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

Section 61245003L7-5
Issue 1, April 1998
CLEI Code # T1L1B284AA

MODEL DDM PLUS HTU-C
HIGH BIT-RATE DIGITAL SUBSCRIBER LINE TRANSCEIVER UNIT - CENTRAL OFFICE INSTALLATION/MAINTENANCE

CONTENTS

FIGURES

TABLES

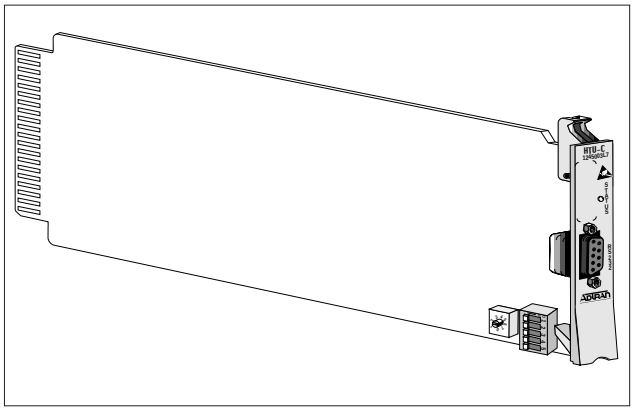

Figure 1. ADTRAN DDM PLUS HTU-C

1. GENERAL

The ADTRAN DDM Plus HTU-C, part number 1245003L7, is the central office (CO) unit used to deploy a repeaterless T1 circuit using 4-wire metallic facilities. The unit occupies one slot in an AT&T DDM Plus DS1 Extension shelf. The unit is illustrated in Figure 1.

DSX-1 signals are provided to and from the network while 2B1Q HDSL signals are provided to the local loop. The ADTRAN HTU-C works in conjunction with the ADTRAN HTU-R and HRE to provide a DS1 service up to 24,000 feet on the local loop.

This HTU-C works with multiple list versions of the HDSL unit remote end (HTU-R) and HDSL range extender (HRE) as listed below:

- 1242004L2, HTU-R T400 CP
- 1242035L2, HTU-R SA
- 1242031L2, HRE
- 1244021L1, Low Voltage HTU-R T400 CP
- 1244022L1, Low Voltage HTU-R SA
- 1244041LX, Low Voltage T400 HRE
- 1244042L1, Low Voltage 819A HRE
- 1244044L1, Low Voltage 439 HRE
- 1245021L1, Low Voltage HTU-R T200 CP
- 1245022L1, Low Voltage HTU-R SA
- 1245026L1, Low Voltage HTU-R CI

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

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

System power and alarm bus connections are made through the backplane of the DDM Plus shelf. DSX-1 and HDSL signals are connected through the wire-wrap pins related to each individual slot located on the rear of the shelf.

The HTU-C contains onboard fuses. If a fuse opens, it supplies a -48 VDC voltage to the fuse alarm bus and all front panel indicators will be *Off*. These fuses are not designed to be field replaceable.

The DDM Plus HTU-C uses a DC-to-DC converter to derive its internal logic and span powering voltages from the -48 VDC office supply.

2. INSTALLATION

After unpacking the unit, immediately inspect it for possible shipping damage. If damage is discovered, file a claim immediately with the carrier, then contact ADTRAN Customer Service (see subsection 10 of this practice).

The DDM Plus HTU-C plugs directly into the AT&T DDM Plus shelf. The unit may be plugged into any of the 28 numbered slots in this shelf. No installation wiring is required.

One eight-position rotary switch (SW1) and one five-position Dipswitch pack (SW2) are used to configure the mode of operation. Figure 2 shows the location of these switches.

A definition of each switch is shown in Tables A and B. Configuration may be performed by manually selecting each option switch, or alternatively, may be performed using the RS-232 craft access port.

Faceplate Indicator
The HTU-C has one faceplate LED which indicates operational status. Table C defines this LED.

Shelf Population (based on power requirements)
Typically the AT&T DDM Plus shelf is fused at 10 amps per side (one half of the shelf). Appendix C contains a worksheet for calculating the maximum number of DDM PlusHTU-Cs allowed in the AT&T DDM Plus Shelf.

Several HTU-Cs can be mixed with other DDM Plus standard plug-ins, providing that the total current draw per shelf side is less than or equal to 5 A. Refer to the original equipment manufacturer's specifications for more detail on specific power requirements of these units.

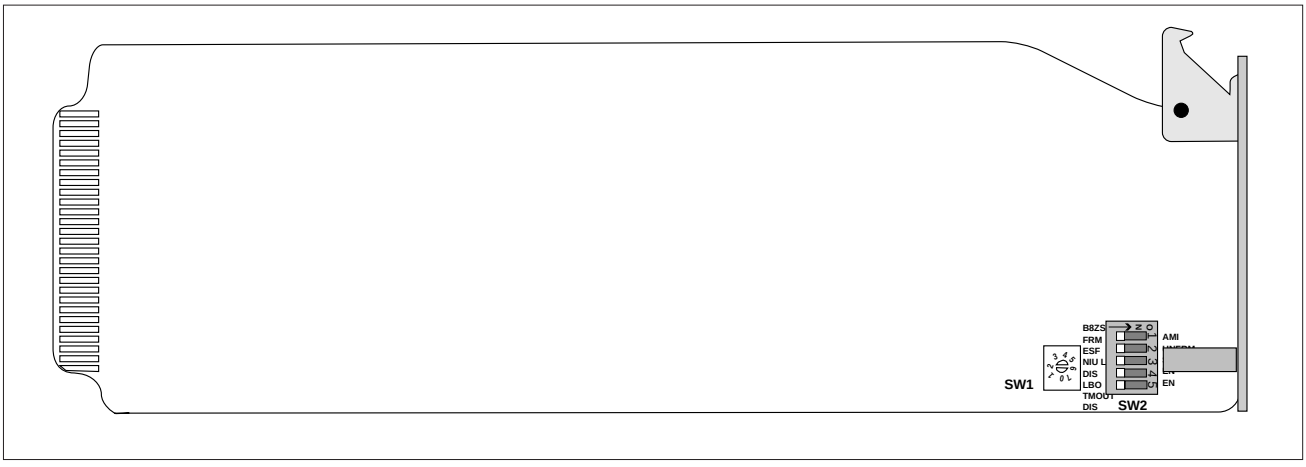

Figure 2. DDM Plus HTU-C Option Switch Locations

Table A. Circuit Board Rotary Switch Option Settings [1]
(Default settings are indicated in **bold** typeface)

Switch	Function	Description
SW1	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

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

Switch	Function	Description
	Manual Code Select	
SW2-1	AMI	Alternate Mark Inversion (AMI) is selected.
	B8ZS	**B8ZS line code is selected.**
	T1 Framing	
SW2-2	Unframed	Selects Unframed (UFRM) operation; SW2-3 is ignored.
	Framed	**Selects Framed operation.**
	Manual Frame Select	
SW2-3	SF	Selects Superframe (SF) format.
	ESF	**Selects Extended Superframe (ESF) format.**
	NIU Loopback	This switch programs the ADTRAN HDSL system to respond to traditional T1 network interface unit (NIU) loop-up and loop-down codes. See Appendix A for more information on specific codes.
SW2-4	**Enabled**	
	Disabled	
	Loopback Timeout	
SW2-5	Enabled	Loopback Timeout is Enabled.[3, 4]
	Disabled	**Loopback Timeout is Disabled.**

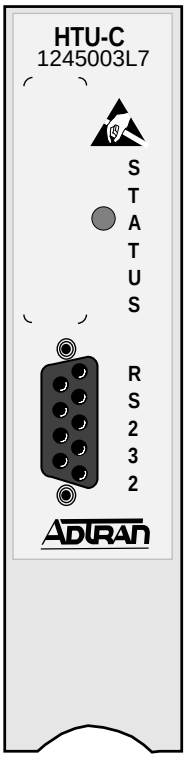

Table C. Front Panel Indicator

Indicator	Description	
STATUS	Blinking Red	Signal Quality of 0 or No Sync on at least one loop
	Solid Red	Alarm on any of HTU-C loops, HRE loops, DSX, or DS1 [5]
	Blinking Amber	Armed to accept inband loopbacks
	Solid Amber	Loopbacks active
	Blinking Green	ES, SES, or BPV occurred
	Solid Green	Everything functioning OK

[1] The HTU-C transfers the local configuration to the HTU-R when circuit synchronization is achieved. The HTU-R then sets its configuration to match the HTU-C.
[2] The HTU-C transfers the local configuration to the HTU-R when circuit synchronization is achieved. The HTU-R then sets its configuration to match the HTU-C.
[3] Loopback timeout must be selected prior to initiating a loopback.
[4] 20-minute timeout is the default for Loopback Timeout Enabled. 60-minute and 120-minute timeouts are also available from the craft interface.
[5] The Status LED will be red if customer equipment is not installed. If this is the case, a BERT test or the craft interface should be used to determine if HDSL loop synchronization has been achieved.

3. CONNECTIONS

The DDM Plus HTU-C occupies one card slot in an AT&T DDM Plus shelf. Power and alarm signals are provided to the card through the backplane of the shelf. DSX-1 and HDSL loop signals are connected to the shelf connector and transmitted to the corresponding slot the unit occupies. See Figure 3 for HTU-C edge connection wiring.

The HTU-C is capable of span powering the HTU-R by applying simplex current to the local loop. Approximately 100 *m*A of current is coupled onto the HDSL span to power the HTU-R along with a Network Interface Unit or CSU that is located between the HTU-R and the customer. Loop 1 has the most negative potential for span powering. The span powering voltage is <-140 volts with Loop 1 providing the negative voltage and Loop 2 the return (see Figure 4).

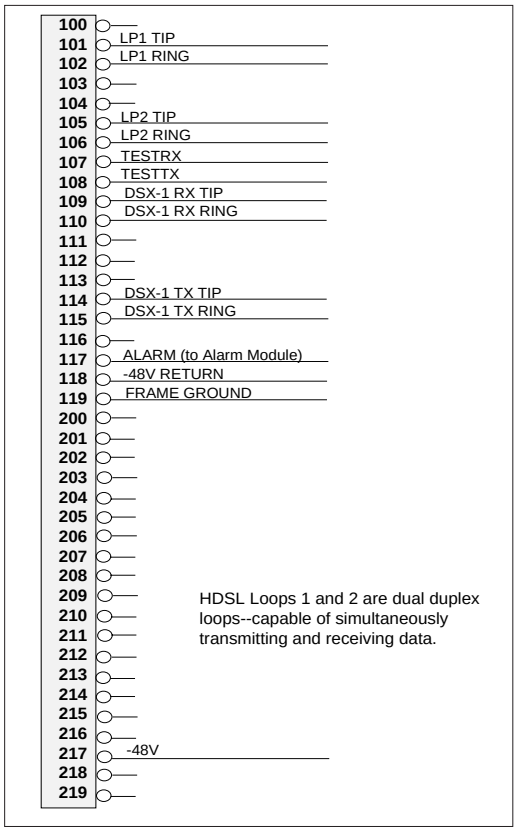

Figure 3. HTU-C Edge Connector Wiring

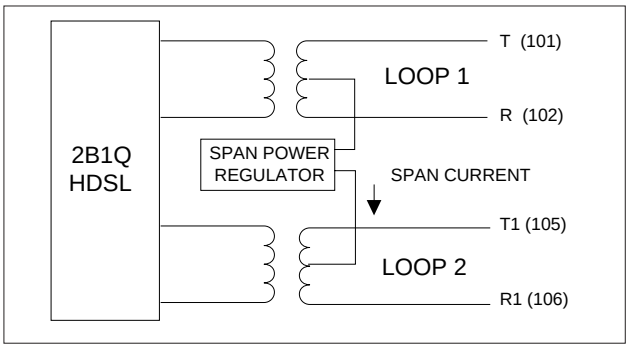

Figure 4. HTU-C Span Powering Diagram

Alarm Connections

The following alarm signal is connected to the DDM Plus Alarm Module:

Pin 117
Label ..... LOS and Fuse Alarm
Function ... Loss of signal and fuse alarm of -48 V supply

Alarm processing is actually performed by the DDM Plus Alarm Module. Refer to the DDM Plus Alarm module documentation for further information.

Alarm conditions are not reported at the DDM Plus HTU-C until the HDSL circuit is terminated by connecting an HTU-R. This allows circuit pack pre-provisioning. Once the HTU-C is terminated with an HTU-R, the unit will go into an in-service state.

4. HDSL SYSTEM TESTING

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

HTU-C Loopbacks

The HTU-C responds to two different loopback activation processes. First, loopback may be commanded manually using the control port interface. Figure 11 depicts the Loopback Options Screen which provides for both HTU-C and HTU-R loopbacks.

Secondly, the HTU-C responds to the industry defacto standard for HDSL loopbacks, T1E1.4/92. 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 HTU-C where the DSX-1 signal passes into the HDSL modulators. Figure 5 depicts all the loopback locations possible with ADTRAN HDSL equipment.

In addition to network-side loopbacks, the HTU-C provides customer-side loopbacks initiated by using the terminal control port. In this mode, an AIS signal is supplied to the network. Customer-side loopbacks must be deactivated using the terminal.

NOTE *When the 11000 in-band code is used to loop the HTU-R, the HTU-R will re-enter armed state upon loopback timeout, or upon terminal deactivation. See Appendix A for a more detailed description of loopback element states.*

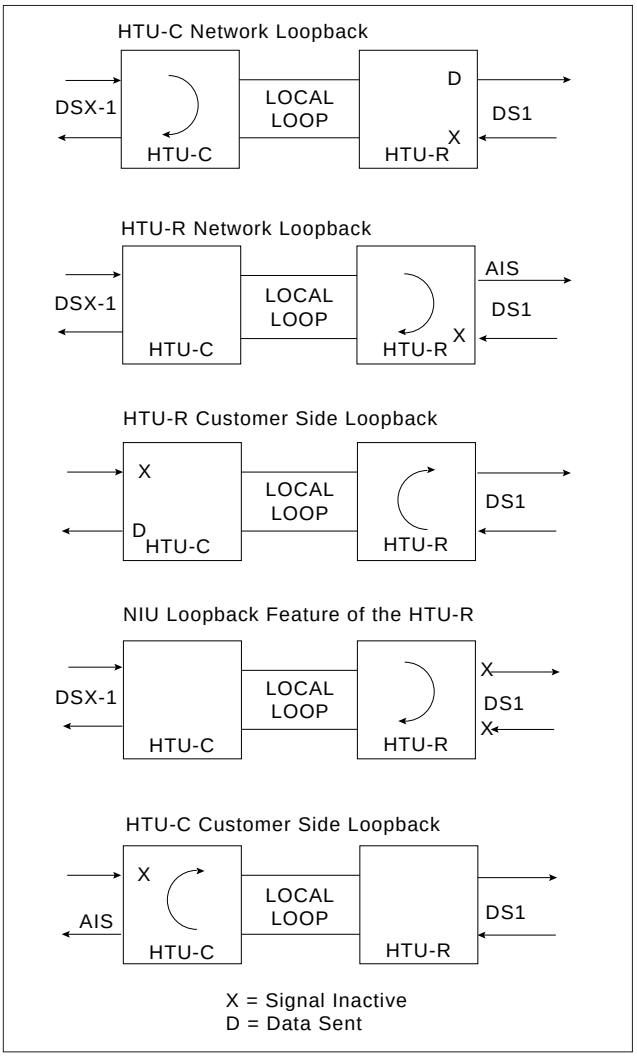

Figure 5. HDSL Loopbacks

5. CONTROL PORT OPERATION

The HTU-C provides a faceplate-mounted DB9 connector that supplies an RS-232 interface for connection to a controlling terminal. The pinout of the DB9 is illustrated in Figure 6.

The terminal interface operates at data rates from 1.2 kbps to 19.2 kbps. The asynchronous data format is

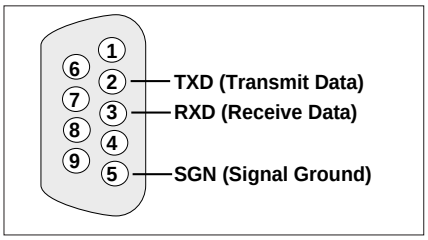

Figure 6. RS-232 (DB9) Pin Assignments

fixed at 8 data bits, no parity, and 1 stop bit. The supported terminal type is VT 100 or compatible.

Many portable personal computers use power-saving programs that are known to interfere with applications running on the personal computer. If using a portable personal computer with terminal emulation capability, communication between the computer and the HDSL unit may be periodically disrupted if power saving programs are being used on the personal computer. The symptoms may include misplaced characters appearing on the screen and/or the occurrence of screen timeouts. These symptoms are not disruptive to the operation of the circuit and are avoidable if the power saving options are disabled or removed.

Operation

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

The screens illustrated in Figures 7 through 14 are for an HDSL circuit deployed with ADTRAN's Low Voltage HDSL technology. The circuit includes an HTU-C, HTU-R, and HRE. This scenario was chosen for inclusiveness of functionality. However, other configurations are possible 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 HTU-C to determine the speed of the terminal. Once the speed has been determined, an Introductory Menu is presented, as illustrated in Figure 7.

From the Introductory Menu, the Main Menu may be selected. The Main Menu provides access to detailed performance and configuration information, as illustrated in Figure 8, HDSL Main Menu Screen.

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

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

Table D. Screen Abbreviations Defined

Abbreviation	Definition
ES	Errored Seconds
	DSX/DS1 (SF) — Second in which a BPV or frame bit error occurs.
	(ESF) — Second in which a BPV or CRC error occurs.
	HDSL — Second in which a CRC error occurs.
SES	Severely Errored Seconds
	DSX/DS1 (SF) — Second in which 1544 BPVs or 8 frame bit errors occur.
	(ESF) — Second in which 1544 BPVs or 320 CRC errors occur.
	HDSL — Second in which 165 CRC errors occur.
UAS	Unavailable Seconds
	DSX/DS1 — Second in which there is a loss of signal or sync.
	HDSL — Second in which there is a loss of signal or sync.
SF	Superframe Format
ESF	Extended Superframe Format
B8ZS	Binary 8 Zero Substitution
AMI	Alternate Mark Inversion
LBO	Line Build-Out
BPV	Bipolar Violation
	DSX/DS1 — Second in which a bipolar violation occurs
NIU	T1 Network Interface Unit
S/N	Serial Number
15M	Fifteen-Minute period
24H	Twenty-Four-Hour period

The Current System Status screen illustrated in Figure 9 provides quick access to status information for both the HTU-C and HTU-R.

The Elapsed Time display indicates the period of time since the unit began collecting performance information. At each 15-minute interval, the performance information is transferred to the 15-minute performance data register accessed from the Performance History screen. At each 24-hour interval, the performance data is transferred into the 24-hour performance data register also accessed using the Performance History screen. The Performance History screen is shown in Figure 10.

By typing the letter “Z” at the Current System Status screen, the current performance registers will be reset to zero on the Current System Status screen and Performance History screen.

LOSS ..... Pulse Attenuation Measurement *

** LOSS is typically several dB less than the insertion loss measured at 200 kHz. The LOSS measurement is a better indication of the loop’s attenuation of the 2B1Q signal than the insertion loss measured at a single frequency. Adtran HDSL can operate on cables with an excess of 30 dB LOSS.*

SYNC ..... HDSL Loop 1 and Loop 2 Sync Status
ES 15M/24H ..... Errored Seconds*
SES 15M/24H .... Severely Errored Seconds*
UAS 15M/24H .... Unavailable Seconds*

** The first number is for the current 15-minute period and the second is the current 24-hour period (Loop 1 and Loop 2 numbers are displayed).*

An indication of Pair Reversal (if present) is given at the bottom of the first key column. Status and configuration information for the DS1 and DSX-1 signals is located in the center of the screen near the bottom.

FRAME ..... T1 Framing Format selected
CODE ..... T1 Line Code selected
LBO ..... Line Build-Out selected (for DSX-1); Customer Signal of 0 or -15 dB (for DS1)
NIU ..... Network Interface Unit enabled?
BPV ..... Bipolar Violations detected (DSX-1 and DS1)
ES ..... Errored Seconds (DSX-1 and DS1)
SES ..... Severely Errored Seconds (DSX-1 and DS1)
UAS ..... Unavailable Seconds (DSX-1 and DS1)
Alarms ..... Lists current alarm condition status

A measure of signal quality for each HDSL loop is displayed in graphic form on the bottom of the screen. The measure is from 0 (poor signal quality) to 9 (excellent signal quality). Guidelines for interpreting the indicators are given below.

0 ..... Noise margin is ≤ 0 dB (≈ 10^{-7} BER)
1-8 ..... Margin measurement above 10^{-7} BER in dB
9 ..... Margin is ≥ 9 dB (excellent quality) above 10^{-7} BER

The HDSL Loopback and Self-Test Option screens are illustrated in Figures 11 and 12. Loopbacks and Self-Test may be evoked or terminated using these screens. A status of current loopback conditions is also provided.

The Provisioning screen, illustrated in Figure 13, displays current provisioning settings and allows for changing the system configuration. Provisioning changes are only allowed at the CO end of the circuit. Provisioning changes made through this screen override the manual switch settings. The unit retains the last provisioning changes to determine its operating mode.

NOTE *The DS1 Output Level option in the Provisioning Screen of the HTU-C can only be altered if the circuit contains a 2nd or 4th generation HTU-R. (The generation of the product is identified in the fourth digit of the product number.)*

The Troubleshooting Display, illustrated in Figure 14, graphically presents an HDSL circuit. The unit reviews red, yellow, and blue alarm conditions in the circuit to automatically predict where a fault is located. Once a fault location is suspected, the corresponding portion of the circuit on the screen is highlighted and a message describing the failure is presented.

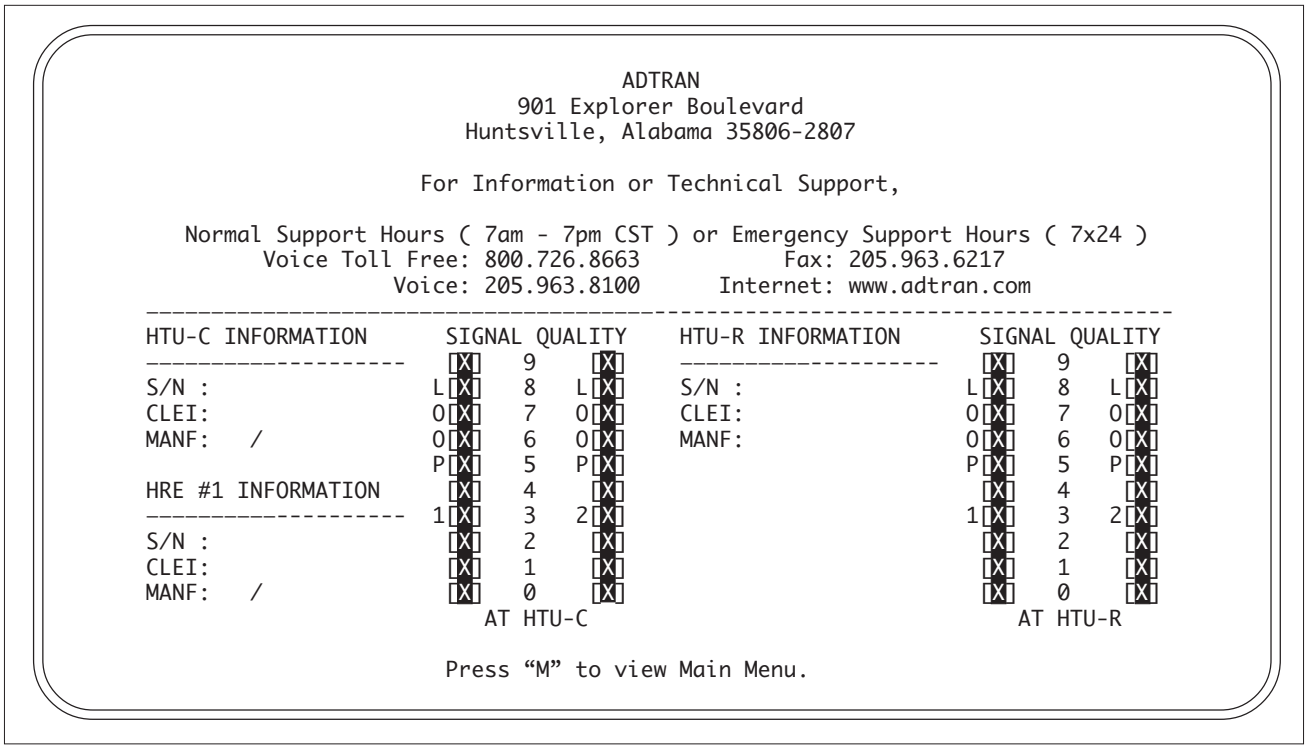

Figure 7. Introductory Menu Screen

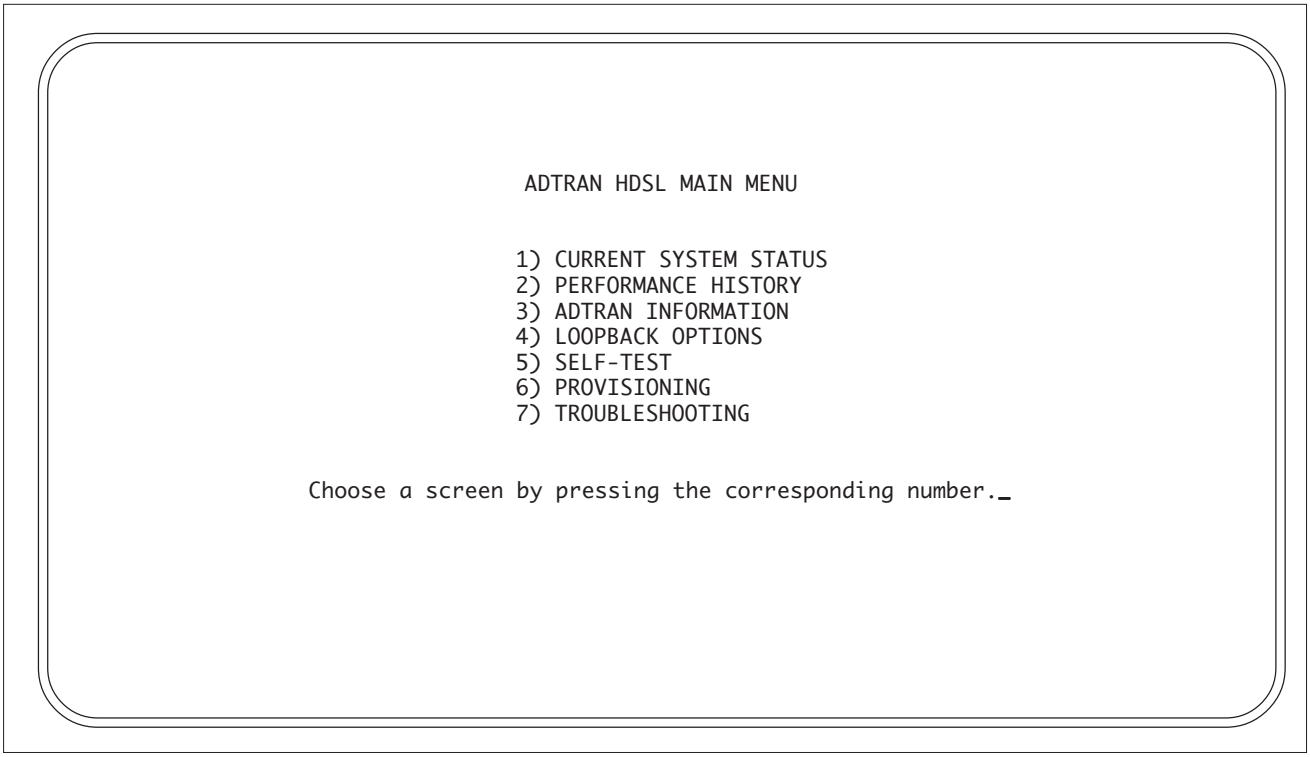

Figure 8. HDSL Main Menu Screen

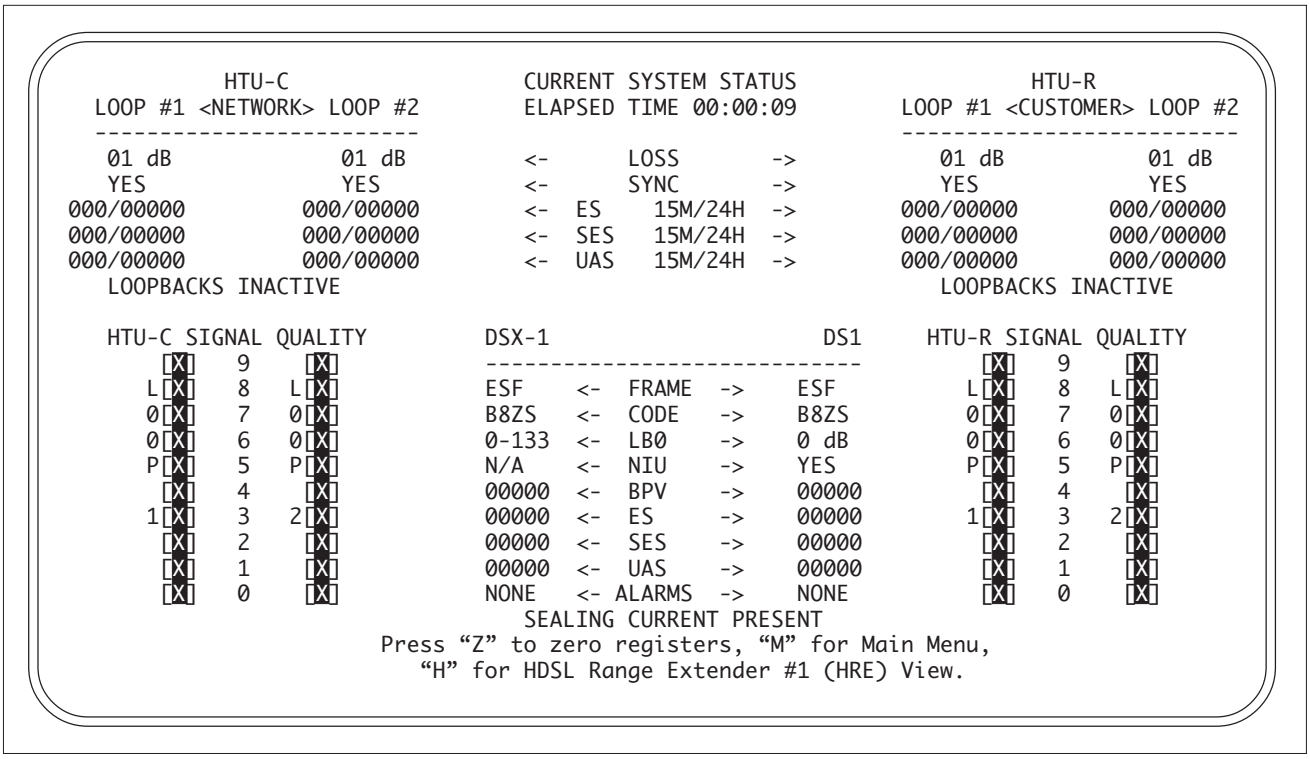

Figure 9. Current System Status Screen

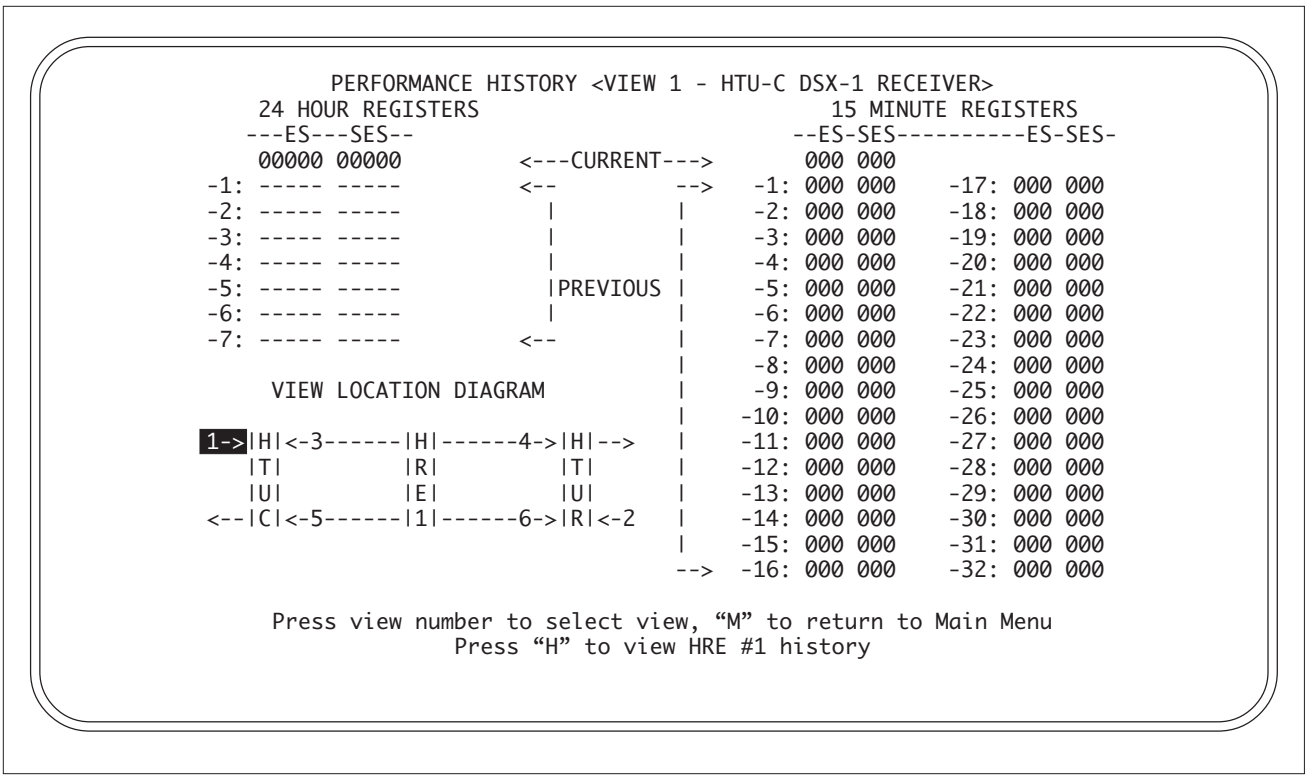

Figure 10. Performance History Screen

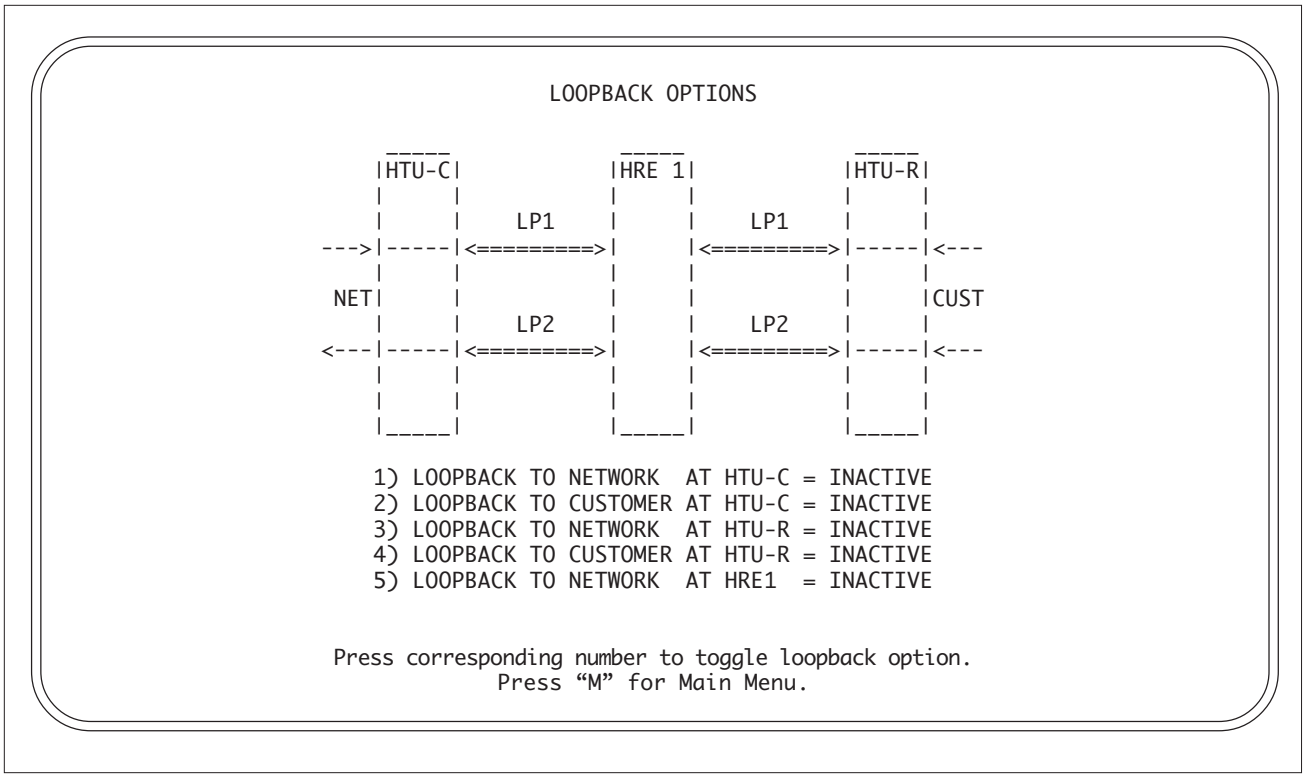

Figure 11. Loopback Options Screen

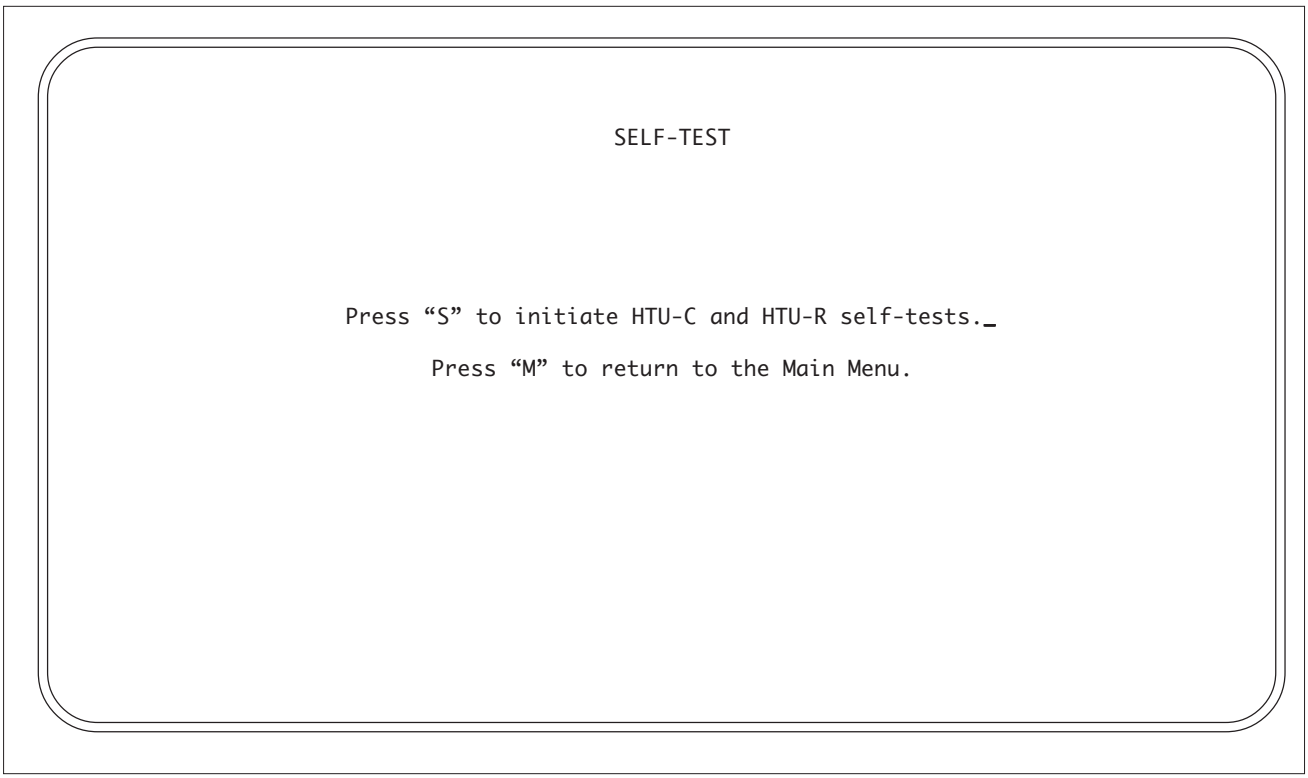

Figure 12. Self Test Options Screen

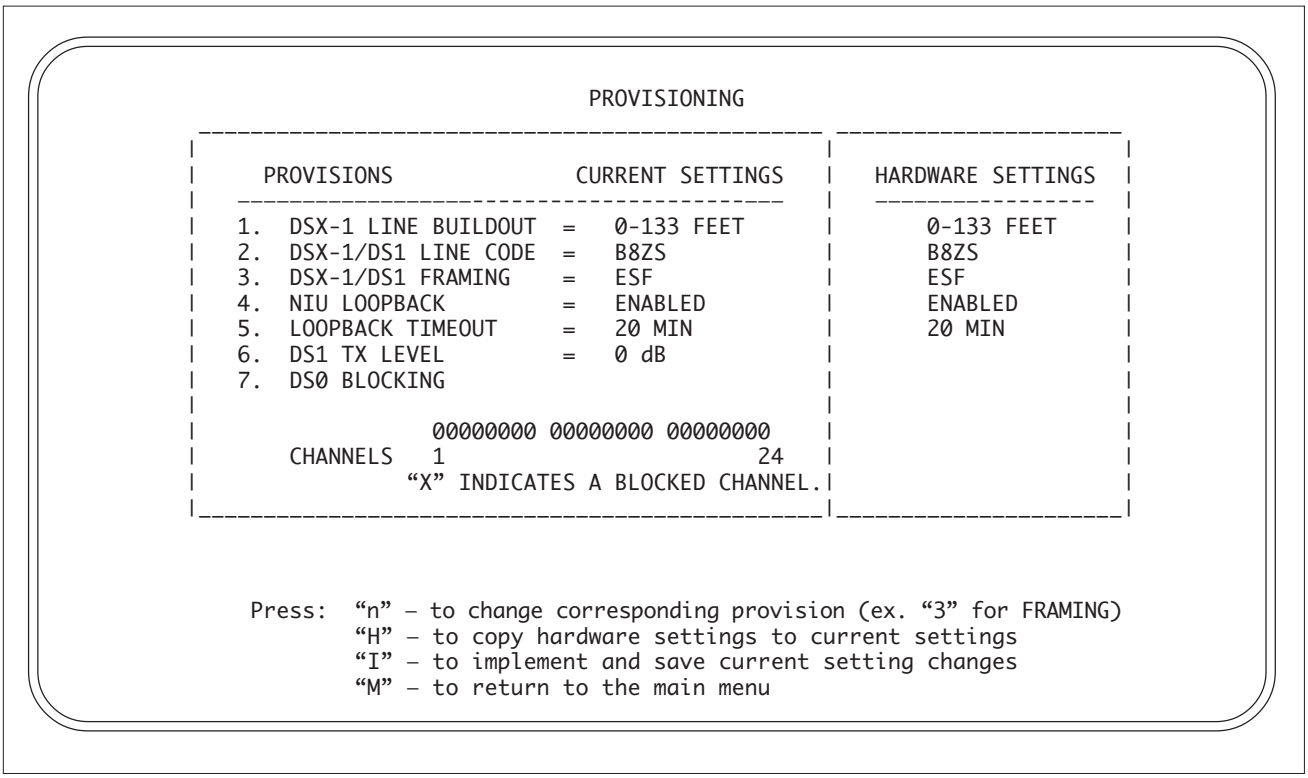

Figure 13. Provisioning Screen

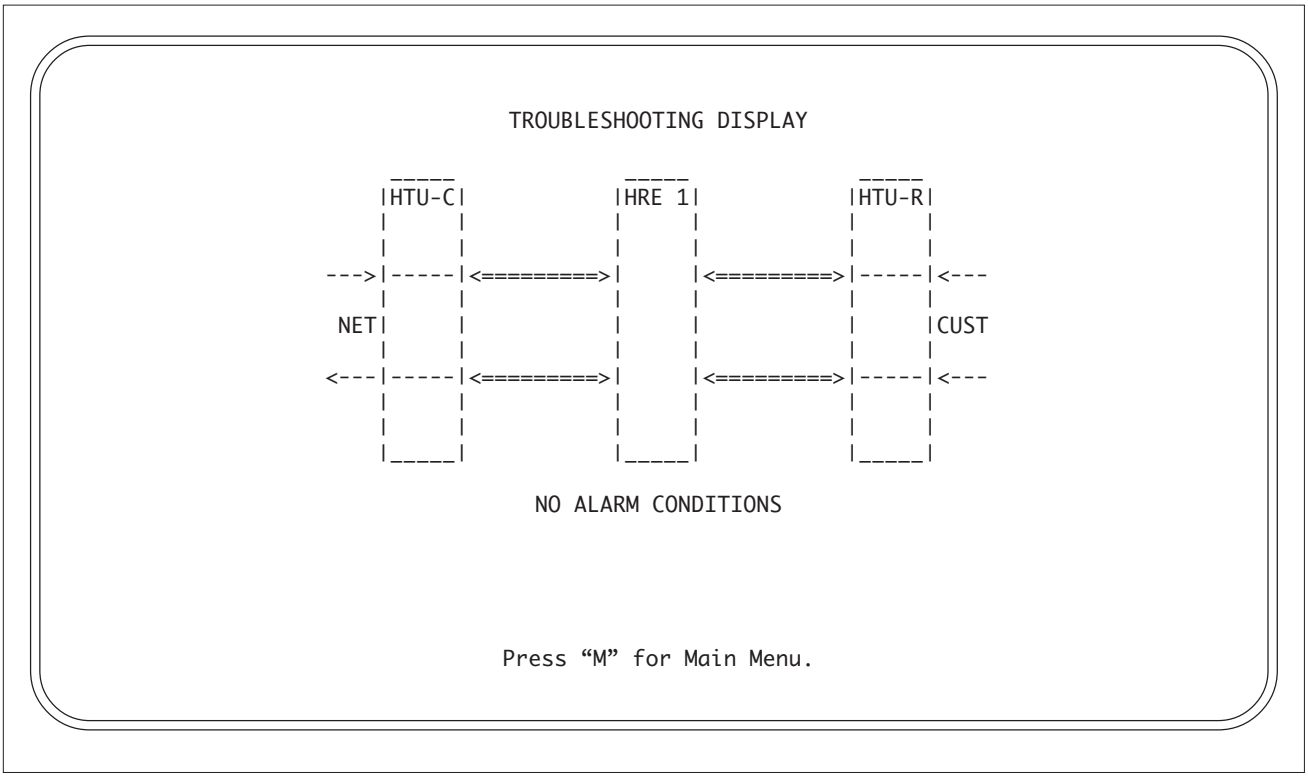

Figure 14. Troubleshooting Display

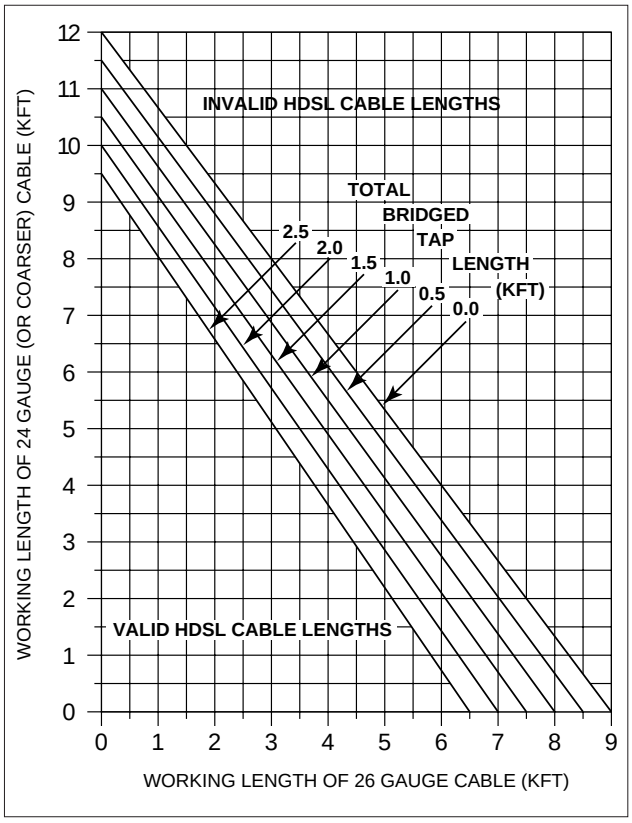

Figure 15. HDSL Deployment Guidelines

6. HDSL DEPLOYMENT GUIDELINES

The ADTRAN HDSL system is designed to provide DS1 based services over loops designed to comply with carrier service area (CSA) guidelines. CSA deployment guidelines are given below.

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

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

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

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

This deployment criteria is summarized in the chart shown in Figure 15.

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

Table E. HDSL Loss Values

(200 kHz cable loss in dB/Kft at 135Ω)

Cable Gauge	Cable Type	Temperature: 68°	90°	120°
26	PIC	3.902	4.051	4.253
26	Pulp	4.030	4.179	4.381
24	PIC	2.863	2.957	3.083
24	Pulp	3.159	3.257	3.391
22	PIC	2.198	2.255	2.333
22	Pulp	2.483	2.45	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, 135Ω, resistive termination is provided in Table F.

Table F. 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

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

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

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

7. TROUBLESHOOTING PROCEDURES

Table G is a troubleshooting guide for the ADTRAN DDM Plus HTU-C.

8. MAINTENANCE

The ADTRAN DDM Plus HTU-C requires no routine maintenance. In case of equipment malfunction, use the faceplate-mounted DB9 RS-232 terminal interface to help in troubleshooting the source of the problem.

ADTRAN does not recommend that repairs be performed in the field. Repair services may be obtained by returning the defective unit to the ADTRAN Customer Service RMA Department.

9. PRODUCT SPECIFICATIONS

Product specifications are detailed in Table H.

10. WARRANTY AND CUSTOMER SERVICE

ADTRAN will replace or repair this product within ten years from the date of shipment if it does not meet its published specifications or fails while in service (see ADTRAN Equipment Warranty, Repair, and Return Policy and Procedure).

Return Material Authorization (RMA) is required prior to returning equipment to ADTRAN.

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

ADTRAN Customer Service:
ADTRAN Telco Technical Support . (800) 726-8663
Standard support hours ..... Monday-Friday
7 a.m. - 7 p.m. CST
Emergency support ..... 7 days/week, 24 hours/day

Sales ..... (800) 827-0807

Customer and Product Support ..... (256) 963-8722

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

Table G. Troubleshooting Guide

Condition	Solution
Front panel indicator is *off*.	1. Verify that -48 VDC power is properly connected to the shelf. 2. Inspect the fuse (F1) and verify that it is not blown. 3. Insert the HTU-C into a slot known to be in good working condition, and verify that the Status indicator is *on*. 4. If Steps 1 and 2 pass, but Step 3 fails, replace the HTU-C.
Status indicator is *off*.	At least one loop has poor signal quality or loss of sync. Basic troubleshooting procedures should identify a problem with a cable pair.
Status indicator is *solid red*.	If customer equipment is no installed, implement an HTU-R to Network Loopback and BERT test. If this test fails, or the craft interface indicates a loss of sync, there is a problem with a cable pair that should be indentified through basic troubleshooting procedures.
Status indicator is *blinking green*.	Errors are being taken on either the DSX, DS1, or HDSL loops. The craft interface will identify the source. BERT tests to the appropriate loopbacks should also reveal the source of the problem.

Table H. HDSL DDM Plus HTU-C Unit Specifications (Part Number 1245003L7)

Loop Interface

Modulation Type 2B1Q
Mode ..... Full Duplex, Echo Cancelling
Number of Pairs ..... Two
Bit Rate ..... 784 kbps per pair
Baud Rate ..... 392K baud per pair
Service Range ..... Defined by Carrier Service Area Guidelines
Loop Loss ..... 36 dB maximum @ 200 kHz
Bridged Taps ..... Single Taps < 2000 feet, Total Taps < 2500 feet
Performance ..... Compliant with Bellcore TA-NWT-001210
HDSL Tx Signal Level ..... 13.5 dBm
Input Impedance ..... 135 Ω
Return Loss ..... 20 dB (40 kHz to 200 kHz)

Network Interface

4-WIRE DSX-1
DSX-1 Output Level ..... 0 dB
DSX-1 Line Build Out ..... 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
DSX-1 Channelization ..... Channels 1-12 on Loop 1, Channels 13-24 on Loop 2

Power

HTU-C Power Dissipation ..... 4.7 Watts without an HRE, 5.9 Watts with an HRE
HTU-C -42.5 VDC Current Drain ..... .19 Amps without an HRE, .40 Amps with an HRE
Span Power ..... <-140 VDC (Internally Generated) current limited at 250 *m*A
Fusing ..... 1.00 A

Clock

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

Tests

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

Physical

23" DDM Plus Shelf-Mounted
Dimensions ..... 3.51" High, .71" Wide, 9.89" Deep
Weight ..... Less than 1 lb.

Environment

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

Control Port

Interface RS-232 (DB9)
Terminal Type ..... VT 100 or compatible
Async Speed ..... 2.4 kbps to 19.2 kbps
Data Format ..... 8 data bits, no parity, 1 stop bit

Appendix A
HDSL LOOPBACKS

HDSL MAINTENANCE MODES

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

Upon deactivation of a loopback, the HDSL system will synchronize automatically. Note that the synchronization process of the HDSL system upon deactivation of the HRE loopback could take up to 15 seconds, ensuring all system elements are synchronized.

Loopback Process Description

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

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

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

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

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

Loopback Control Codes

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

NOTE *In all control code sequences presented, the in-band codes are shown left-most bit transmitted first, and the ESF data link codes with right-most bit transmitted first.*

Table A-1. HDSL Loopback Control Codes

Type	Source	Code	Name
Abbreviated	(N)	3in7 (1110000)	Loopback data from network toward network in the HTU-R.
	(N)	4in7 (1111000)	Loopback data from network toward network in the HTU-C.
	(N)	2in6 (110000)	Loopback data from network toward network in first HRE.
	(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.
Wescom	(N)	FF1E	Loopback data from network toward network at HTU-C.
	(C)	3F1E	Loopback data from customer toward customer at HTU-C.
	(N)	FF04	Loopback data from network toward network at HRE1.
	(C)	3F04	Loopback data from customer toward customer at HRE1.
	(N)	FF02	Loopback data from network toward network at HTU-R.
	(C)	3F02	Loopback data from customer toward customer at HTU-R.
	(C)	FF48 (ESF-DL)	Loopback data from customer toward customer at HTU-R.
	(N)	1in6 (100000)	Loopback data from network toward network at HTU-R.
	(N)	FF48 (ESF-DL)	Loopback data from network toward network at HTU-R.
	(N/C)	1in3 (100)	Loopdown everything.
	(N/C)	FF24 (ESF-DL)	Loopdown everything.

Notes: The Source column indicates which side of the interface the control codes are sent from. For example, an (N) indicates a network sourced code while a (C) indicates a customer sourced code.

All codes are inband unless labeled ESF-DL

All codes listed above must be sent for a minimum of 5 seconds in order for them to be detected and acted upon.

Table A-2. Inband Addressable Loopback Codes

Function	Code	Response
ARM	11000 (also known as a 2-in-5 pattern)	NIU LOOPBACK ENABLED: The HTU-R will loopup towards the network. No AIS or errors will be sent as a result of this loopback. The HTU-C and HRE will ARM.
DISARM	11100 (also known as a 3-in-5 pattern)	The HTU-C and HRE are removed from the armed state. If any of the units are in loopback when the 11100 pattern is received, they will loopdown. The LBK LEDs will turn off on all units.
HTU-C NETWORK LOOPUP	D3D3 (1101 0011 1101 0011)	If the units have been armed and no units are in loopback*, the HTU-C will loopup towards the network, 2 seconds of AIS (all 1s) will be sent, 5 seconds of data will pass, and then 231 bit errors will be injected into the DSX-1 signal. As long as the pattern continues to be sent, 231 errors will be injected every 20 seconds. When the pattern is removed, the unit will remain in loopback. If the pattern is reinstated, the injection of 231 bit errors will resume at 20 second intervals.
HRE NETWORK LOOPUP	C741 (1100 0111 0100 0001)	If an HRE is present, the units have been armed, the HRE will loopup towards the network, 2 seconds of AIS (all 1s) will be sent, 5 seconds of data will pass, and then 10 bit errors will be injected into the DSX-1 signal. As long as the pattern continues to be sent, 10 errors will be injected every 20 seconds. When the pattern is removed, the unit will remain in loopback. If the pattern is reinstated, the injection of 10 bit errors will resume at 20 second intervals.
LOOPDOWN	9393 (1001 0011 1001 0011)	Any HTU-C and HRE units currently in loopback towards the network will loopdown and will not attain the armed state.
QUERY LOOPBACK	D5D5 (1101 0101 1101 0101)	If the units are armed and the HTU-C, HRE, or HTU-R are in network loopback, errors are injected into the DSX-1 signal upon detection of the query loopback pattern. As long as the pattern continues to be sent, errors are injected again every 20 seconds. The number of errors injected each time depends on which unit is in loopback. 231 errors are injected if the HTU-C is in network loopback, 20 at a time if the HTU-R is in network loopback, and 10 at a time if the HRE is in network loopback.
LOOPBACK TIMEOUT OVERRIDE	D5D6 (1101 0101 1101 0110)	If the units are armed and this pattern is sent, the loopback timeout will be disabled. The timeout option will be updated on the PROVISIONING menu of the HTU-R (viewable through the RS-232 port) to NONE. As long as the units remain armed, the timeout will remain disabled. When the units are disarmed, the loopback timeout will return to the value it had before the D5D6 code was sent.
SPAN POWER DISABLE	6767 (0110 0111 0110 0111)	If the units are armed and this pattern is sent, the HTU-C will deactivate its span power supply, turning off the HTU-R and HRE (if present). As long as the pattern continues to be sent, the span power supply will remain disabled. When the pattern is no longer being sent, the HTU-C will reactivate its span power supply, turning the remote unit(s) on. All units will retrain and return to the disarmed and unlooped state.

Note: all codes listed above must be sent for a minimum of 5 seconds in order for them to be detected and acted upon.
* If NIU is enabled, then the HTU-R can be in network loopback when the HTU-C or HRE loopup codes are sent.

Appendix B
DS0 BLOCKING

ADTRAN has implemented the DS0 blocking feature enabling the HDSL system to remain transparent to customer data. This allows ADTRAN products to comply with the transparency requirements of Bellcore TA-NWT-001210. However, when the circuit is provisioned for ESF operation, this transparency results in a condition described below.

If a customer of a Fractional T1 service fills any of the unused DS0 channels with information other than an all 1s idle code, the ADTRAN HDSL system will block this information from reaching the remote end of the circuit. This forces information in those DS0 channels to be an all 1s idle code.

The result of this blocking is that the CRC checksum delivered to the remote end will not match the checksum calculated by the remote T1 CSU. This implies errors are being made on the loop when actually the blocking function created the CRC errors. Enabled DS0 channels pass error-free.

In order to avoid this condition, Fractional T1 customers are encouraged to fill the unused timeslots with an idle code. This is a common capability on Fractional T1 CSU/DSU, D4 channel banks, and other CPE devices capable of connecting to Fractional T1 service.

Appendix C
SHELF CONFIGURATION

DDM Plus Shelf Population (Power Requirements)

1. Determine shelf fusing (A). ..... _____ Amps
   Typically: 20 Amp for DDM Plus shelf (10 amp per side)

2. Divide (A) by 2 to provide 100% over current protection (B). ..... _____ Amps

3. Determine the mix of HDSL circuits.
   Percentage of circuits without an HRE in the circuit (C) ..... _____ Percent
   Percentage of circuits with an HRE in the circuit (D) ..... _____ Percent

4. Determine current draw of HDSL circuits.
   Multiply (C) by .19 Amps (without an HRE) (E) ..... _____ Amps/Unit
   Multiply (D) by .40 Amps (with an HRE) (F) ..... _____ Amps/Unit

5. Add (E) and (F) to get total current draw (G) ..... _____ Amps/Unit

6. Divide (B) by (G) to get the number of Units per shelf ..... _____ Units/Shelf *

* DDM Plus Shelf is physically limited to only 28 units per shelf.