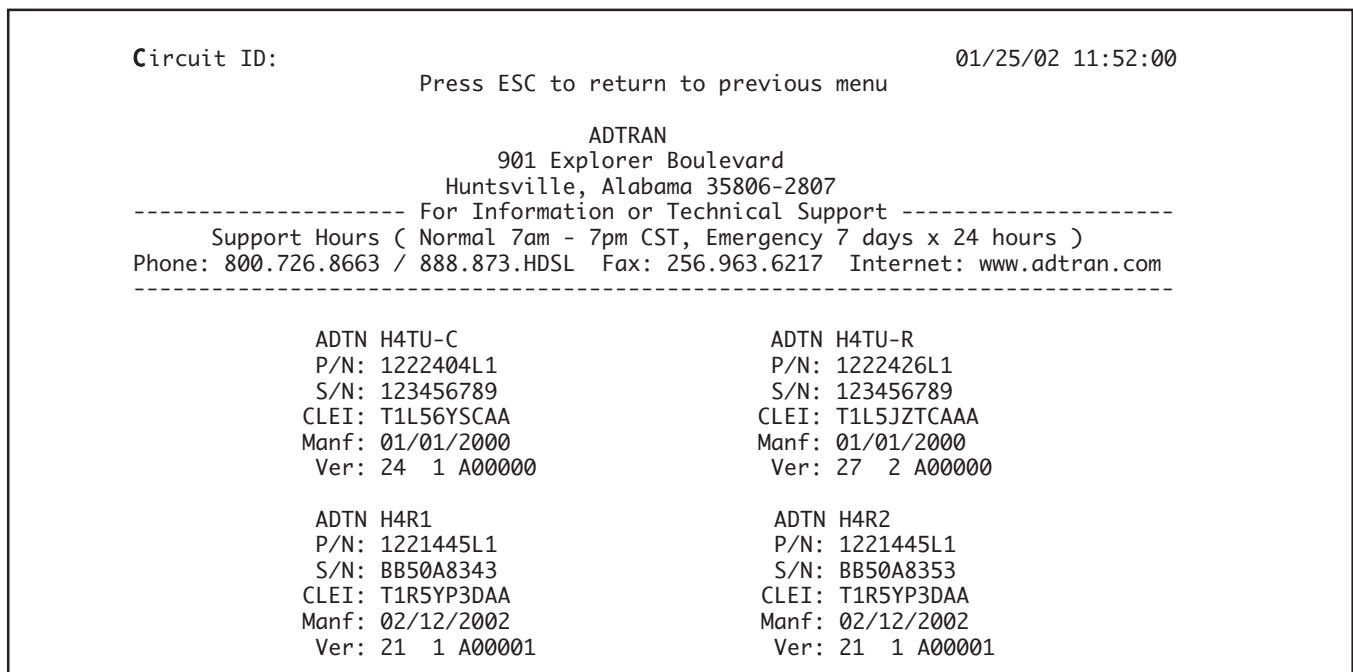


Figure 7. Unit Information Screen

The Provisioning screen illustrated in **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 3 are available with the H4TU-R (P/N 1222426L1). Some settings may differ when using different H4TU-Rs.

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

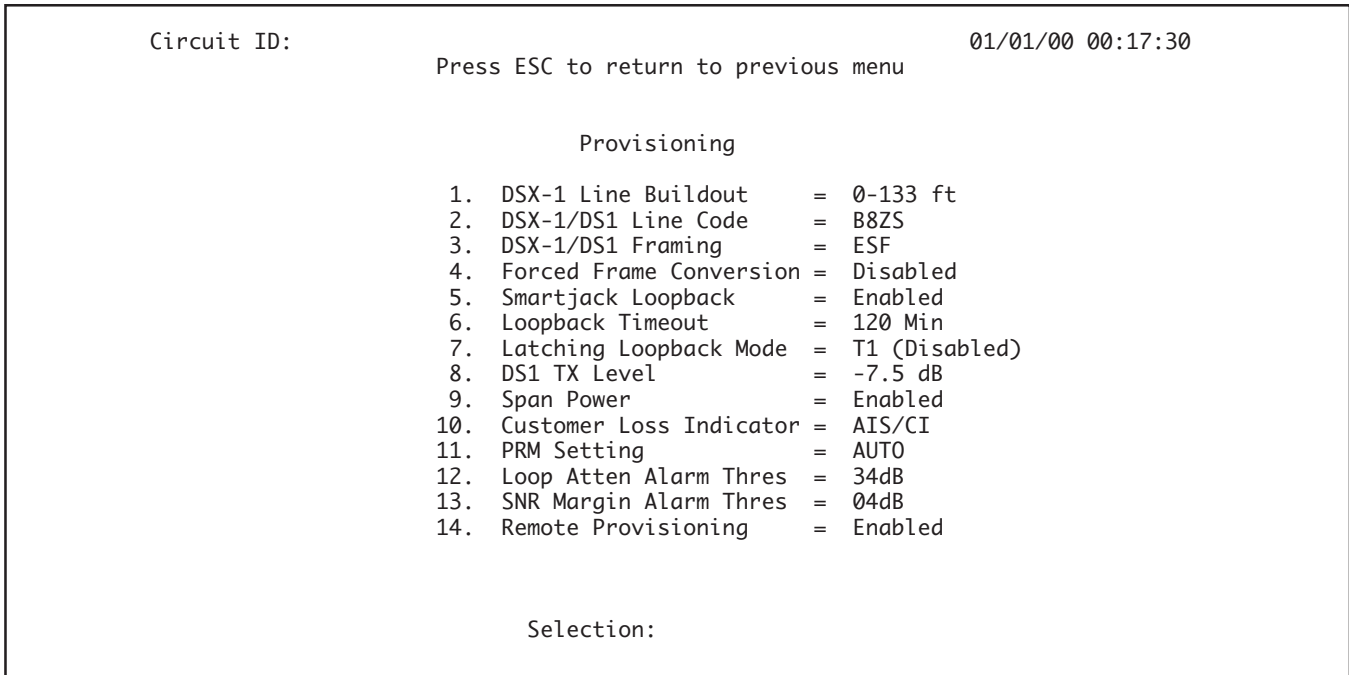


Figure 8. Provisioning Screen

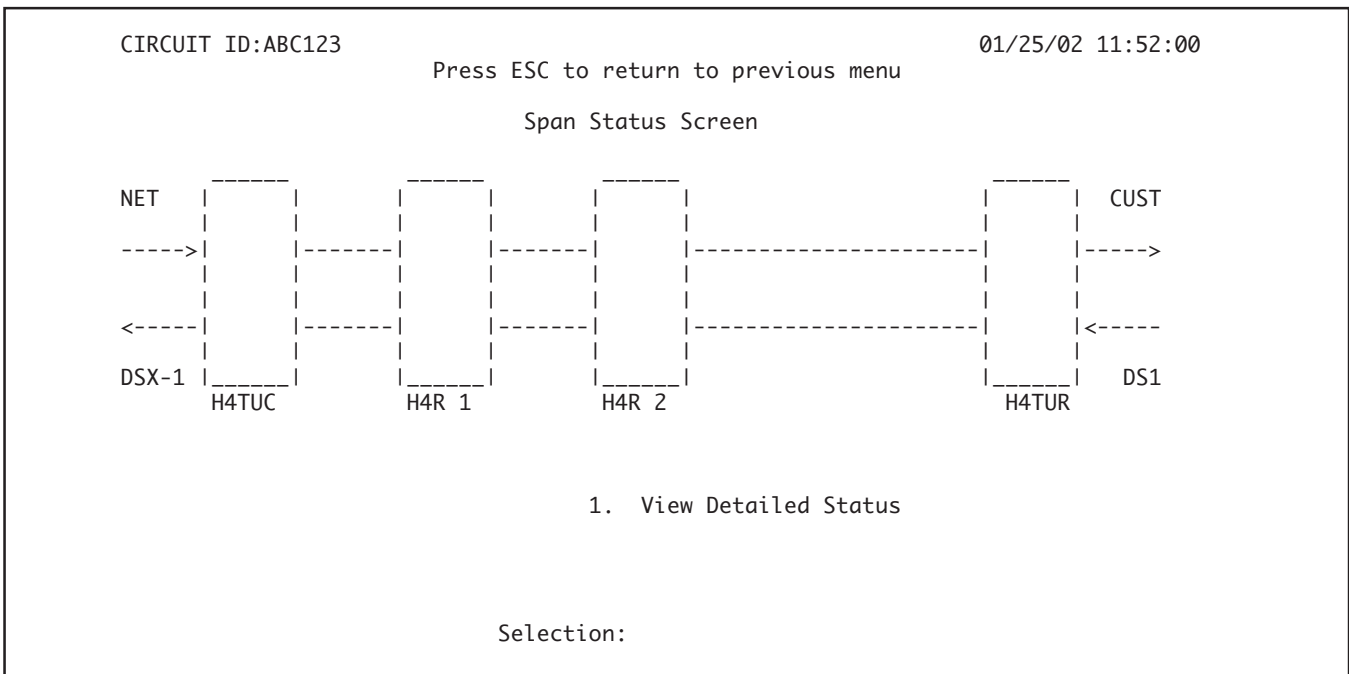


Figure 9. Span Status Screen

The Detailed Status screen from the Span Status menu, illustrated in **Figure 10**, displays the HDSL4 status for each receiver point.

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.

Figure 11 illustrates the Loopbacks and Test Commands Screen, which provides the user with the ability to invoke or terminate all available HDSL4 loopbacks.

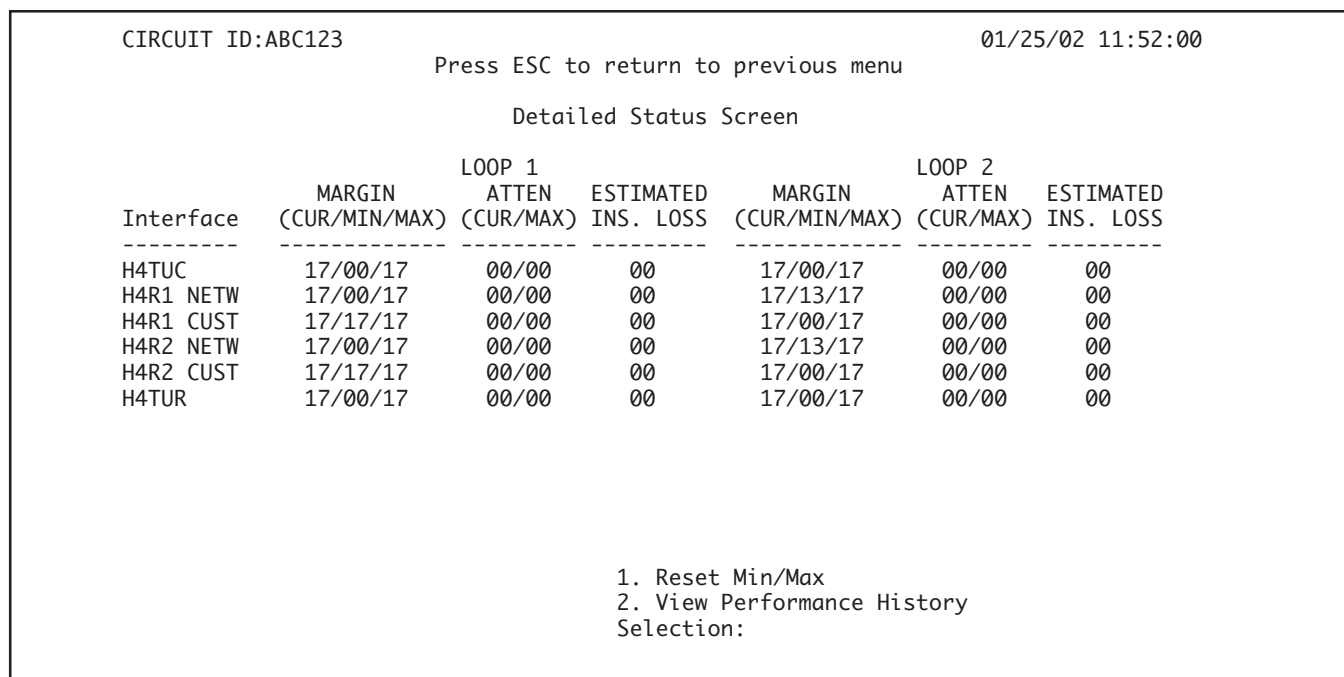


Figure 10. Detailed Status Screen

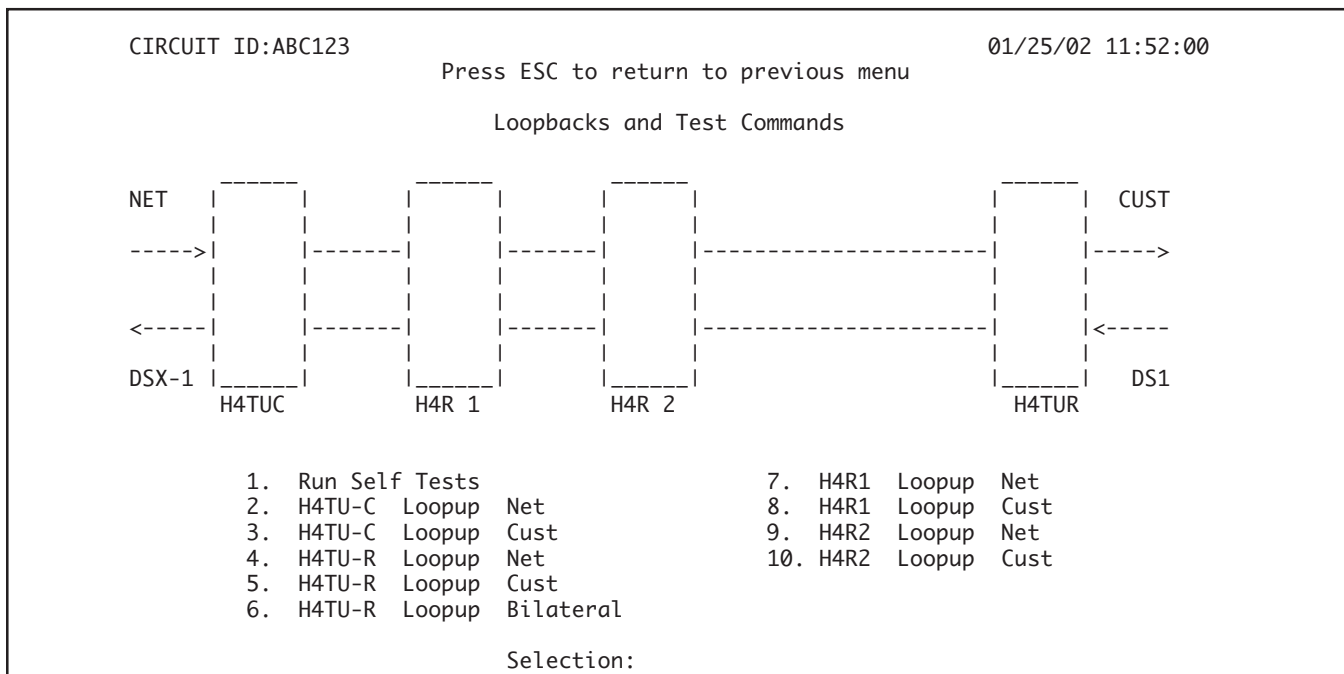


Figure 11. Loopbacks and Test Commands Screen

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.

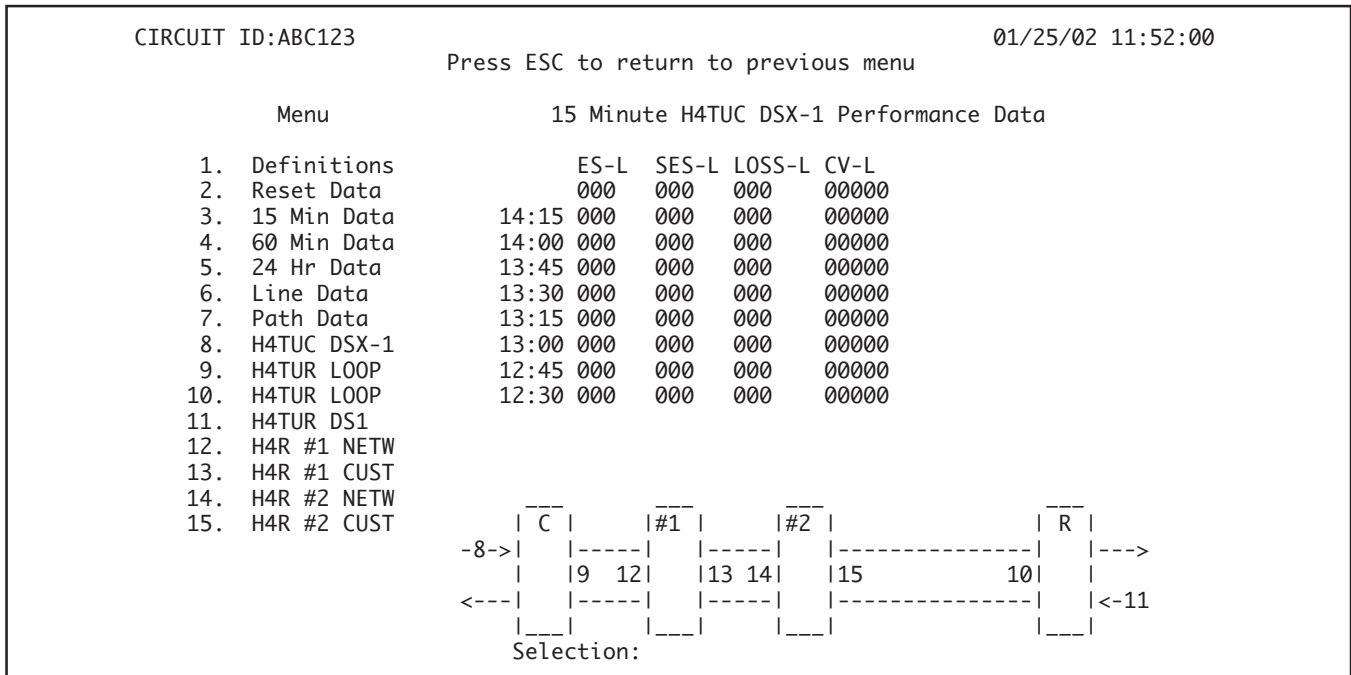


Figure 12. 15-Minute H4TU-C DSX-1 Performance Data Screen

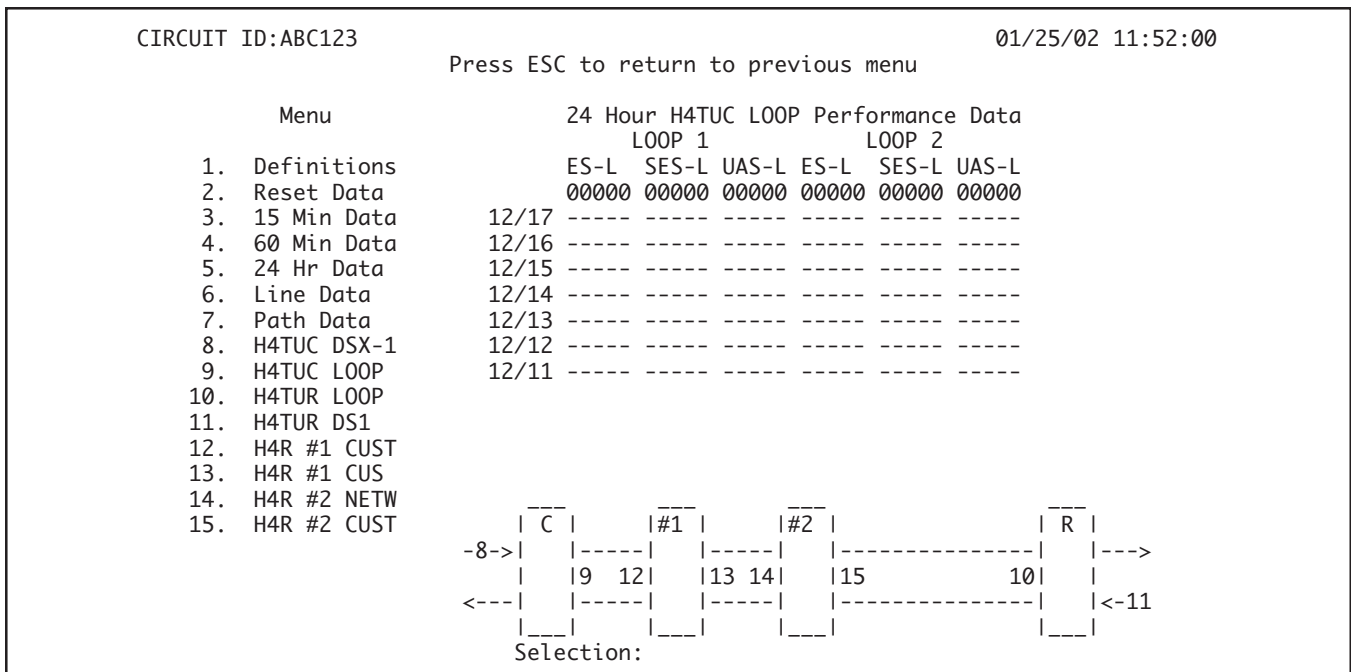


Figure 13. 24-Hour H4TU-C Loop Performance Data Screen

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

Circuit ID:	01/25/02 11:52:00
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	Selection:
P. Previous	

Figure 14. Performance Data Definitions – HDSL4 Loop Related Screen

Circuit ID:	01/25/02 11:52:00	
Performance Data Definitions		
DS1 and DSX-1 Path Related:	Superframe	Extended Superframe
ES-P Errored Seconds	FE>=1 or SEF>=1 or AIS>=1	CRC>=1 or SEF>=1 or AIS>=1
SES-P Severely Errored Seconds	FE>=8 or SEF>=1 or AIS>=1	CRC>=320 or 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 – DS1 and DSX-1 Path Related Screen

Figure 16 illustrates the Scratch Pad, Circuit ID, and Time/Date screen. The Scratch Pad data can be any alphanumeric string up to 50 characters in length. The Circuit ID can be any alphanumeric string up to 25 characters in length. The time should be entered using military time. (For example, enter 3:15 p.m. as “151500”.) The date should be entered as MMDDYY. (For example, enter January 02, 2003, as “010203”.)

The T1 Alarm History screen and HDSL4 Span History screen, **Figure 17** and **Figure 18**, provide a detailed alarm history and events log for the HDSL4 and T1 spans. These screens include a time, date, first/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:                                01/25/02 11:52:00

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 and Circuit ID Screen

```

CIRCUIT ID:                                01/25/02 11:52:00
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 Screen

The Event History Sscreen illustrated in **Figure 19** provides a log history of HDSL4 circuit events.

CIRCUIT ID:ABC123		Press ESC to return to previous menu		01/25/02 11:52:00	
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:ABC123		Press ESC to return to previous menu		01/25/02 11:52:00	
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 from the Main Menu offers four types of reports on performance monitoring. Selecting a report type will then display all the reports for that category on the screen at once, which is more efficient than stepping through the menus individually. See **Figure 20**.

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

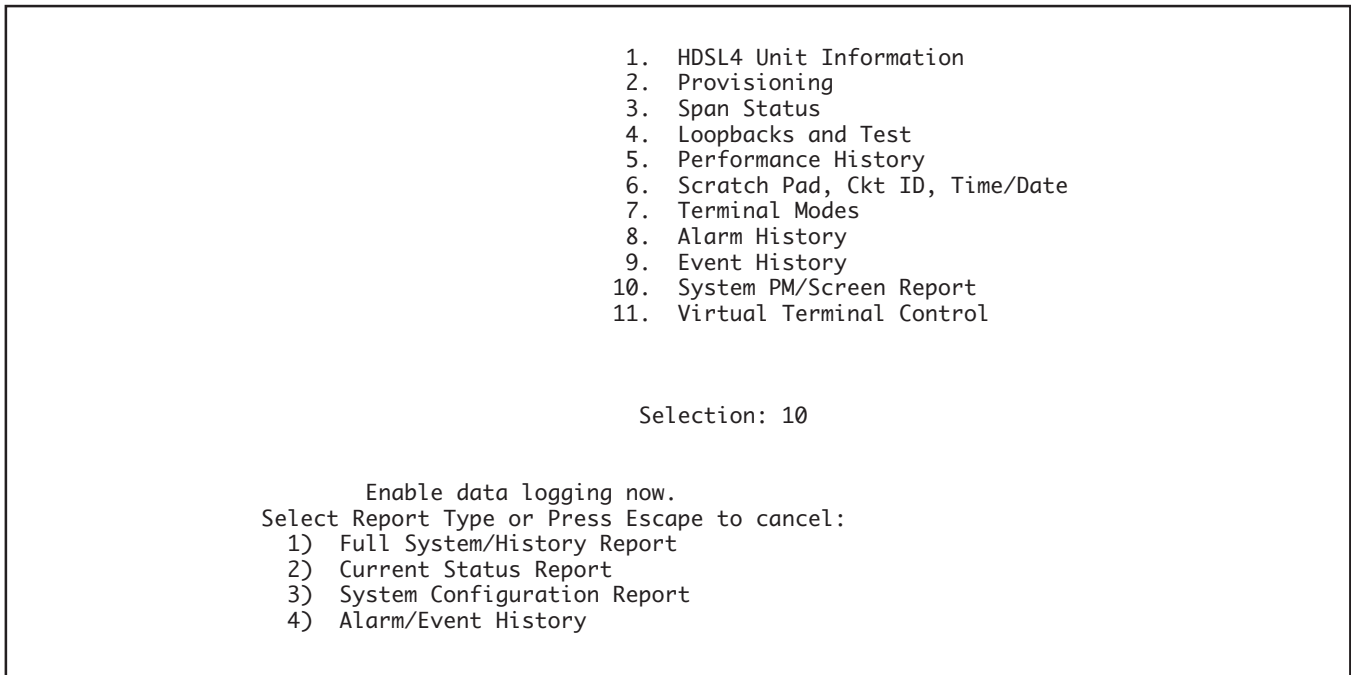


Figure 20. System PM/Screen Report Option

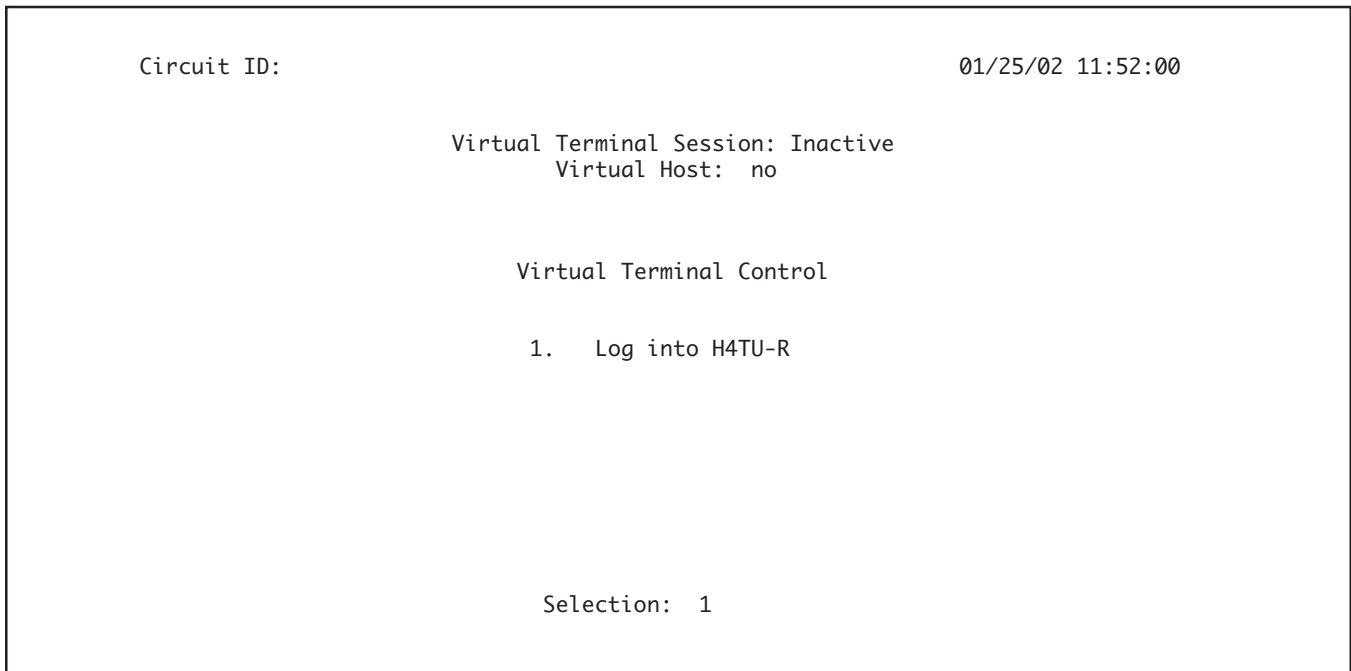


Figure 21. Virtual Terminal Control Screen

6. HDSL4 DEPLOYMENT GUIDELINES

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

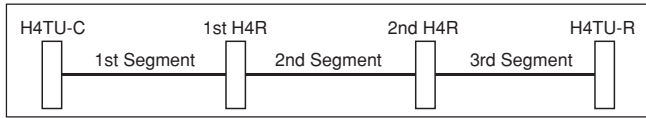


Figure 22. HDSL4 Circuit Segments

Range Calculations

The ADTRAN HDSL4 system provides DS1-based services over loops designed to comply with the guidelines given below. These guidelines apply to a single segment circuit, or an HDSL4 circuit with no H4Rs; to a circuit having two segments (with one H4R); or to a circuit having 3 segments (with two H4Rs).

According to the number of H4Rs in the HDSL4 circuit, the following service ranges apply:

- An HDSL4 circuit containing no H4Rs will reach up to 15,250 ft. on the local loop (24 AWG) [10,800 ft for 26 AWG].
- An HDSL4 circuit containing one H4R will reach up to 15,250 ft on the first segment and 15,050 ft on the second segment (24 AWG) [10,550 ft for 26 AWG].
- An HDSL4 circuit containing two H4Rs will reach to 12,000 ft. on the first segment, 13,500 ft. on the second segment, and 15,000 ft. on the third segment (24 AWG). *

**This is one example of a circuit with two H4Rs. Other loop length configurations are possible in compliance with loop resistance restraints.*

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. Loop Attenuation:

	<u>Upstream</u>	<u>Downstream</u>
1st segment	31 dB	33 dB
2nd segment	30 dB	30 dB
3rd segment	30 dB	30 dB

5. Insertion Loss is within limits. See **Table 5** for loop insertion loss requirements.

**This is one example of a circuit with 2 H4Rs. Other loop length configurations are possible in compliance with loop resistance restraints.*

The simplified loop qualification procedure below provides the technician some assurance of the HDSL4 performance.

Table 5. HDSL4 Loop Insertion Loss Values

Frequency (kHz)	1 st Segment Loss (dB)	2 nd and 3 rd Segment Loss (dB)
50	31.5	29.9
80	35.3	33.5
130	39.1	37.1
196	43.0	N/A

Simplified Loop Qualification Procedure

Use **Table 6** and **Table 7** for the following calculations:

For each of the measured insertion loss values, compute the difference between the maximum loss and the measured loss (max minus measured). If all of the differences are positive, then the loop meets the performance criteria. If any one of the three difference values is negative (measured loss is more than maximum loss), then the sum of the (differences must be at least +3 dB (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 6. Single Span and First Segment of Repeated Loop

Frequency (kHz)	Maximum Loss (dB)	Measured Loss (dB)	Delta Loss (dB) (Max-Meas)
50	31.5		
80	35.3		
130	39.1		
196	43.0		
*Sum Delta Loss =			
If any single frequency insertion loss exceeds the maximum loss (delta loss < 0), then the sum of the four delta loss values must be > 3.0 dB			

Table 7. Second Segment of Repeated Loop

Frequency (kHz)	Maximum Loss (dB)	Measured Loss (dB)	Delta Loss (dB) (Max-Meas)
50	29.9		
80	33.5		
130	37.1		
*Sum Delta Loss =			
If any single frequency insertion loss exceeds the maximum loss (delta loss < 0), then the sum of the four delta loss values must be > 1.0 dB			

Resistance Values

Each of the three segments associated with span powering two H4Rs and a H4TU-R must satisfy the recommended insertion loss, loop attenuation requirements in addition to the DC resistance budgets. 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.

The segment resistance (Ω_{segment}) is determined using this equation:

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

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

Table 8 lists single pair cable DC resistance values to be used in the equation above.

Table 8. Single Pair Cable DC Resistance Value (Ω)

Resistance (Ohms/kft)				
AWG	70°F	90°F*	120°F	140°F**
19	16.465	17.183	18.261	18.979
22	33.006	34.446	36.606	38.046
24	52.498	54.789	58.225	60.516
26	83.475	87.117	92.581	96.223

* Interpolated between 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 23** to decide if the H4TU-C is capable of span powering two H4Rs and one H4TU-R. Follow these steps to utilize the graph shown in Figure 23:

1. Find the line on the graph which represents the known third segment resistance. These are the lines running diagonally across the graph labeled 300 - 1100 ohms. This line represents the upper limit for two H4Rs plus H4TU-R span powering.
2. Find the first segment resistance on the vertical axis.
3. Find the second segment resistance on the horizontal axis.

4. Find the instance where the two points from Steps 2 and 3 meet on the graph.
5. The point found in step 4 must be below the upper limit line defined by the third segment measurement (Step 1). If the instance where these two points is above this line, the H4TU-C cannot span power two H4Rs and the H4TU-R.

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

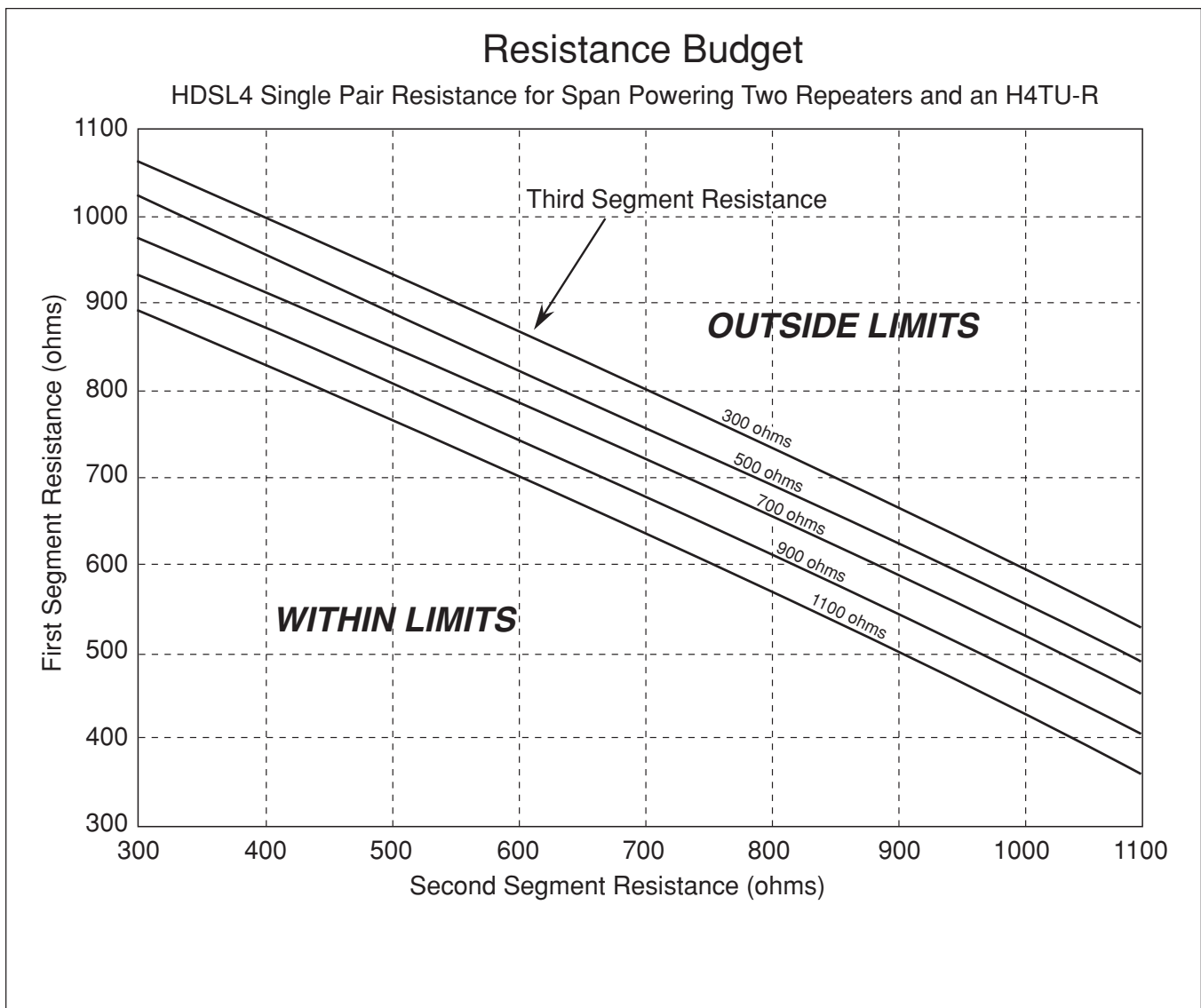


Figure 23. Resistance Budget Span Powering Two Repeaters

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

1. Find the 900 ohm third segment resistance line on the graph. This line is depicted in bold in Figure 24. This line is the upper span power limit.
2. Find the 600 ohm first segment resistance point on the vertical axis.
3. Find the 700 ohm second segment resistance point on the horizontal axis.

4. Find the instance on the graph where the points from Steps 2 and 3 meet.
5. If this points below the bold line defined in Step 1, the current is capable of span powering two H4Rs and one H4TU-R.

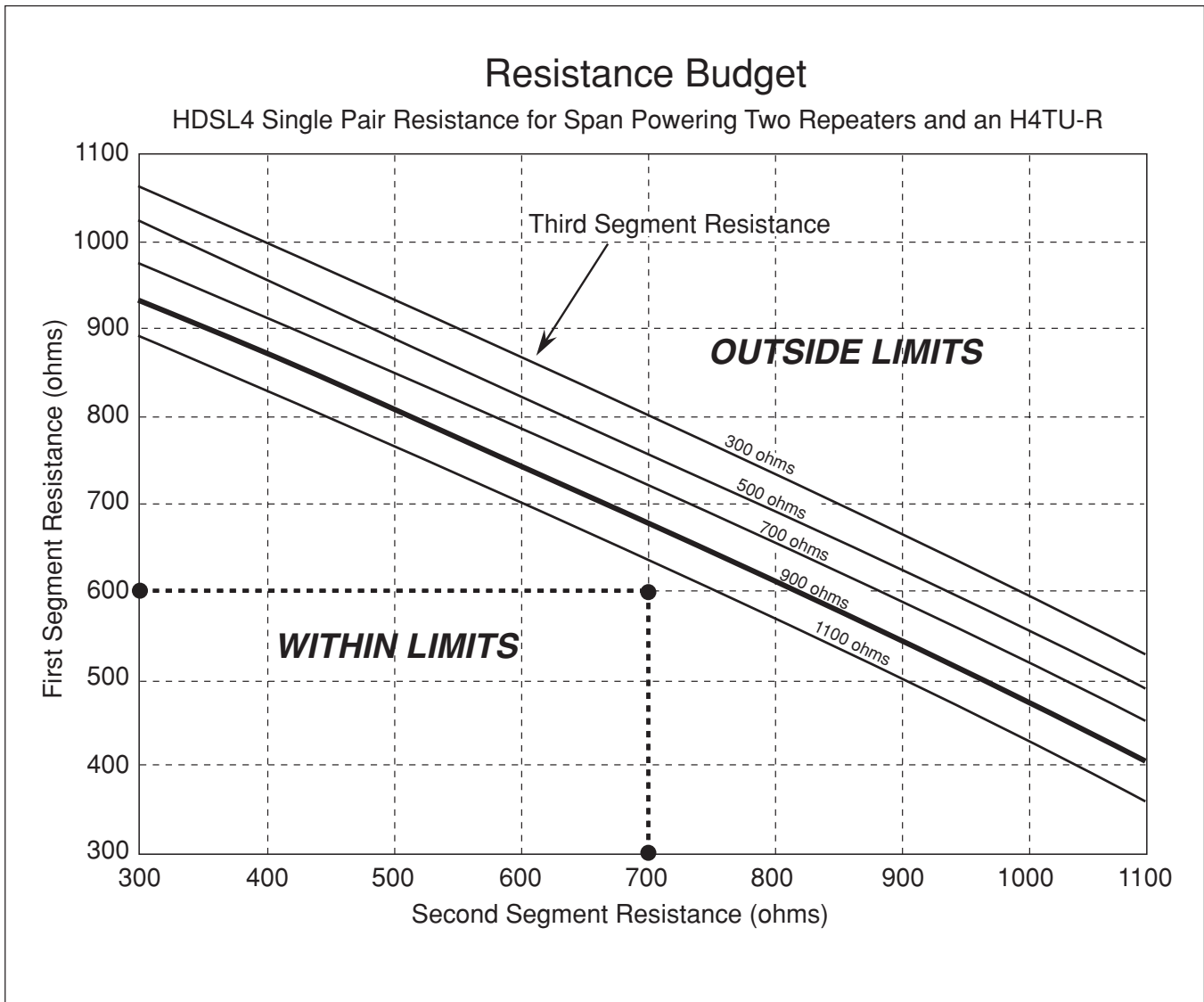


Figure 24. Resistance Budget Span Powering Two Repeaters (Example)

7. MAINTENANCE

The ADTRAN H4TU-C requires no routine maintenance. In case of equipment malfunction, use the front panel 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. For more information refer to the *Warranty and Customer Service* section of this practice.

8. PRODUCT SPECIFICATIONS

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

9. 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 9. 3192 H4TU-C Specifications

Specification	Description
Loop Interface	
Modulation Type	16 TC PAM
Mode	Full duplex, Ppartially overlapped echo canceling
Number of Pairs	2
Line Rate	1.552 Mbps
Baud Rate	261.333 k baud
Loop Loss	See <i>HDSL4 Deployment Guidelines</i> , Section 6 of this document.
Bridged Taps	Single taps < 2000 ft., total taps < 2500 ft.
Performance	Compliant with T1.418-2000 (HDSL2 Standard, issue 2)
H4TU-C Transmit Power (Data) Level	14.1 ±0.5 dBm (0 to 400 kHz)
H4TU-C Transmit Power (Activation) Level	14.1 ±0.5 dBm (0 to 307 kHz)
Input Impedence	135 ohms
Maximum Loop Resistance	1150 ohms (nonrepeated circuit)
Return Loss	12 dB (50 kHz to 200 kHz)
Network Interface	
DS1 Transmit Level	0 dB to -7.5 dB (default), -15 dB
DSX-1 Line Build Out	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-R (1222426L1) and H4R (1221445L1)	
H4TU-C Total Power	-48 VDC @ 215 mA with H4TU-R -48 VDC @ 375 mA with H4TU-R and one H4R -48 VDC @ 585 mA with H4TU-R and two H4Rs
H4TU-C Power Dissipation	5.8 watts with H4TU-R 6.6 watts with H4TU-R and one H4R 7.8 watts with H4TU-R and two H4Rs
Span Power	-190 VDC (internally generated) Class A2 compliant, GFI current limited at < 5 mA, loop current Llimited at 150 mA
Fusing	1.00 A (not field-replaceable)
Clock	
Clock Sources	Internal, 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), Repeater Loopback (H4R)
Physical	
3192 Office Repeater Shelf-Mounted Weight	< 1 lb.
Environment	
Operating Temperature (Standard)	-40°C to +70°C
Storage Temperature	-40°C to +85°C
Compliance	
UL 60950 GR-1089-CORE GR-63-CORE ANSI T1.418-2002 ANSI T1.102 (DS1 interface)	
Part Number	
3192 H4TU-C	1222404L1

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Appendix A

HDSL4 Loopbacks

HDSL4 MAINTENANCE MODES

This appendix describes operation of the HDSL4 system with regard to detection of in-band and ESF facility data link loopback codes. Upon deactivation of a loopback, the HDSL4 system will synchronize automatically.

Loopback Process Description

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

Loopback Control Codes

Control sequences are summarized in **Table A-1** and **Table A-2**.

NOTE

In all control code sequences presented, the in-band codes are shown with the 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)
(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 (ESF-DL) (1111 1111 0100 1000)	Loopback data from customer toward customer at HTU-R
(N)		1in6 (100000)	Loopback data from network toward network at HTU-R
(N)		FF48 (ESF-DL) (1111 1111 0100 1000)	Loopback data from network toward network at HTU-R
(N/C)		1in3 (100)	Loopdown everything
(N/C)		FF24 (ESF-DL) (1111 1111 0010 0100)	Loopdown everything

^{A-1} The Source column indicates which side of the interface the control codes are sent from. For example, an (N) indicates a network sourced code while a (C) indicates a customer sourced code.

^{A-2} All codes are in-band unless labeled ESF-DL

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

Table A-2. Loopback and Control Codes

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

¹Units must be armed with 11000b or FF48h before this code will work.

²Loopback and error injection will only occur if the in-band code is received by the unit that is to go into loopback. In other words, if another loopback blocks the in-band code from being transmitted to the unit that is to go into loopback, loopback and error injection will not occur.

Note: All codes listed above must be sent for a minimum of 5 seconds to be detected and acted upon.

Table A-2. Loopback and Control Codes (Continued)

Function	Code	Response
Loopback Time Out Override ¹	D5D6 (hex) or 1101 0101 1101 0110 (binary)	<p>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.</p> <p>H4TU-C.....231 bps H4R1.....110 bps H4R2.....2200 bps H4TU-R.....20 bps</p>
Span Power Disable ¹	6767 (hex) or 0110 0111 0110 0111 (binary)	<p>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.</p>
First H4R Loop Up ^{1,2}	C741 (1100 0111 0100 0001)	<p>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.</p>
Second H4R Loop Up ^{1,2}	C754 (1100 0111 0101 0100)	<p>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.</p>
H4TU-R Address 20 for Extended Demarc ^{1,2}	C742 (1100 0111 0100 0010)	<p>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.</p>

¹Units must be armed with 11000b or FF48h before this code will work.

²Loopback 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.