Section 61246045L1-5B
Issue 2, April 2000
CLEI Code # T1R6LJPD_ _

239 HRE
High-bit-rate Digital Subscriber Line Range Extender
Installation and Maintenance

CONTENTS

FIGURES

TABLES

1. GENERAL

This practice provides installation and maintenance (I/M) instructions for the ADTRAN 239 T1 HDSL Range Extender (HRE) (ADTRAN part number 1246045L1). **Figure 1** is an illustration of the HRE. HRE equipment features include:

- Up to 12 kft of 24-gauge wire range in each direction
- 2B1Q line coding
- Lightning protection

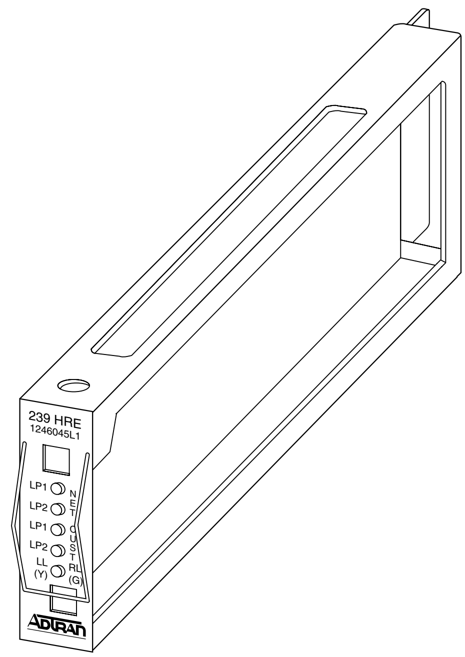


Figure 1. ADTRAN 239 HRE

- In-band loopback control
- Designed for use in standard DDS or ISDN repeater apparatus case
- Remote provisioning and pass-thru performance monitoring

The ADTRAN 239 HRE can effectively double the deployment range of standard HDSL and provide Carrier Service Area (CSA)-compliant loops on both sides of the HRE. The unit extends the digital subscriber loop serving range up to 36 kft over 24-AWG twisted wire.

The HRE is used in conjunction with any span powering T1 HDSL transceiver unit for the central office (HTU-C) and any Low Voltage HDSL transceiver unit for the remote end (HTU-R). Compatible ADTRAN HDSL transceiver units are as follows:

Part Number	Unit Name
1242002LX	220/E220 HTU-C
1242016LX	3192 HTU-C
1242023LX	DDM Plus HTU-C
1244001LX	4th Generation 220/E220 HTU-C
1244021LX	4th Generation T400 HTU-R CP
1244022LX	4th Generation T400 HTU-R SA
1245001LX	5th Generation 220/E220 HTU-C
1245021LX	5th Generation T200 HTU-R CP
1245022LX	5th Generation T200 HTU-R SA
1245003LX	5th Generation DDM and HTU-C
1245004LX	5th Generation 3192 HTU-C
1245026LX	5th Generation T200 HTU-R
1245002LX	Litespan AHT1U
1245024LX	T400 HTU-R
1246001LX......	6th Generation 220/E220 HTU-C
1246003LX......	6th Generation DDM+ HTU-C
1246004LX......	6th Generation 3192 HTU-C
1246026LX......	6th Generation T200 HTU-R

There are no manual option settings on the HRE.

HRE operating power is derived from an HTU-C, independent of line impedance or wire gauge. The operating power from the HTU-C is also used to span power the Low Voltage HTU-R.

The HRE operates at line losses up to 35 dB at 196 kHz, in both directions from the extender and regenerates the 2B1Q signals to meet the transmitted power spectrum of Bellcore TA-NWT-0001210.

Revision History

This revision is provided to correct Table 4. LED Indicators.

2. INSTALLATION

Remove the ADTRAN 239 HRE from the carton and visually ensure that damage has not occurred during shipping or handling. If damage has occurred, file a claim with the carrier, then contact ADTRAN. See *Warranty and Customer Service* (subsection 7 of this practice).

The ADTRAN 239 HRE is shipped in a separate carton and must be installed in an environmental apparatus case.

Electrical Code Compliance

Table 1 shows the Telecommunications Codes for the 239 HRE. The 239 HRE complies with the requirements covered under UL 1950 third edition and is intended to be installed in an enclosure with an Installation Code (IC) of "B" or "E."

NOTE:
This product is intended for installation in Restricted Access Locations only.

Table 1. Telecommunications Codes

Code	Input	Output
IC	A	-
TC	X	X
PC	C	C

c UL us
LISTED
Custom Telecom
E190349

When installing the ADTRAN 239 HRE, refer to the ADTRAN Installation/Maintenance practice for the housing being used.

All connections are made through card edge connectors. **Table 2** gives the card edge pin assingments.

NOTE:
Ensure that the chassis groungd is securly connected to apparatus case. Ground pin designations are defined in Table 2.

The ADTRAN 239 HRE is designed for installation in a prewired apparatus case, and the capacity guidlines for deployment are defined in **Table 3**.

Table 2. Card Edge Pin Assignment

Pin	Designation	Description
1	GND	Ground
2	NC	No Connect
3	T1	Customer Loop 1 Tip
4	R1	Customer Loop 1 Ring
5	T1	Network Loop 1 Tip
6	R1	Network Loop 1 Ring
7	NC	No Connect
8	T	Network Loop 2 Tip
9	R	Network Loop 2 Ring
10	GND	Ground
11	T	Customer Loop 2 Tip
12	R	Customer Loop 2 Ring

NOTE:

These capacity guidelines were generated through extensive testing per Bellcore guidelines GR-487-CORE, requiring units to operate normally at ambient temperatures up to 47°C, with solar loading.When installing the ADTRAN 239 HRE, refer to the ADTRAN Installation/ Maintenance practice for the housing being used.

CAUTION:

For use in other housings, the HRE dissipates a maximum of 3.5 watts.

The ADTRAN 239 HRE is designed for deployment using any 239-type repeater case. A retainer patch is available for use with the 239 HRE for securing into the ADTRAN apparatus cases.

3. FACEPLATE FEATURES

The ADTRAN Low Voltage HRE faceplate has five LEDs indicating diffrent states of the HDSL circuit. **Table 4 and 5** explains the meaning of the diffrent LED indicators.

4. 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:

   $12 - \{(3*L26)/(9-L^{BTAP})\}$ (in kft)

   L26 = Total length of 26-AWG cable excluding bridged taps (in kft)

   LBTAP= Total length of all bridged taps (in kft)

This deployment criteria is summarized in the chart shown in **Figure 2**.

Recommended maximum local loop loss information for PIC cable at 70°F, 135Ω, resistive termination is provided in **Table 6**.

An approximation for the maximum amount of wideband noise on a DSL 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 DSL loop is ≤ 50 dBrn.

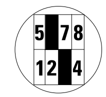
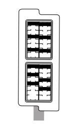
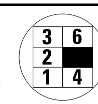
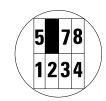
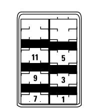
These approximations are to be used as guidelines only and may vary slightly on different loops. Adhering to the guidelines should produce performance in excess of 10^{-7} BER.

5. MAINTENANCE

The ADTRAN 239 HRE requires no routine maintenance. In case of equipment malfunction, perform an in-band loopback from the central office (CO), as defined in **Appendix A**. If a malfunction is confirmed, replace the unit.

The ADTRAN 239 HRE has looping capability through the channel allowing digital loopback in fault isolation. The looping is accomplished remotely as defined in Appendix A of this practice.

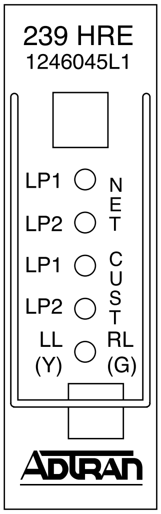
Table 3. 239 HRE Capacity Guidelines

Description	Part Number	CLEI Code	Slots	Material	Stub	Mechanics	Service Capacity (Units) Above Ground	Service Capacity (Units) Below Ground
ADTRAN 239/439	1150027L1 1150027L2	DDMOABA1MA DDMOBBA1MA	4	Stainless Steel Dome	Air-core Gel-filled	239/439	4	4
ADTRAN 239/439	1152010L4 1152010L3	DDMOBAO1MC DDMOBAO1MC	2	Valox Plastic	Air-core Gel-filled	239/439	2	2
ADTRAN 4-slot Universal	1150057L1 1150057L2	DDMODAO1RA DDMOCAO1RA	4	Stainless Steel	Air-core Gel-filled	239/439/819	4 Vertical stub down only	4
ADTRAN 8-slot Universal	1150058L1 1150058L2	DDMOEEO1RA DDMOFEO1RA	8	Stainless Steel	Air-core Gel-filled	239/439/819	6 Vertical stub down only 	8
ADTRAN 16-slot	1190816L1 1190816L2	TBD	16	Stainless Steel	Air-core Gel-filled	239/439 (no 819A)	TBD	16
AT&T, Keptel & ABACON 25-slot	819		25	Polymer		239/819A	12  1, 4, 7, 8, 11, 14, 15, 17, 19, 20, 23, 25	16*  1, 3, 5, 7, 8, 10, 12, 14, 15, 16, 18, 19, 20, 22, 24, 25
SPC 6-slot	7130-0656P-TA† 7130-0656P-TB2#	DDMOKJOARA DDMOLJOARA	6	Stainless Steel	Air-core Gel-filled	239/439 (no 819A)	5 Vertical stub down only 	6
SPC 8-slot	7130-V856P-TQA† 7130-V856P-TQB2#	DDMOKKOARA DDMOLKOARA	8	Stainless Steel	Air-core Gel-filled	239/439 (no 819A)	7 Vertical stub down only 	8
Keptel 8-slot	820		8	Polymer		239	8 Vertical stub down only	8
AT&T/Keptel 12-slot	809		12	Polymer		239	6  1, 3, 5, 7, 9, 11	N/A
Lucent Cabinet 100-slot	841C		100			239	42 Shelf 1: 1, 3, 5, 7, 9, 11 Shelf 2: 1, 3, 5, 7, 9, 11, 14, 16, 18, 20, 23, 24, Shelf 3: 1, 3, 5, 7, 9, 11, 14, 16, 18, 20, 22, 24 Shelf 4: 1, 3, 5, 7, 9, 11, 14, 16, 18, 20, 22, 24	N/A

Note:
* 16 units can be loaded inside the 819 housing for all below-ground mounting orientations. If the 819 housing is mounted specifically in the virtical, stub down direction, 18 units can be loaded in slots 1, 3, 5, 7, 8, 10, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 24, 25.

Table 4. LED Indicators

Five tricolored faceplate LEDs indicate these HRE states.



LED	Descriptions and Indications
NET LP1	This LED indicates the HDSL signal quality and errors on NET loop 1. The NET LP1 LED will flash once when an errored second is detected on NET loop 1. If the NET LP1 LED flashes yellow rapidly (six times per second), sealing current is present and the HRE is attempting to synchronize with the other HDSL circuit elements.
	Off .... No synchronization with the HTU-C.
	Green ...... Synchronized with good signal quality on NET loop 1 (> 2 dB margin).
	Yellow .... Synchronized with marginal signal quality on NET loop 1 (1 to 2 dB margin).
	Red .... Synchronized with poor signal quality on NET loop 1 (0 dB margin).
NET LP2	This LED indicates the HDSL signal quality and errors on NET loop 2. NET LP2 LED will flash once when an errored second is detected on NET loop 2.
	Off .... No synchronization with the HTU-C.
	Green ...... Synchronized with good signal quality on NET loop 2 (> 2 dB margin).
	Yellow .... Synchronized with marginal signal quality on NET loop 2 (1 to 2 dB margin).
	Red .... Synchronized with poor signal quality on NET loop 2 (0 dB margin).
CUST LP1	This LED indicates HDSL signal quality, loopback status, and errors on CUST loop 1. It will flash once when an errored second is detected on CUST loop 1.
	Off .... No synchronization with the HTU-R.
	Green ...... Synchronized with good signal quality on CUST loop 1 (> 2 dB margin).
	Yellow .... Synchronized with marginal signal quality on CUST loop 1 (1 to 2 dB margin).
	Red .... Synchronized with poor signal quality on CUST loop 1 (0 dB margin).
CUST LP2	This LED indicates HDSL signal quality and errors on CUST loop 2. It will flash once when an errored second is detected on CUST loop 2.
	Off .... No synchronization with the HTU-R.
	Green ...... Synchronized with good signal quality on CUST loop 2 (> 2 dB margin).
	Yellow .... Synchronized with marginal signal quality on CUST loop 2 (1 to 2 dB margin).
	Red .... Synchronized with poor signal quality on CUST loop 2 (0 dB margin).
LL	Local Loopback. Indicates loopback from the HRE toward the network is active.
RL	Remote Loopback. Indicates loopback from the HRE toward the customer is active.
Loopback control codes are governed by the HTU-C (and HRE(s) if deployed). Standard or Enhanced loopback codes are used dependent on the type of HTU-C deployed. See Appendix A for a more detailed description of Standard and Enhanced loopback coding.	
Note: If the signal quality is good and the pulse attenuation is bad, the LED will blink green. If the signal quality is marginal and the pulse attenuation is good, the LED will be solid Yellow.	

Table 5. LED Operation During Standard/Enhanced Loopbacks

LED	Descriptions and Indications
Standard Operation:	
NET LP1 and LP2	Both of these LEDs will remain solid when an HRE network loopback is active.
CUST LP1 and LP2	Both of these LEDs will go Off when an HRE network loopback is enabled, and will come back On after the unit has synchronized with the HTU-C.
LL/RL	This LED will be yellow when an HRE network (local) loopback is active. HRE customer (remote) loopback is not available when using Standard Loopback code.
Enhanced Operation:	
NET LP1 and LP2	Both of these LEDs will remain solid when an HRE network or customer loopback is active.
CUST LP1 and LP2	Both of these LEDs will remain solid when an HRE network or customer loopback is active.
LL/RL	This LED will be yellow when an HRE network (local) loopback is active. The LED will be green when an HRE customer (remote) loopback is active.

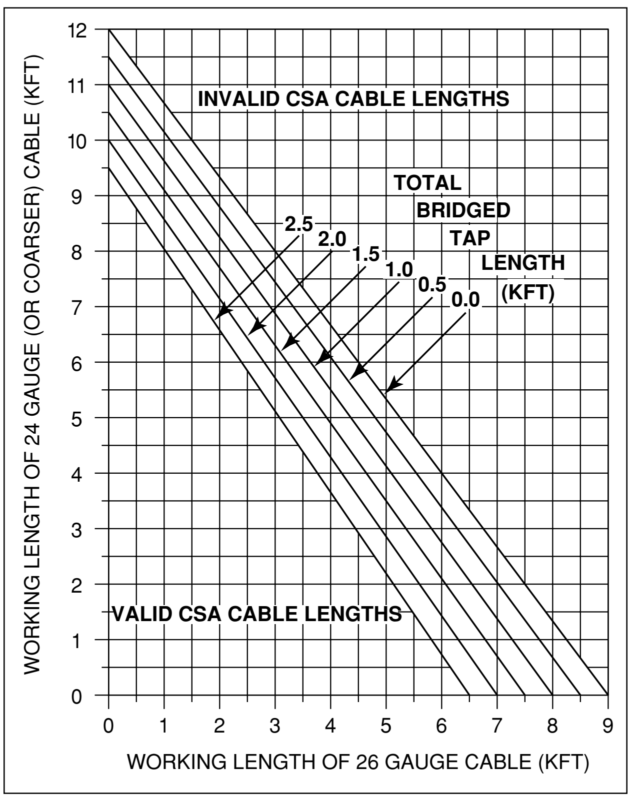


Figure 2. CSA Deployment Guidelines

Table 6. Loop Insertion Loss Data

Frequency (Hz)	Maximum Loss (dB)
3000	12.0
10,000	15.0
50,000	25.5
100,000	30.0
150,000	32.75
200,000	35.25

Performance monitoring, diagnostics, and loopbacks are also available from the craft interface at the HTU-C and HTU-R.

When testing indicates a faulty circuit pack, refer to the housing installation/maintenance practice for the entry and pressurization control, then replace the faulty circuit pack.

An in-band loopback test can be performed from the central office (see Appendix A of this practice).

ADTRAN does not recommend field repair of this unit. Repair services may be obtained by returning the defective unit to the ADTRAN Customer and Product Support (CAPS) Department.

6. SPECIFICATIONS

Specifications for the ADTRAN 239 HRE are detailed in **Table 7**.

Table 7. ADTRAN 239 HRE Specifications

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 CSA guidelines
Loop Loss	36 dB maximum @ 200 kHz
Bridged Taps	Single taps < 2 kft, total taps < 2.5 kft
Performance	Compliant with Bellcore TA-NWT-001210
Return Loss	20 dB (40 kHz to 200 kHz)
HDSL Tx Signal Level	13.5 dBm
Input Impedance	135Ω
DS1 Channelization	Channels 1-12 on Loop 1, Channels 13-24 on Loop 2
Power:	
Input Power	Span-powered by HTU-C: 3.5 watts, maximum
Tests:	
Diagnostics	Loopback initiated with HDSL in-band codes or from HTU-C or HTU-R craft interface. Self-test initiated from the HTU-C or HTU-R.
Physical:	
Dimensions	0.719" x 2.625" x 6.5"
Weight	< 1 lb.
Environment:	
Temperature	Operating (Standard): -40°C to +70°C; Storage: -40°C to +85°C
Relative Humidity	Up to 95%, non-condensing

7. WARRANTY AND CUSTOMER SERVICE

ADTRAN will replace or repair this product within 10 years from the date of shipment if it does not meet its published specifications or fails while in service (see *ADTRAN Carrier Networks Equipment Warranty, Repair, and Return Policy and Procedure,* document 60000087-10A).

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

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

Part Number

1246045L1

ADTRAN Sales

Pricing/Availability
(800) 827-0807

ADTRAN Technical Support

Presales Applications/Postsale 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/Upgrades
(256) 963-8722

Repair and Return Address

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

Appendix A
HDSL Loopbacks

This Appendix describes the use and operation of loopback control code sequences used in ADTRAN's HDSL system.

Loopback control codes are governed by the HTU-C (and HRE(s) if deployed). Two types of HTU-Cs exist which enable two different sets of loopback codes: Standard or Enhanced loopbacks. The Standard loopbacks are those that have been contained in ADTRAN's HDSL product family beginning with 2nd Generation products. The Enhanced loopbacks are contained in selected ADTRAN HTU-C units. The following table denotes whether the HTU-C (part number) contains Standard or Enhanced loopback capabilities.

Standard Loopback

Part Number	Description
1242002Lx	220/E220 HTU-C
1242016L1	3192 HTU-C
1242023L1	DDM+ HTU-C
1244001L1	E220/220 Low Voltage T1 HTU-C
1244002L1 - L3	Litespan AHDSL
1244002L4 - L6	Litespan AHT1U
1245001L1-L2	E220/220 Low Voltage 5th Gen HTU-C
1245003L1-L2	DDM+ 5th Gen HTU-C
1245004L1-L2	3192 5th Gen HTU-C

Enhanced Loopback

Part Number	Description
1245001L4-L8	E220/220 HTU-C
1245002L6	Litespan AHT1U
1245003L4-L8	DDM+ HTU-C
1245004L4-L8	3192 HTU-C
1246001L4-L8	E220/220 HTU-C
1246003L4-L8	DDM+HTU-C
1246004L4-L8	3192 HTU-C

The HREs and HTU-Rs' loopback capabilities are controlled from the central office unit (HTU-C).

NOTE:
If the HTU-C on a circuit contains Standard loopbacks, then refer to subsection 1 of this Appendix to determine its capabilities. If the HTU-C on a circuit contains Enhanced loopbacks, then refer to subsection 2 of this Appendix to determine its loopback capabilities.

A-1. STANDARD LOOPBACKS

This subsection describes operation of the HDSL system in 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 is a regenerative loopback of the DSX-1 signal toward the network.

HTU-R loopback is 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. The HDSL loopbacks are implemented such that the downstream HDSL elements (toward the customer) remain synchronized.

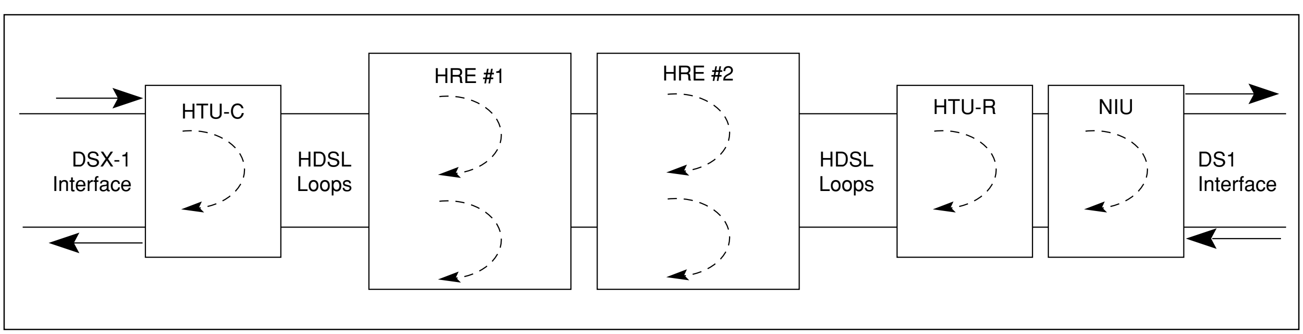


Figure A-1. HDSL Loopback Points

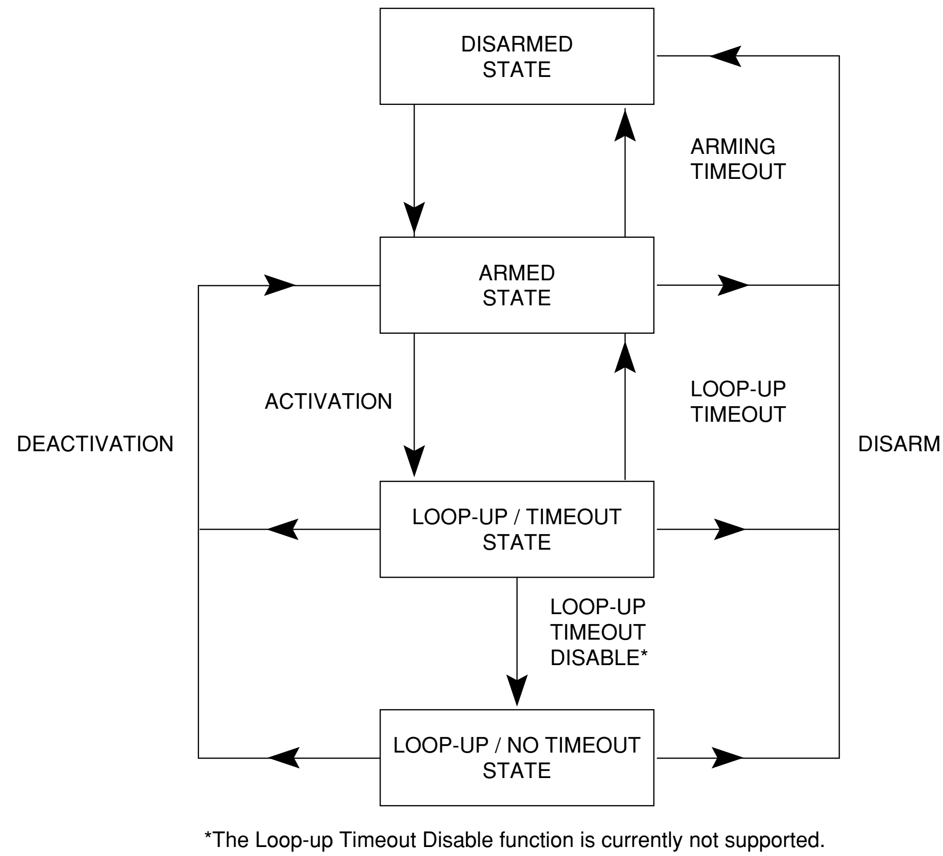


Figure A-2. HDSL Element State Diagram

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

Loopback Process

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 A-2. The four states are disarmed, loop-up, armed, and loop-up/timeout-disable.

State transitions result from in-band, ESF data link sequences, and timeout operations. The sequences and timeouts are as follows:

- Arming (in-band and ESF)
- Activation
- Deactivation
- Disarming (in-band and ESF)
- Loop-up Timeout
- Arming Timeout

A summary of timeout and control sequences is given in **Table A-1 and A-2**.

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.

Table A-1. HDSL Standard Loopback Control Codes

Name	Code	Detection Time	Comments
Arming (In-band)	11000	5 Seconds	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.
Arming (ESF)	0001 0010 1111 1111	4 Repetitions	
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 (HRE #1)	1100 0111 0100 0001	> 4 Seconds	
Activation (HRE #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)	11100	5 Seconds	Signal sent in-band or over ESF data link. HDSL elements in any state make transition.
Disarming (ESF)	0010 0100 1111 1111	4 Repetitions	
Arming Timeout	N/A	2 Hours	HDSL elements in armed state make transition to disarmed state.
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 unit can detect the loopback activation or deactivation code sequence *only* if an error rate of $1E^{-03}$ or better is present.

NOTE:

In all control code sequences presented, the in-band codes are shown leftmost bit transmitted first, and the ESF data link codes with rightmost bit transmitted first.

Disarmed 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 HDSL elements is the standard 5-bit in-band sequence used for NIU Smartjack loop-up. Each HDSL element arms after receiving the following code for five seconds:

Arm Sequence

11000

The arming process ensures unambiguous race-free operation of HDSL element arming and Smartjack loop-up. The HDSL unit can detect the sequence without interfering with the detection by the Smartjack. Presently, the Smartjack loop-up response requires a duration of at least five seconds. The objective of the HDSL detection scheme is to arm the HDSL elements without interfering with the Smartjack loop-up.

The requirement imposed on the arm sequence is that the Smartjack should loop-up and all HDSL elements make a transition from the disarmed state into the armed state. All other control code sequences are ignored in the disarmed state.

The ESF data link sequence used to simultaneously arm the loopback capability of all HDSL elements is the standard 16-bit ESF data link sequence used for NIU Smartjack loop-up.

Table A-2. 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
	(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	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 HRE 1
	(N)	FF06	Loopback data from network toward network at HRE 2
	(C)	3F04	Loopback data from customer toward customer at HRE 1
	(C)	3F06	Loopback data from customer toward customer at HRE 2
	(N)	FF02	Loopback data from network toward network at HTU-R
	(C)	3F02	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.

ESF Arm Sequence
0001 0010 1111 1111
for four repetitions

Race-free operations of the HDSL element arming and Smartjack loop-up is accomplished as described for the in-band code. For example, the ESF arm sequence causes the Smartjack to loop-up and all of the HDSL elements to move from the disarmed state into the armed state. All other ESF data link control code sequences are ignored in the disarmed sate.

Armed State

In the armed state, the HDSL system element continues to be transparent to data flow. However, the in-band data flow is monitored for the activation and disarming sequences. The ESF data link is monitored for the disarming sequence.

All other in-band and ESF data link control code sequences are ignored in the armed state. An arming timeout value causes automatic return 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
101 0011 1101 0011

HTU-R Activation Sequence
1100 0111 0100 0010

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

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:

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 detections 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 Timeout
2 Hours

Loop-up State

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 igneored 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 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 Timeout
programmable from 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 previously described.

A-2. ENHANCED LOOPBACKS

HDSL Maintenance Modes

This subsection 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 in-line 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 deactiviation code sequence *only* if an error rate of $1E^{-03}$ or better is present.

DDS Latching Loopback Operation

If the unit is optioned for FT1 mode, then DDS Latching Loopback operation is supported as described in Bellcore TA-TSY-000077, Issue 3, Section 5.1.3. The HTU-C and any HRE units which are in the HDSL circuit are treated as Identical Tandem Dataports and the HTU-R is treated as a Different Tandem Dataport.

Loopback Control Codes

A summary of control sequences is given in **Table A-3.**

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 the right-most bit transmitted first.

Table A-3. Inband Addressable Loopback Codes

Function / Code Response
Arm/ 11000 (also known as a 2-in-5 pattern)
The HTU-R will loop up towards the network. No AIS or errors will be sent as a result of this loopback. The HTU-C and HRE will arm. When sent from the customer, this code will arm all units.
Disarm/ 11100 (also known as a 3-in-5 pattern)
All units are removed from the armed state. If any of the units are in loopback when the 11100 pattern is received, they will loop down. The LBK LEDs will turn off on all units.
HTU-C Network Loop-up / D3D3 (1101 0011 1101 0011) [1]
If the units have been armed and no units are in loopback*, the HTU-C will loop up 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.
HRE1 Network Loop-up / C741 (1100 0111 0100 0001) [1]
If an HRE is present, the units have been armed, the HRE will loop up 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.
HRE2 Network Loop-up / C754 (1100 0111 0101 0100) [1]
If a second HRE is present, the units have been armed, the HRE will loop up towards the network, 2 seconds of AIS (all 1s) will be sent, 5 seconds of data will pass, and then 200 bit errors will be injected into the DSX-1 signal. As long as the pattern continues to be sent, 200 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 200 bit errors will resume at 20-second intervals.
HTU-R Loop-up / C742 (1100 0111 0100 0010) [1]
ESF facility Datalink: ESF only; when set from the network, an HTU-R network loopback is activated and a 20-bit error confirmation is sent. When set from the customer, an HTU-R customer loopback is activated with a 20-bit error confirmation.
Loopdown / 9393 (1001 0011 1001 0011) [2]
All units currently in loopback will loop down, but remain in the armed state.
Query Loopback / D5D5 (1101 0101 1101 0101) [1]
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, 10 at a time if HRE #1 is in network loopback, and 200 at a time if HRE #2 is in network loopback.
Loopback Timeout Override / D5D6 (1101 0101 1101 0110) [1,3]
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 (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) [1,3]
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 loop-up codes are sent.

[1] Units must be armed with 11000b before this code will work.
[2] In order to behave like a NIU, the HTU-R will not loop down from the network side with 9393h.
[3] This code will be detected only if the units are armed AND there are NO loopbacks active.