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220/E220 HTU-C M High-bit-rate Digital Subscriber Line Transceiver Unit -- Central Office Installation and Maintenance

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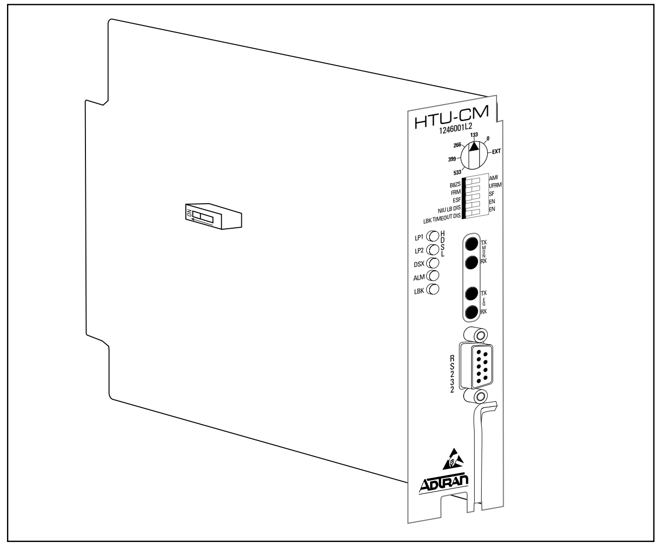


Figure 1. ADTRAN HTU-C M

1. GENERAL

The ADTRAN 220/E220 HDSL Transceiver Unit for the Central Office (HTU-C M), part number 1246001L2, is the Central Office (CO) unit used to deploy an HDSL T1 circuit using 4-wire metallic facilities, and span power multiple HDSL elements. The unit occupies one slot in a standard 220 Office Repeater Bay or the ADTRAN E220 Shelf.

DSX-1 signals are provided to and received from the network while 2B1Q HDSL signals are provided to the local loop. The ADTRAN HTU-C M works in conjunction with the ADTRAN HTU-R and HRE to provide a DS1 service up to 36,000 feet on the local loop.

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

Part Number	Description
1242004L2	HTU-R T400 CP
1242035L2	HTU-R SA
1242031L2	HRE
1244021L1	Low Voltage HTU-R T400 CP

1244022L1	Low Voltage HTU-R SA
1244041L2	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
1245024L1	T400 HTU-R w/Local Power Option
1245026LX	Low Voltage HTU-R
1246026LX	6th Gen HTU-R
1245041L1	T200 HRE
1245045L1	239 HRE
1246041L1	T200 HRE
1246045L1	239 HRE

The HTU-C M can be deployed in circuits consisting of one HTU-C M and one HTU-R. When deployment requires the HDSL Range Extenders, the HTU-C M can be deployed with one or two Low Voltage HREs 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 M 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.

System power and alarm bus connections are made through the backplane of the 220 shelf. DSX-1 and HDSL signals are connected through the wire-wrap pins or the 50-pin shelf connectors related to each individual slot.

The HTU-C M 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 field-replaceable.

The 220/E220 HTU-C M uses a DC-to-DC converter to derive its internal logic and span powering voltages from the -48 VDC office supply. The 220/E220 HTU-C M can span power HREs and HTU-Rs as listed above. When used with Low Voltage HREs and HTU-Rs, the HTU-C M can span power the Low Voltage HTU-R and Low Voltage HREs at either less than -140 VDC or at -190 VDC. Span powering voltages meet all requirements of Class A2 voltages as specified by Bellcore GR-1089-CORE.

Revision History

This is the second issue of this practice. This revision correct default settings for the SW6 and SW7.

2. INSTALLATION

CAUTION:

Unit subject to electrostatic damage or decrease in reliability. Handling precautions required.

After unpacking the unit, 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).

The 220/E220 HTU-C M plugs directly into standard 220 office repeater shelves. These include Kentrox T-Term 220, Wescom 34220 and 34230, Lynch 303MA30 as well as the ADTRAN E220 Shelf and the ADTRAN E220 RP Shelf. No installation wiring is required.

Electrical Code Compliance

Table 1 shows the UL/CUL Telecommunications Codes for the 220/E220 HTU-C. The 220/E200 HTU-C complies with the requirements covered under UL 1459 third edition and is intended to be installed in an enclosure with an Installation Code (IC) of "B" or "E."

NOTE:

1. **This product is intended for installation in RESTRICTED ACCESS LOCATIONS only.**
2. **Input current at maximum load is 0.7 A**

Table 1. UL/CUL Telecommunications Codes

Code	Input	Output
IC	A	–
TC	–	X
PC	F	C

c UL US
LISTED
Custom Telecom
E190349

Switch Options

One six-position rotary switch (SW7) and a five-position dipswitch pack (SW6) accessible from the faceplate of the unit are used to configure the mode of operation. In addition, a single position dipswitch pack (SW2), is mounted on the board to adjust span powering voltage. Figures 1 and 2 show the location of these switches.

A definition of each switch is shown in Tables 2 and 3. Configuration may be performed by manually selecting each option switch, or alternatively, may be performed using the RS-232 craft access port. Manual configuration can be performed after installing the unit into the shelf.

NOTE:

When the unit is powered up, changing a single faceplate switch only affects that single parameter. When the unit is powered down, changing a single faceplate switch causes a global reset to revert back to all faceplate switch settings. This includes the removal of DS0 Blocking parameters.

NOTE:

Craft interface allows configuration of DS0 Blocking and additional loopback timeout settings.

Faceplate Indicators

The HTU-C M has five faceplate LEDs which indicate operational status. Table 4 defines these LEDs.

Powering Options

Using SW2 (see Figure 2), the HTU-C M can be optioned for two different span powering modes. By selecting "LV" span powering mode, the HTU-C M will provide span powering at less than -140 VDC. This mode allows span powering of circuits without HREs or with one HRE.

By selecting "HV" span powering mode, the HTU-C M will provide span powering at -190 VDC. This mode allows span powering of circuits with two HREs and an HTU-R.

3. CONNECTIONS

The 220/E220 HTU-C M occupies one card slot in a 220 Office Repeater Bay. 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 wire-wrap pins or mass termination shelf connectors corresponding to the slot the unit occupies. See Figure 3 for HTU-C M edge connection wiring.

The HTU-C M is capable of span powering the HTU-R by applying simplex current to the local loop. 10 to 125 *m*A of current is coupled onto the HDSL span to power the HTU-R and HRE(s) when deployed. The span powering voltage is applied with Loop 1 providing the negative voltage and Loop 2 the return (see Figure 4).

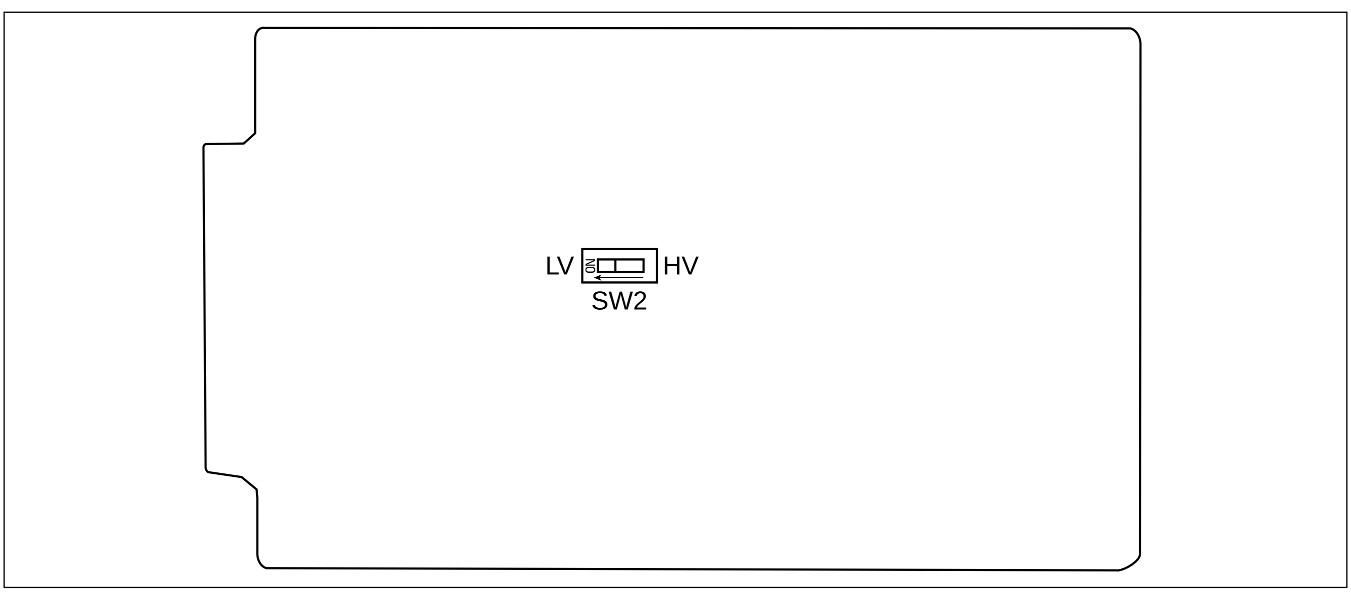


Figure 2. HTU-C M Switch Arrangement

Table 2. Front Panel Rotary Switch Option Setting[1]
(Default setting are in bold)

Switch	Function	Description
SW7	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.
	EXT	Selects external line build-out[1]
	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

[1] If external line build-out is selected, the signal transmitted by the HTU-C is a 12V p-p signal. This must be considered when measuring the signal at the DSX EQ faceplate Bantam jack. The signal may appear hotter than it should be.

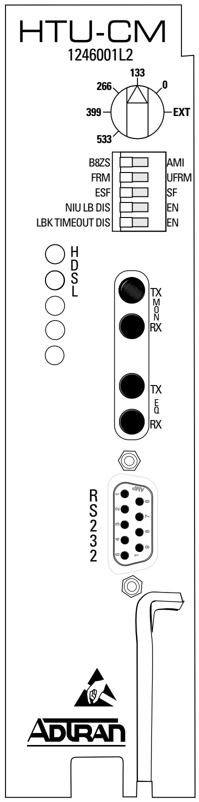
Table 3. SW6 Option Settings[1]
(Default setting are in bold)

Switch	**Function**	**Description**
SW6-1	Loopback Timeout	
	Enabled	Loopback Timeout is enabled.[1,2]
	Disabled	Loopback Timeout is disabled.
SW6-2	NIU Loopback **Enabled** Disabled	This switch programs the ADTRAN HDSL unit to respond to traditional T1 network interface unit (NIU) loop-up and loop-down codes. See Appendix I for more information on specific codes.
SW6-3	Manual Frame Select	This switch selects the format of T1 framing.
	SF	Selects Superframe (SF) format.
	ESF	Selects Extended Superframe (ESF) format.
SW6-4	T1 Framing	This switch selects the T1 framing mode.
	Unframed	Selects Unframed (UFRM) operation; SW6-3 is ignored.
	Framed	Selects Framed operation.
SW6-5	Manual Code Select	This switch selects the T1 line coding.
	AMI	Alternate Mark Inversion (AMI) is selected.
	B8ZS	Binary 8 Zero Substitution (B8ZS) is selected.

[1] Loopback timeout must be selected prior to initiating a loopback.
[2] 20-minute timeout is the default for Loopback Timeout Enabled. 60-minute and 120-minute timeouts are also available from the craft interface

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

Table 4. Front Panel Indicators



LED	Indication	Description
LP1	Off Red Yellow Green Blinking	No synchronization. Poor signal quality on Loop 1 (>10^{-7} BER). Marginal signal quality on Loop 1 ($\leq$2 dB margin above 10^{-7} BER). Good signal quality on Loop 1 (>2 dB margin above 10^{-7} BER). Detected error on either end of Loop 1.
LP2	Off Red Yellow Green Blinking	No synchronization. Poor signal quality on Loop 2 (>10^{-7} BER). Marginal signal quality on Loop 2 ($\leq$2 dB margin above 10^{-7} BER). Good signal quality on Loop 2 (>2 dB margin above 10^{-7} BER). Detected error on either end of Loop 2.
DSX	Off Blinking Solid	Network-side DSX-1 signal is absent or is of a format that does not match the provisiong of the HDSL circuit. Bipolar Violation (BPV), frame bit error (SF mode), or CRC error (ESF mode) detected at DSX-1 signal. Network-side DSX-1 signal is present and synchronized.
ALM	Off Red Yellow	No alarm condition detected. Alarm contition detected either locally (HTU-C), or locally and remotely (HTU-C and HTU-R). Remote alarm condidtion detected.
LBK	Off Blinking Solid	Unit is not in loopback or armed state. The loopback arming sequence has been detected. In this state the unit is armed (ready for loopback) but not in loopback. Local (HTU-C) loopback is active.

The HTU-C M can be optioned via SW2 to adjust the span powering voltage at either less than -140 VDC or -190 VDC. If two HREs are used in the HDSL circuit, then the voltage will be -190 VDC.

HTU-C Alarm Outputs

Pin 32 of the HTU-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.

HFAC Alarm Outputs

If the HTU-C M is operating in an ADTRAN E220 or E220 RP Shelf with an HFAC (P/N 1244051LX or equivalent), the HTU-C M provides information to the HFAC which is used to generate alarms. The HFAC alarm outputs are separate from the HTU-C M alarm pin mentioned above. For more information on the HFAC controlled alarms, see the HFAC Installation and Maintenance practice, section 61244051LX-5.

4. HDSL SYSTEM TESTING

The ADTRAN HDSL system provides the 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. The following subsections describe additional testing features.

HTU-C M DSX EQ Bantam Jacks

The front panel of the HTU-C contains both monitoring and metallic splitting Bantam jacks. In general, the monitoring jacks provide a non-intrusive 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 error rate tester to monitor for synchronization, test patterns, etc. The metallic

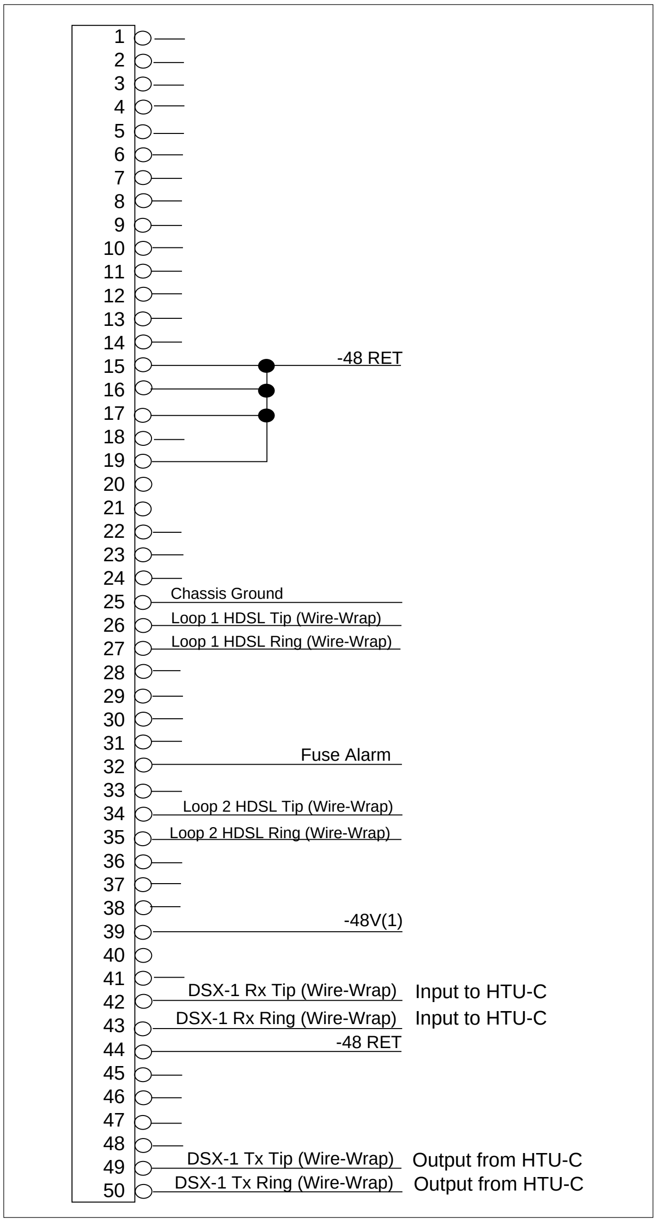


Figure 3. HTU-C M Edge Connector Wiring

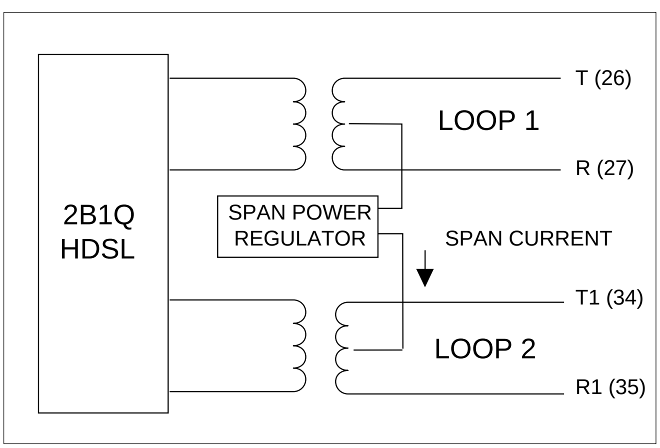


Figure 4. HTU-C M Span Powering Diagram

splitting jacks provide an intrusive, signal interrupting access to the line. This permits parameters to be measured such as loop resistance, background noise level, insertion loss, etc. It is very important to know the direction of the access provided by a metallic splitting jack.

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

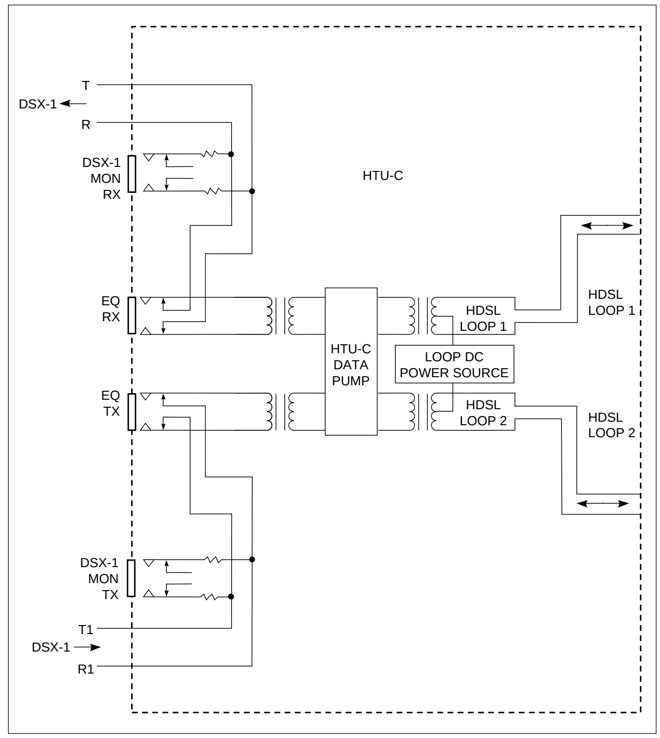


Figure 5. HTU-C M Bantam Jack Arrangement

HTU-C M Loopbacks

The HTU-C M responds to two different loopback activation processes. First, loopback may be activated using the craft interface. The Loopback Options Screen which provides for the HTU-C M, HTU-R, and HRE loopbacks will be described in subsection 5.

Secondly, the HTU-C M 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 HTU-C M where the DSX-1 signal passes into the HDSL modulators. Figure 6 depicts all of the loopback locations possible with ADTRAN HDSL equipment.

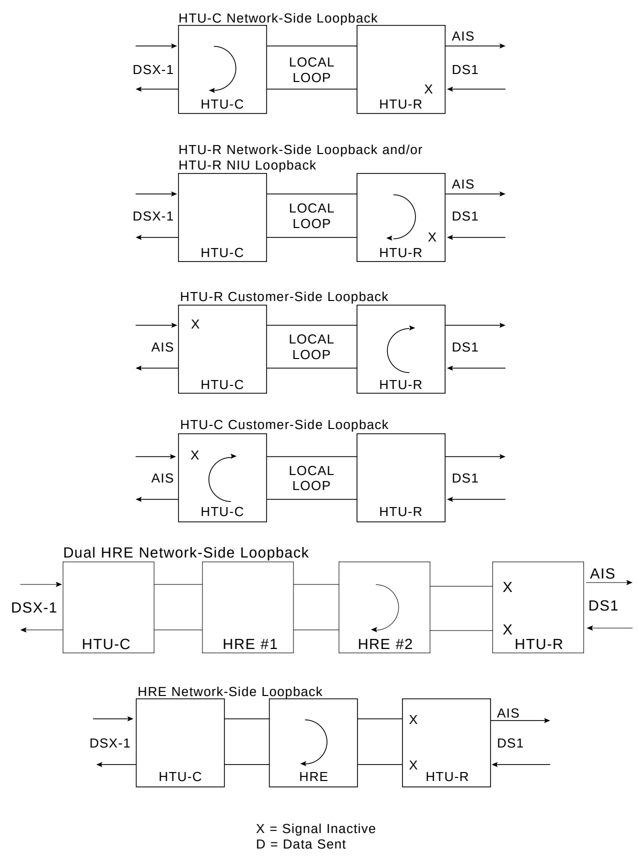


Figure 6. HDSL Loopbacks

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

5. CONTROL PORT OPERATION

The HTU-C M 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 7.

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

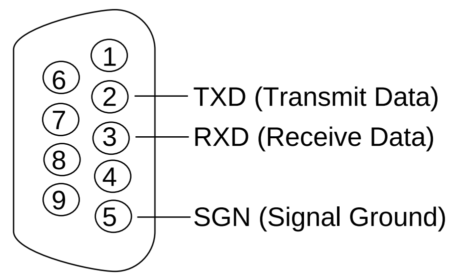


Figure 7. RS-232 (DB9) Pin Assignments

supported terminal type is VT 100 or compatible.

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 HDSL unit may be disrupted, resulting in misplaced characters or screen timeouts.

When operating the unit in the ADTRAN E220 Shelf with an HFAC (HDSL shelf controller), all remote terminal operation must be made through the control port of the shelf controller, not the HTU-C M. Terminal operation via the HFAC control port will vary slightly from that described in the practice for the HTU-C M.

Operation

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

The screens illustrated in Figures 8 through 18 apply to an HDSL circuit deployed with ADTRAN's Low Voltage HDSL technology. The circuit includes an HTU-C M, HTU-R, and two HREs. 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 plugging into the faceplate-mounted DB-9. An Introductory Menu will then appear, as illustrated in Figure 8.

From the Introductory Menu, the Main Menu may be selected. The Main Menu provides access to detailed performance and configuration information, as

Table 5. 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. 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 BVPs or 320 CRC errors occur. HDSL.................Second in which 165 errors occurs.
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	Bipolar with 8 zero substitution
AMI	Alternate mark inversion
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

illustrated in Figure 9, 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

H. Alarm History
S. Set Time/Date/Circuit ID
F. Default Options

The Current System Status screen illustrated in Figure 10 provides quick access to status information for both the HTU-C M and HTU-R. Type “H” once to view the Current System Status screen for HRE #1; type “H” a second time to view the Current System Status Screen for HRE #2. See Figure 10A for the HRE Current System Status screen.

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 11. Type “H” once to view the Performance History screen for HRE #1; type “H” a second time to view the HRE Performance History screen for HRE #2. See Figure 11A for the HRE Performance History screen.

At the Current System Status screen, type “Z” to reset the current performance registers to zero on the Current System Status and Performance History screens. A prompt will require user confirmation prior to executing the zero register function

Figures 10 and 10A consolidate current information for the HDSL, DSX-1, and DS1 interfaces. A key to the information provided is found in the center of the screen. Arrows indicate the key applies to both the HTU-C M and HTU-R.

LOSS	Pulse Attenuation Measurement [2]
SYNC	HDSL Loop 1 and Loop 2 Sync Status
ES	15M/24H Errored Seconds [3]
SES	15M/24H Severely Errored Seconds [3]
UAS	15M/24H Unavailable Seconds [3]

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 ($\approx 10^{-7}$ BER)
1-8	Margin measurement above 10^{-7} BER in dB
9	Margin is ≥ 9 dB (excellent quality) above 10^{-7} BER

Predicting performance based upon signal quality varies with each loop. Generally, a noise margin of 0 or higher will support a bit error rate of better than 10^{-7}. ADTRAN has defined the following as guidelines that correspond to the operation of the HTU-C faceplate LEDs labeled LP1 and LP2.

Margin < 0 (Red)	Poor Loop Quality
$0 \leq$ Margin ≤ 2 (Yellow)	Marginal Loop Quality
Margin > 2 (Green)	Good Loop Quality

Figures 12 and 13 depict the HDSL Loopback and Self Test Option screens. Loopbacks and Self-Test may be evoked or terminated using these screens. A status of current loopback conditions is also provided.

Figure 14 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.

The Troubleshooting Display, shown in Figure 15, graphically presents an HDSL circuit. The unit

[2] 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.

[3] 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).

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 will appear.

The Alarm History Screen, illustrated in Figure 16, provides detailed information on the alarm history of the HDSL and T1 spans. Information provided includes alarm location, type, first and last time/date, current status, and count.

The Set Time/Date/Circuit ID menu screen, illustrated in Figure 17, provides additional provisioning options. Enter the time parameters as military time (for example, enter 3:15 p.m. as “15:15:00”). Enter the date parameters in mm/dd/yy format. Enter the Circuit ID as a 25-character alphanumeric string.

The Default Options screen, illustrated in Figures 18 allows the setting of all provisioning options to the factory defaults.

```
CIRCUIT ID:                                                   01/01/99  00:04:59

                                    ADTRAN
                             901 Explorer Boulevard
                          Huntsville, Alabama 35806-2807

--------------------- For Information or Technical Support --------------------
       Support Hours ( Normal 7am - 7pm CST, Emergency 7 days x 24 hours )
Phone: 800.726.8663 / 888.873.HDSL  Fax: 256.963.6217  Internet: www.adtran.com
-------------------------------------------------------------------------------
HTU-C INFORMATION E220 SIGNAL QUALITY    HTU-R INFORMATION      SIGNAL QUALITY
--------------------   [X]   9    [X]    --------------------   [X]   9    [X]
S/N :                 L[X]   8   L[X]    S/N :                 L[X]   8   L[X]
CLEI:                 O[X]   7   O[X]    CLEI:                 O[X]   7   O[X]
MANF:   /             O[X]   6   O[X]    MANF:   /             O[X]   6   O[X]
                      P[X]   5   P[X]                          P[X]   5   P[X]
HRE #1 INFORMATION     [X]   4    [X]    HRE #2 INFORMATION     [X]   4    [X]
--------------------  1[X]   3   2[X]    --------------------  1[X]   3   2[X]
S/N : B905A5505        [X]   2    [X]    S/N : A917C2045        [X]   2    [X]
CLEI: T1RGDJEDAA       [X]   1    [X]    CLEI: T1R6DTEDAA       [X]   1    [X]
MANF: 05/99            [X]   0    [X]    MANF: 06/99            [X]   0    [X]
                          AT HTU-C                                 AT HTU-R

                       Press "M" to view Main Menu.
```

Figure 8. Introductory Menu Screen

```
CIRCUIT ID:                                                   01/01/99  00:02:08



                            ADTRAN HDSL MAIN MENU


                           1) CURRENT SYSTEM STATUS
                           2) PERFORMANCE HISTORY
                           3) ADTRAN INFORMATION
                           4) LOOPBACK OPTIONS
                           5) SELF-TEST
                           6) PROVISIONING
                           7) TROUBLESHOOTING
                           H) ALARM HISTORY
                           S) SET TIME/DATE/CIRCUIT ID
                           F) DEFAULT OPTIONS



            Choose a screen by pressing the corresponding character.
```

Figure 9. HDSL Main Menu Screen

```
CIRCUIT ID:                                                  01/01/99  00:02:45
LOOP #1 <NETWORK> LOOP #2    CURRENT SYSTEM STATUS    LOOP #1 <CUSTOMER>LOOP #2
--------- HTU-C ---------                             --------- HTU-R ---------
29(29) dB       29(29) dB    <-  LOSS  CUR(MAX) ->    29(29) dB       30(30) dB
   YES             YES       <-  SYNC           ->       YES             YES
000/00000       000/00000    <-  ES    15M/24H  ->    000/00000       000/00000
000/00000       000/00000    <-  SES   15M/24H  ->    000/00000       000/00000
000/00000       000/00000    <-  UAS   15M/24H  ->    000/00000       000/00000
    LOOPBACKS INACTIVE                                    LOOPBACKS INACTIVE

HTU-C SIGNAL QUALITY      DSX-1                  DS1    HTU-R SIGNAL QUALITY
 MIN[X]   9    [X]MIN    ------------------------------    MIN[X]   9    [X]MIN
    [X]L  8   L[X]        ESF     <-  FRAME ->     ESF        [X]L  8   L[X]
    [X]O  7   O[X]        B8ZS    <-  CODE  ->    B8ZS        [X]O  7   O[X]
    [X]O  6   O[X]        399-533 <-  LBO   ->    0 dB        [X]O  6   O[X]
    [X]P  5   P[X]        N/A     <-  NIU   ->      NO        [X]P  5   P[X]
    [X]   4    [X]        00000   <-  BPV   ->   00000        [X]   4    [X]
    [X]1  3   2[X]        00000   <-  ES    ->   00000        [X]1  3   2[X]
    [X]   2    [X]        00000   <-  SES   ->   00000        [X]   2    [X]
    [X]   1    [X]        00000   <-  UAS   ->   00000        [X]   1    [X]
    [X]   0    [X]        NONE    <- ALARMS ->    NONE        [X]   0    [X]

       Press "Z" to zero registers, "X" to restart MIN/MAX, "M" for Main Menu
             "H" for HDSL Range Extender #1 (HRE) View.
```

Figure 10. Current System Status Screen

```
CIRCUIT ID:                                                  01/01/99  00:03:56
LOOP #1 <NETWORK> LOOP #2    CURRENT SYSTEM STATUS    LOOP #1 <CUSTOMER>LOOP #2
-------- HRE  #1 --------                             -------- HRE  #1 --------
27(27) dB       28(28) dB    <-  LOSS  CUR(MAX) ->    29(29) dB       29(29) dB
   YES             YES       <-  SYNC           ->       YES             YES
000/00000       000/00000    <-  ES    15M/24H  ->    000/00000       000/00000
000/00000       000/00000    <-  SES   15M/24H  ->    000/00000       000/00000
000/00000       000/00000    <-  UAS   15M/24H  ->    000/00000       000/00000
    LOOPBACK  INACTIVE                                    LOOPBACK  INACTIVE

HRE#1 NET SIGNAL QUALITY  N = NETWORK SIDE RECEIVER    HRE#1 CUST SIGNAL QUALITY
 MIN[X]   9    [X]MIN     C = CUSTOMER SIDE RECEIVER       MIN[X]   9    [X]MIN
    [X]L  8   L[X]                                            [X]L  8   L[X]
    [X]O  7   O[X]    ____ LP1  ____ LP1  ____      ____      [X]O  7   O[X]
    [X]O  6   O[X]   |HTUC|    |HRE1|    |HRE2|    |HTUR|     [X]O  6   O[X]
    [X]P  5   P[X]   |    |===N|    |C===|    |====|    |     [X]P  5   P[X]
    [X]   4    [X]   |    |    |    |    |    |    |    |     [X]   4    [X]
    [X]1  3   2[X]   |    |===N|    |C===|    |====|    |     [X]1  3   2[X]
    [X]   2    [X]   |____|    |____|    |____|    |____|     [X]   2    [X]
    [X]   1    [X]        LP2       LP2                       [X]   1    [X]
    [X]   0    [X]                                            [X]   0    [X]

       Press "Z" to zero registers, "X" to restart MIN/MAX, "M" for Main Menu
             "P" for previous view, "H" for HDSL Range Extender #2 (HRE) view.
```

Figure 10A. Current System Status Screen - HRE

```
CIRCUIT ID:                                                   01/01/99  00:04:19
      24 HOUR REGISTERS     PERFORMANCE HISTORY     15 MINUTE REGISTERS
     ---ES-SES-UAS---                         -ES-SES-UAS----ES-SES-UAS-
      00000 00000 00000   <-- CURRENT -->         000 000 000
12/31 ----- ----- -----   <--         -->  00:00 --- --- ---  20:00 --- --- ---
12/30 ----- ----- -----     |         |    23:45 --- --- ---  19:45 --- --- ---
12/29 ----- ----- -----     |         |    23:30 --- --- ---  19:30 --- --- ---
12/28 ----- ----- -----     |         |    23:15 --- --- ---  19:15 --- --- ---
12/27 ----- ----- -----     |PREVIOUS |    23:00 --- --- ---  19:00 --- --- ---
12/26 ----- ----- -----     |         |    22:45 --- --- ---  18:45 --- --- ---
12/25 ----- ----- -----   <--         |    22:30 --- --- ---  18:30 --- --- ---
                                      |    22:15 --- --- ---  18:15 --- --- ---
VIEW 1 : HTU-C DSX-1                  |    22:00 --- --- ---  18:00 --- --- ---
                                      |    21:45 --- --- ---  17:45 --- --- ---
1->|H|-3---|H|-----|H|-4---|H|-->     |    21:30 --- --- ---  17:30 --- --- ---
   |T|     |R|     |R|     |T|        |    21:15 --- --- ---  17:15 --- --- ---
   |U|     |E|     |E|     |U|        |    21:00 --- --- ---  17:00 --- --- ---
<--|C|-5---|1|-----|2|-6---|R|<-2     |    20:45 --- --- ---  16:45 --- --- ---
                                      |    20:30 --- --- ---  16:30 --- --- ---
Press view number to select view      -->  20:15 --- --- ---  16:15 --- --- ---
Press “H” to view HRE #1 history
                                            Press “B” to go back 8 hours

                    Press “M” to return to the Main Menu
```

Figure 11. Performance History Screen

```
CIRCUIT ID:                                                   01/01/99  00:04:40
      24 HOUR REGISTERS     PERFORMANCE HISTORY     15 MINUTE REGISTERS
     --ES----SES---UAS--                         --ES-SES-UAS--------ES--SES-UAS-
      00000 00000 00000   <-- CURRENT -->         000 000 000
12/31 ----- ----- -----   <--         -->  00:00 --- --- ---  20:00 --- --- ---
12/30 ----- ----- -----     |         |    23:45 --- --- ---  19:45 --- --- ---
12/29 ----- ----- -----     |         |    23:30 --- --- ---  19:30 --- --- ---
12/28 ----- ----- -----     |         |    23:15 --- --- ---  19:15 --- --- ---
12/27 ----- ----- -----     |PREVIOUS |    23:00 --- --- ---  19:00 --- --- ---
12/26 ----- ----- -----     |         |    22:45 --- --- ---  18:45 --- --- ---
12/25 ----- ----- -----   <--         |    22:30 --- --- ---  18:30 --- --- ---
                                      |    22:15 --- --- ---  18:15 --- --- ---
VIEW 1 : HRE #1 NETWORK LP1           |    22:00 --- --- ---  18:00 --- --- ---
                                      |    21:45 --- --- ---  17:45 --- --- ---
-->|H|-1---|H|-2---|H|-----|H|-->     |    21:30 --- --- ---  17:30 --- --- ---
   |T|     |R|     |R|     |T|        |    21:15 --- --- ---  17:15 --- --- ---
   |U|     |E|     |E|     |U|        |    21:00 --- --- ---  17:00 --- --- ---
<--|C|-3---|1|-4---|2|-----|R|<--     |    20:45 --- --- ---  16:45 --- --- ---
                                      |    20:30 --- --- ---  16:30 --- --- ---
Press view number to select view      -->  20:15 --- --- ---  16:15 --- --- ---
Press “H” to view HRE #2 history
Press “P” for previous view                 Press “B” to go back 8 hours

                    Press “M” to return to the Main Menu
```

Figure 11A. Performance History Screen - HRE

```
CIRCUIT ID:                                                  01/01/99  00:05:23
                                LOOPBACK OPTIONS
                 _____         _____         _____         _____
                |HTU-C|       |HRE 1|       |HRE 2|       |HTU-R|
                |     |  LP1  |     |  LP1  |     |  LP1  |     |
             --->|-----|<=====>|-----|<=====>|-----|<=====>|-----|<--
                |     |       |     |       |     |       |     |
            NET |     |       |     |       |     |       |     | CUST
                |     |  LP2  |     |  LP2  |     |  LP2  |     |
             <---|-----|<=====>|-----|<=====>|-----|<=====>|-----|-->
                |     |       |     |       |     |       |     |
                |_____|       |_____|       |_____|       |_____|

                  1) LOOPBACK TO NETWORK  AT HTU-C = INACTIVE
                  2) LOOPBACK TO CUSTOMER AT HTU-C = INACTIVE
                  3) LOOPBACK TO NETWORK  AT HTU-R = INACTIVE
                  4) LOOPBACK TO CUSTOMER AT HTU-R = INACTIVE
                  5) LOOPBACK TO NETWORK  AT HRE-1 = INACTIVE
                  6) LOOPBACK TO CUSTOMER AT HRE-1 = UNAVAILABLE
                  7) LOOPBACK TO NETWORK  AT HRE-2 = INACTIVE
                  8) LOOPBACK TO CUSTOMER AT HRE-2 = UNAVAILABLE

              Press corresponding number to toggle loopback option.
                      Press “M” to return to the Main Menu
```

Figure 12. Loopback Options Screen

```
CIRCUIT ID:                                                  01/01/99  00:05:38




                                   SELF-TEST




              Press “S” to initiate HTU-C and HTU-R self-tests.

                     Press “M” to return to the Main Menu.
```

Figure 13. Self Test Options Screen

```
CIRCUIT ID:                                              01/01/99 00:05:50
                                PROVISIONING
     ________________________________________________ ______________________
    |                                                |                      |
    |    PROVISIONS             CURRENT SETTINGS     |   HARDWARE SETTINGS  |
    |   ____________________________________________ |   _________________  |
    |   1.  DSX-1 LINE BUILDOUT  =   0-133 FEET      |       0-133 FEET     |
    |   2.  DSX-1/DS1 LINE CODE  =   B8ZS            |       B8ZS           |
    |   3.  DSX-1/DS1 FRAMING    =   ESF             |       ESF            |
    |   4.  NIU LOOPBACK         =   ENABLED         |       ENABLED        |
    |   5.  LOOPBACK TIMEOUT     =   20 MIN          |       20 MIN         |
    |   6.  DS1 TX LEVEL         =   0 dB            |                      |
    |   7.  DS0 BLOCKING                             |                      |
    |                                                |                      |
    |               00000000 00000000 00000000       |                      |
    |       CHANNELS   1                       24    |                      |
    |              "X" INDICATES A BLOCKED CHANNEL.  |                      |
    |________________________________________________|______________________|


       Press:  "n" – to change corresponding provision (ex. "3" for FRAMING)
               "H" – to copy hardware settings to current settings
               "I" – to implement and save current setting changes
               "M" – to return to the main menu
```

Figure 14. Provisioning Screen

```
CIRCUIT ID:                                              01/01/99  00:06:20
                            TROUBLESHOOTING DISPLAY
                  _____       _____       _____       _____
                 |HTU-C|     |HRE 1|     |HRE 2|     |HTU-R|
                 |     |     |     |     |     |     |     |
                 |     |     |     |     |     |     |     |
              --->|     |<=1=>|     |<=1=>|     |<=1=>|     |<---
                 |     |     |     |     |     |     |     |
       NET(DSX-1) |     |     |     |     |     |     |     | CUST(DS1)
                 |     |     |     |     |     |     |     |
              <---|     |<=2=>|     |<=2=>|     |<=2=>|     |--->
                 |     |     |     |     |     |     |     |
                 |     |     |     |     |     |     |     |
                 |_____|     |_____|     |_____|     |_____|

                              NO ALARM CONDITIONS




                        Press "M" to return to the Main Menu
```

Figure 15. Troubleshooting Display

```
CIRCUIT ID:                                               01/01/99  00:07:21
                              T1 Alarm History
LOCATION   ALARM      FIRST                 LAST                CURRENT   COUNT
--------------------------------------------------------------------------------
HTU-C      RED(LOS)                                             OK         000
 (DSX-1)   YELLOW                                               OK         000
           BLUE(AIS)                                            OK         000

HTU-R      RED(LOS)                                             OK         000
 (DS1)     YELLOW                                               OK         000
           BLUE(AIS)                                            OK         000
                              HDSL Span History
--------------------------------------------------------------------------------
SPAN 1     LP1 HLOS                                             OK         000
           LP2 HLOS                                             OK         000

HTU-C      LP1 MRGN                                             OK         000
           LP2 MRGN                                             OK         000

HRE-1      LP1 MRGN                                             OK         000
           LP2 MRGN                                             OK         000


    Press: C to clear history : H to scroll span alarms : M for main menu
```

Figure 16. Alarm History Screen

```
CIRCUIT ID:                                               01/01/99  00:07:37



                           SET TIME/DATE/CIRCUIT ID


                          1) SET TIME
                          2) SET DATE
                          3) SET CIRCUIT ID





             Choose an option by pressing the corresponding number.
                        Press “M” to return to Main Menu.
```

Figure 17. Set Time/Date/Circuit ID Screen

```
CIRCUIT ID:                                                01/01/99  00:07:52


                RESET PROVISIONING OPTIONS TO FACTORY DEFAULTS


           This screen will allow you to reset the provisioning of
           this HDSL circuit back to the factory defaults.  If you
           do this, the options as shown on the provisioning screen
           will change to the values that were programmed into this
           unit from the factory.  After defaulting the options,
           you can always make changes to the options from the
           provisioning screen.


        Press “D” to reset the provisioning options to factory defaults.


                     Press “M” to return to the Main Menu.
```

Figure 18. Default Options Screen

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 19.

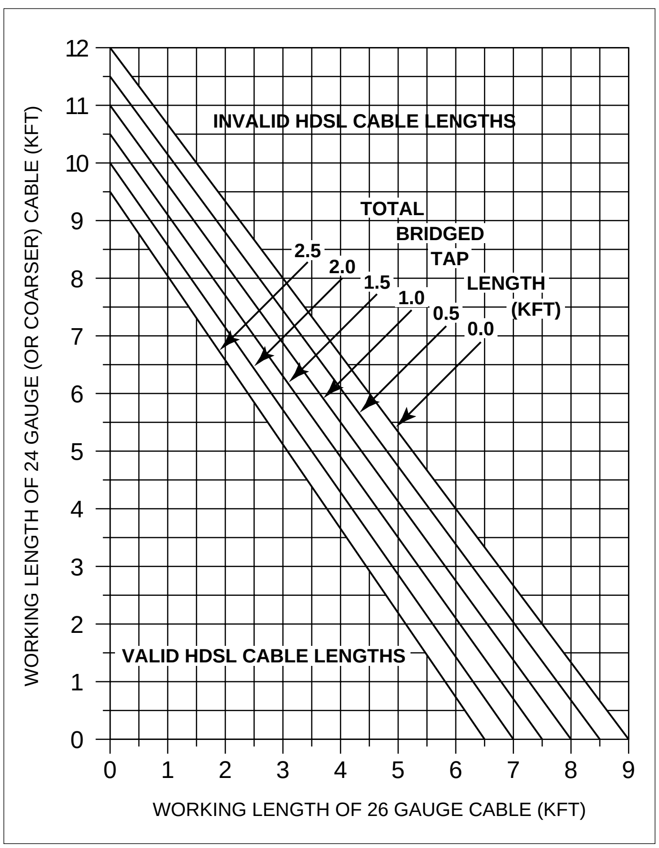


Figure 19. HDSL Deployment Guidelines

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

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

Table 6. HDSL Loss Values

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

Cable Guage	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

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

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 8 is a troubleshooting guide for the 220/E220 HTU-C M.

Table 8. Troubleshooting Guide

Condition	Solution
All front panel indicators are *off*	1. Verify the -48 VDC power is properly connected to the shelf. 2. Insert the HTU-C into an operational slot and check the LED indicators. When the unit is powered, at least one LED will be on. 3. If step 1 passes, but step 2 fail, replace the HTU-C.

8. MAINTENANCE

The ADTRAN 220/E220 HTU-C M 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 the ADTRAN Customer Service RMA Department.

9. PRODUCT SPECIFICATIONS

Product specifications are detailed in Table 9.

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

RMA (repair service) .... (256) 963-8722

Repair and Return Address:

ADTRAN, Inc.
Customer and Product Support (CAPS)
901 Explorer Boulevard
Huntsville, Alabama 35806-2807

Table 9. HDSL 220/E220 HTU-C M Specifications

Loop Interface	
Modulation Type Mode Number of Pairs Bit Rate Baud Rate Service Range Loop Loss Bridged Taps Performance HDSL Tx Signal Level Input Impedance Return Loss	2B1Q Full Duplex, Echo Cancelling Two 784 kbps per pair 392K baud per pair Defined by Carrier Service Area Guidelines 35 dB maximum @ 196 kHz Single Taps < 2000 feet, Total Taps < 2500 feet Compliant with Bellcore TA-NWT-001210 13.5 dBn 135 20 db (40 kHz to 200 kHz)
Network Interface (4-wire, DSX-1)	
DSX-1 Output Level DSX-1 Line Build Out DSX-1 Line Code DSX-1 Format DSX-1 Channelization	0 dB External (EXT) 0-133 feet ABAM 134-266 feet ABAM 267-399 feet ABAM 400-533 feet ABAM 534-655 feet ABAM AMI, B8ZS SF, ESF, Unframed Channels 1-12 on HDSL Loop1, Channels 13-24 on HDSL Loop2
Power *Tested with the ADTRAN Low-Voltage HRE (P/N 1245041L1) and the ADTRAN Low-Voltage HTU-R (1246026L6)*	
Total Power HTU-C Power Dissipation Span Power Fusing	-48 VDC @ 160*m*A with HTU-R -48 VDC @ 280*m*A with HTU-R and HRE -48 VDC @ 430*m*A with HTU-R and two HREs 4.6 watts with HTU-R 5.0 watts with HTUR and HRE 6.2 watts with HRE and two HREs -137 or -190 VDC for voltage and current limit at 125*m*A 1.00 A (not field-replaceable)
Clock	
Clock Source Internal Clock Accuracy	Internal, DSX-1 Derived ±25 ppm (exceeds Stratum 4). Meets T1.101 timing requirements
Tests	
Diagnostics	Self-test, Local (HTU-C), Remote (HTU-R), HRE Loopbacks
Physical *23" 220 Office Repeater Shelf-Mounted*	
Dimensions Weight	5.6" High x 1.25' Wide x 10.1" Deep Less than 1 lb
Environment	
Temperature	Operational (standard): -40 to +70° C Storage: -40 to +85° C
Control Port	
Interface Terminal Type Async Speed Data Format	RS-232 (DB9) VT 100 or compatible 1.2 kbps to 19.2 kbps 8 data bits, no parity, 1 stop bit
Part Number	
HTU-C 220/E220 Circuit Pack	1246001L2

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. The operation of the loopback commands in the ADTRAN HDSL system is compliant with the recommendation to ANSI recorded in T1E1.4/92. The HDSL network loopback points described below are shown in Figures A-1 and A-2.

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

HTU-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 HTU-R and the Smartjack loopback initiation.

HRE Loopback: A regenerative loopback of the HDSL signal toward the network.

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.

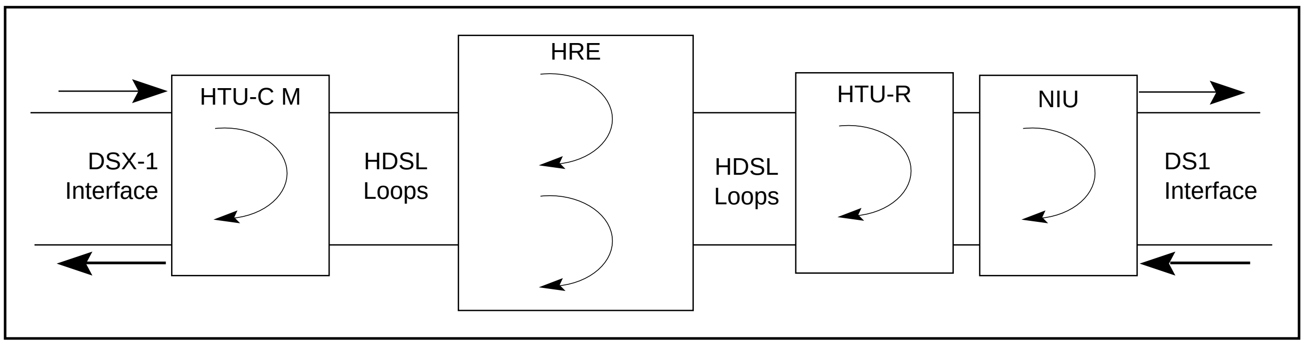


Figure A-1. HDSL Loopback Points

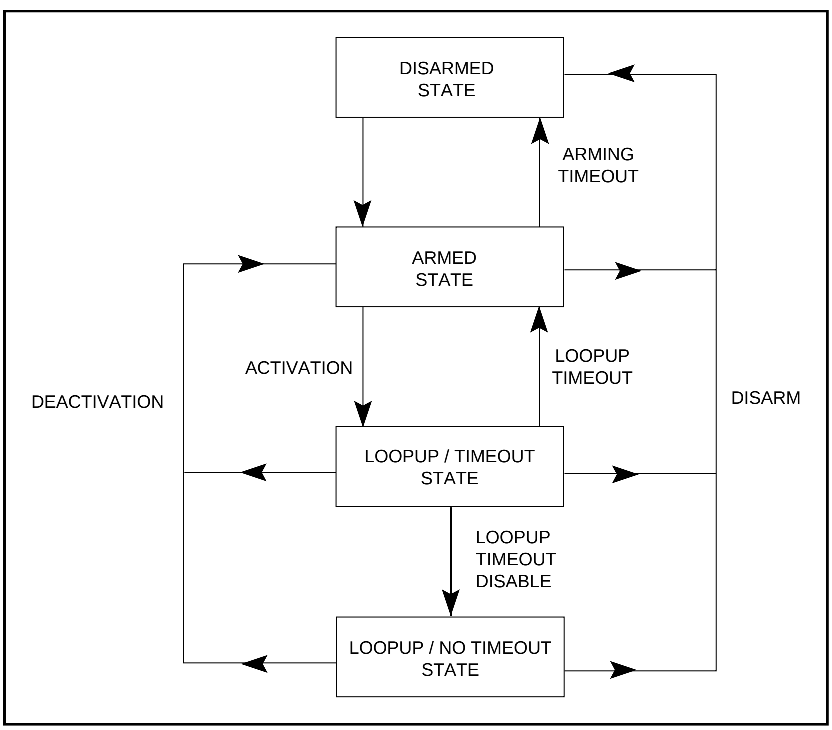


Figure A-2. HDSL Element State Diagram

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.

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

State transitions result from in-band and ESF Data Link sequences as well as timeout operations. The sequences and timeout 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 Timeout
6. Arming Timeout

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.

States and State Transitions

A summary of timeout 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.

Table A-1. HDSL 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. HDSL elements in disarmed state make transition to armed state. Detection of either code results in Smartjack loop-up, if NIU loopback is enabled.
Activation (HTU-C)	1101 0011 1101 0011	> 4 Seconds	Signal sent in-band. HDSL elements in armed state make transition to loop-up state. Loop-up state timeout is programmable from the HTU-C.
Activation (HDSL Range Extender #1)	1100 0111 0100 0001	> 4 Seconds	
Activation (HDSL Range Extender #2)	1100 0111 0101 0100	> 4 Seconds	
Activation (HTU-R)	1100 0111 0100 0010	> 4 Seconds	
Deactivation (all HDSL elements)	1001 0011 1001 0011	> 5 Seconds	Signal sent in-band. HDSL 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. HDSL elements in any state make transition to disarmed state.
Arming Timeout	N/A	2 Hours	
Loop-up Timeout	N/A	Programmable from HTU-C: None, 20, 60, or 120 minutes	HDSL element in loop-up makes transition to armed state.

The **Disarmed State** is the normal mode of operation. Each HDSL 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 HDSL 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 HDSL circuit is enabled (see *HTU-C Switch Options*), the arming sequence will activate the NIU loopback in the HTU-R. If the NIU loopback feature is disabled and an external Smartjack NIU is present, the HDSL 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 HDSL elements is the following 16-bit pattern ESF data link sequence:

ESF Arm Sequence 0001 0010 1111 1111
for four repetitions

HDSL 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 HDSL 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 HDSL element to the disarmed state.

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

HTU-C Activation Sequence 1101 0011 1101 0011
HTU-R Activation Sequence 1100 0111 0100 0010
HRE Activation Sequence 1100 0111 0100 0001

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

If the NIU loopback feature for the HDSL circuit is enabled (see *HTU-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 HTU-R.

Transition from Armed to Disarmed State: All HDSL 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 HDSL element must disarm after receiving the following code for five seconds per element:

Disarm Sequence 11100

The disarming process ensures race-free operation of HDSL 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 HDSL elements and the Smartjack.

All HDSL 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 HDSL 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 HDSL elements and the Smartjack. This sequence will loop-down the Smartjack and the HDSL element.

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

Arming Time-Out .... 2 Hours

In the **Loop-up State**, the selected HDSL 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 timeout 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 HDSL 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 HDSL elements.

Deactivation Sequence 1001 0011 1001 0011

An HDSL 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 HDSL elements. The deactivation sequence does not disarm the HDSL elements. They can still respond to activation sequence control codes.

All HDSL elements automatically move from the loop-up state into the armed state when the selected loop-up timeout value is reached.

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

Transition from Loop-up to Disarmed State: All HDSL 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*.

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.