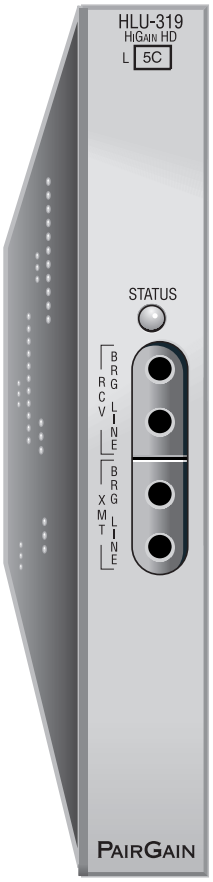
HiGain Line Unit

Model	List Number	Part Number	CLEI Code
HLU-319	5C	150-1140-53	T1L2B27AAA



PairGain Technologies, Inc.
Engineering Services Technical Practice

Section 150-319-153-01

PairGain

REVISION HISTORY OF THIS PRACTICE

Revision	Release Date	Revisions Made
01	April 30, 1999	Initial release

USING THIS TECHNICAL PRACTICE

Two types of messages, identified by icons, appear in the text.

Notes contain information about special circumstances.

Cautions indicate the possibility of equipment damage or the possibility of personal injury.

When installing an HLU in a chassis, be sure to wear an antistatic wrist strap. Avoid touching components on the circuit board.

If you have comments or questions about this Technical Practice, send email to *technical_publications@pairgain.com*.

Type the product name and document "section" number in the subject area of the email message.

INSPECTING SHIPMENT

Upon receipt of the equipment:

- Unpack each container and visually inspect the contents for signs of damage. If the equipment has been damaged in transit, immediately report the extent of damage to the transportation company and to PairGain. Order replacement equipment, if necessary.
- Check the packing list to ensure complete and accurate shipment of each listed item. If the shipment is short or irregular, contact PairGain as described in the Warranty. If you must store the equipment for a prolonged period, store the equipment in its original container.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

OVERVIEW

The PairGain® HiGain® HLU-319 List 5C is the Central Office (CO) side of a repeaterless, T1 transmission system. When used in conjunction with a HiGain Remote Unit (HRU) the system provides 1.544 Mbps transmission on two unconditioned copper pairs over the full Carrier Service Area (CSA) range. This line unit can be used in applications with or without HDUs. To provision and view status, use the HiGain Management Unit (HMU-319).

The CSA includes loops up to 12,000 feet of 24 AWG or 9,000 feet of 26 AWG wire, including bridged taps. The HiGain system uses HDSL transmission technology as recommended by Bellcore TA-TSY-001210. The HiGain system complies with GR-63-CORE, TR-TSY-000499, and GR-1089-CORE.

PRODUCT ENHANCEMENTS

New features of the HLU-319 include:

- Five-span range with four doublers (60 kft, 24 AWG)
- Four line-powered spans (three doublers and a remote)
- Low line-power option (135 V) for circuits with a single doubler
- Reduced power consumption
- Ultra-low wander (Stratum 1 compliant)
- Selectable Power Feed (PWRF) modes: AUTO, HIGH and LOW
- HDSL grounded loop detection
- BPV transparency options
- BER alarm options
- HRU Loopback screen
- Inventory Screen (displays Circuit ID and model number)
- LOS/AIS (Alarm Indicating Signal) payload alarm option (ALMP)
- RLOS ALARM disable option (RDA)
- Supports HRU-411 in PCS applications
- Improved performance for AUTO DS1 line code mode
- Default setting screen option
- Payload (PL) or HiGain (HG) loopback source ID

STANDARD FEATURES

- Selectable DS1 pre-equalizer
- DS1 splitting and bridge access
- Status LED
- Compatible with Span Terminating Shelf (STS) high-density shelves
- Selectable loopback activation codes
- Network Management and Administration (NMA) interface
- Lightning and power cross protection on HDSL interfaces
- Full duplex 2B1Q HDSL transmission on two pairs at 784 kbps
- Margin threshold alarm

COMPATIBILITY

For a list of compatible T1 repeater shelves, see "Appendix C - Compatibility" on page 51.

All generations of HiGain HLU and HRU modules are compatible with each other. To take advantage of the enhanced features of newer HiGain doublers, refer to Table 22 on page 52.

APPLICATIONS

HiGain systems provide a cost-effective, easy-to-deploy method for delivering T1 High Capacity Digital Service (HCDS) over metallic pairs.

- The service is deployed over two unconditioned, non-loaded copper pairs, yet it demonstrates a quality that is competitive with fiber optics.
- Conventional, in-line, T1 repeaters are not required.
- Cable pair conditioning, pair separation and bridged tap removal are not required.

HiGain systems can do the following:

- operate with any number of other T1, POTS, Digital Data Service (DDS) or other HiGain systems sharing the same cable binder group.
- can be used with customers requiring DS1 service on a temporary or permanent basis.
- provide a means of quickly deploying service in advance of fiber-optic transmission systems.

With a HiGain system, service can be provided within hours. Fiber-optic systems can be installed incrementally and cut-over from the installed HiGain system when convenient to do so.

Applications without HiGain Doublers

For applications without doublers, the HLU-319 is directly connected to the HRU by the two HDSL cable pairs. HLU-319 is compatible with all HiGain HRUs.

Applications with HiGain Doublers

For doubler applications, one to four doublers may be used in the HDSL loops between the HLU and HRU.

- The HLU-319 can power three doublers and a remote unit (HRU-402 or HRU-411) for a total of four spans.
- If the HRU is locally powered, the HLU can power up to four doublers for a total of five spans.

These extended ranges are only available when using the HDU-409, HDU-404 or HDU-407 micro-doublers with the HRU-411 or HRU-402. Older doublers (HDU-451, HDU-439 and HDU-437) cannot be used in circuits with more than two doublers in any line or local power system. For additional information refer to the respective technical practice
(see "Documentation" on page 53).

PCS Applications

The HLU-319 is required for Personnel Communications Systems (PCS) applications that use the HRU-411. The HRU-411 has an onboard 130 V, 8.5 W power supply that can power the 200 mW PCS remote radio ports. The Line Unit recognizes the HRU-411 (when the Customer Premises Equipment [CPE] POWER switch is set to ON) and performs the following two functions required by the HRU-411 to bring up the NEC radio port:

- Increases the HDSL line voltage to its high ± 220 V level with the PWRF option set to AUTO
- Enables HRU-411 to turn on its 130 V radio port supply

For a list of compatible T1 repeater shelves and related equipment, refer to
"Appendix C - Compatibility" on page 51.

FRONT PANEL

The HLU-319 front panel is shown is Figure 1. The front panel components are described in Table 1 on page 5.

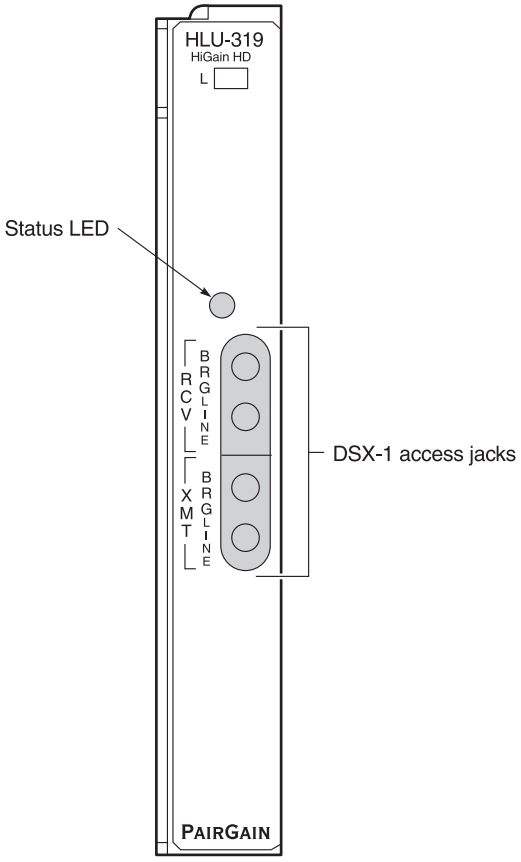


Figure 1. *HLU-319 Front Panel*

Table 1. *Front Panel Description*

Front Panel Feature	Function
Status LED	
Green	Normal operation
Flashing green	HDSL loop acquisition
Red	Fuse Alarm
Flashing red	System alarm
Yellow	Self Test is in process or an HLU-319 Customer Remote Loopback (CREM) or a Network Local Loopback (NLOC) is in effect.
Flashing yellow	HLU-319 is in an Armed state
DSX-1 access jacks	
XMT and RCV testing	Provides splitting jack access to (XMT) and from (RCV), the HDSL span at the DSX-1 interface. Breaks the XMT and RCV paths to permit test signal insertion and retrieval.
XMT and RCV bridging	Provides non-intrusive bridging jack access to (XMT) and from (RCV) the HDSL span at the DSX-1 interface. Allows the two T1 payloads to be monitored.
CLEI and ECI bar code label (located on the side of the unit)	Provides the human-readable Common Language Equipment Identifier (CLEI) code number and the Equipment Catalog Item (ECI) bar code number.
Configuration Number (located on the side of the unit)	Contains either a five-digit or six-digit warranty configuration number or a standalone two or three-digit configuration number as follows: • Digit 1 = Last digit of shipment year • Digits: 2 and 3 = Shipment month • Digits: 4 and 5 = Configuration number The configuration number can also be found on a small bar label that also contains the Julian date code and part number. This gummed label may be attached to the PC board or to the front panel.

INSTALLATION

Upon receipt of the equipment, visually inspect it for signs of damage. If the equipment has been damaged in transit, immediately report the extent of damage to the transportation company and to PairGain Technologies, Inc.

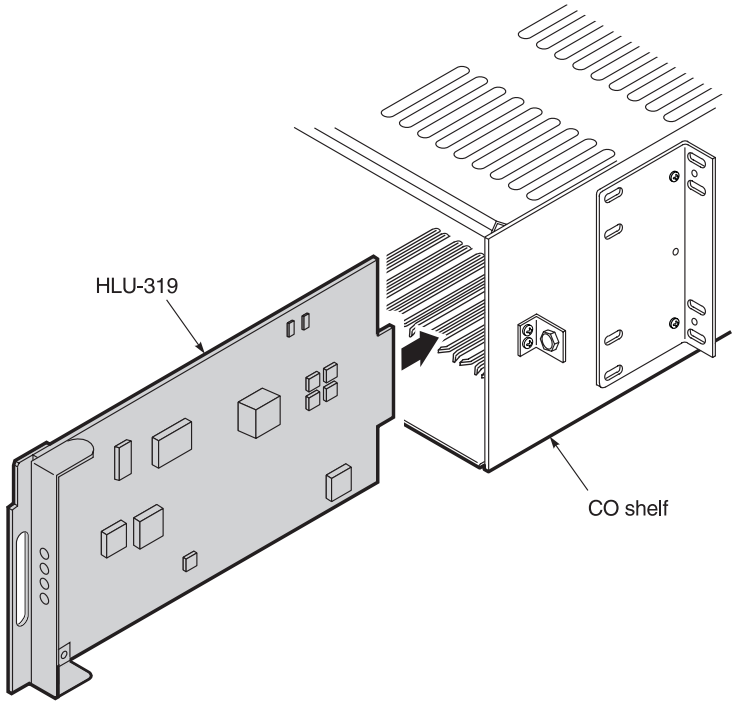


Figure 2. *Installing the HLU-319 into a Shelf*

When installing an HLU in a chassis, be sure to wear an antistatic wrist strap. Avoid touching components on the circuit board.

To install the HLU-319:

1 Slide the HLU-319 into the card guides for the desired slot, then push the unit back until it touches the backplane card-edge connector and the retaining latch on the front panel opens (Figure 2).

2 Place your thumbs on the HLU-319 front panel and push the HLU-319 into the card-edge connector until it is entirely within the card guides and the retaining latch closes. This indicates that the card is properly seated.

PROVISIONING

NAVIGATING THE MAINTENANCE TERMINAL SCREENS

The following sections describe how the Maintenance Terminal displays an HLU-319 system with and without doublers, how to navigate through the maintenance screens, and how to select options.

System Spans

As shown in Figure 3, the HLU can support up to four doublers with five HDSL spans. The Span Status, Performance Data, and Performance History may display as many six screens to depict an HLU-319 system.

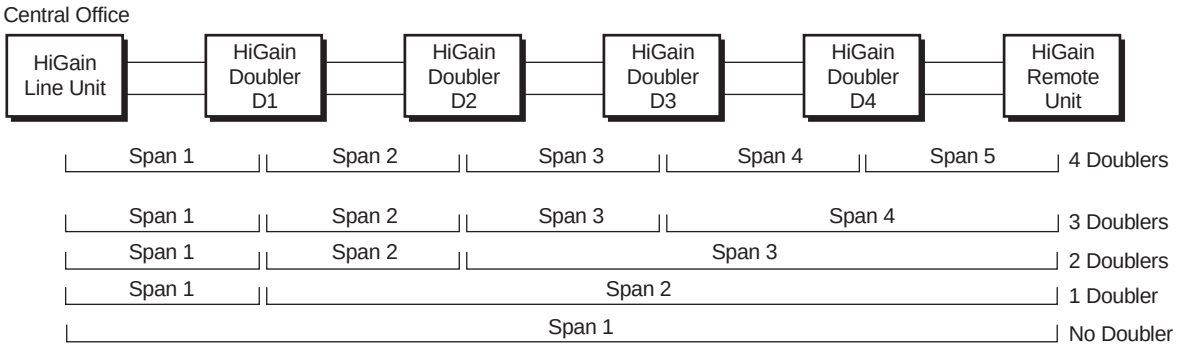


Figure 3. *System Spans*

Navigation Keys

Table 2 lists keys you can use on the maintenance terminal to navigate within the Maintenance Terminal screens.

Table 2. *Navigational Keys on the Maintenance Terminal*

Key	Function
U	Updates a report.
C	Clears a report.
S	Selects the next Span Status screen, or 1, 2, 3, 4, or 5 will access span directly (for doubler applications).
P	Selects the previous page of a report.
N	Selects the next page of a report.
E	Exits the current screen.

Selecting an Option

To select an option within the Maintenance Terminal screens, you can:

- Press the key indicated to the left of the selection.
- Press the letter in parenthesis of the parameter to be changed.

An invalid entry produces the following message and identifies the name of a field where the invalid entry occurred:

```
> error
```

This happens only for margin alarm threshold or DSO blocking.

ACCESSING THE MAINTENANCE TERMINAL SCREENS

The maintenance terminal screens can not be accessed through the HLU-319 List 5C, as this model does not provide a craft port. View these maintenance terminal screens through the HiGain Management Unit (HMU) or OS port located on the rear of the HiGain shelf or WBS-3190.

Figure 4 shows the Maintenance Terminal Main Menu from which you can access eight system administration screens. The function of each screen selection is listed in Table 3.

```
HI-GAIN HLU-319     MAINTENANCE TERMINAL MAIN MENU   (ver V7.0L-5C)
                         CIRCUIT ID#:

                    A. VIEW SPAN STATUS
                    B. SET CLOCK
                    C. SYSTEM SETTINGS
                    D. LOOPBACK MODE:  NONE
                    E. VIEW PERFORMANCE DATA
                    F. VIEW PERFORMANCE HISTORY
                    G. VIEW ALARM HISTORY
                    H. VIEW SYSTEM INVENTORY
```

Figure 4. *Maintenance Terminal Main Menu*

Table 3. *Maintenance Terminal Screens*

Screen	Function	See page:
View Span Status	Provides access to subscreens that allow you to monitor the HDSL line between the HLU and the HRU.	10
Set Clock	Allows you to set both the time and the date parameters at the HLU, and to update the same settings at the HRU.	14
System Settings	Allows you to set all user options.	15
Loopback Mode	Provides access to subscreens that allow you to issue and disable loopbacks from both the network and customer side.	21
View Performance Data	Provides access to subscreens that allow you to view the Errored Seconds (ES) and Unavailable Seconds (UAS) between the HLU and the HRU in 15-minute intervals over a four-hour time period.	24
View Performance History	Provides access to subscreens that allow you to view the ES and UAS between the HLU and the HRU in 24-hour intervals over a 31-day period.	26
View Alarm History	Provides access to subscreens that allow you to view alarm conditions between the HLU and the HRU.	28
View System Inventory	Allows you to enter a unique circuit ID (up to 24 characters).	31

VIEW SPAN STATUS

The View Span Status option allows you to view six system status screens that provide information about the HDSL Loop 1, HDSL Loop 2, and the DS1. For doubler applications, the available Span Status screens depend on whether the system includes one, two, three, or four doublers.

From each Span Status screen you can:

- Press **C** to clear the cur (current), min (minimum) and max (maximum) numeric counts.
- Press **U** to update cur (current) values.
- Press **S** to view the next available span (for doubler applications).
- Press **E** to return to the previous screen.

Span Status Screen for Non-doubler Applications

Press **A** from the Maintenance Terminal Main Menu to open the Span Status screen (Figure 5). If no doubler (HDU) is present, the screen reports span status for the subscriber lines between the HLU and the HRU.

```
                          SPAN STATUS
TIME: 00:14:11
DATE: 04/13/99            Circuit ID#:
ALARMS:   NONE
LOOPBACK: OFF
POWER LEVEL: LOW
                        HLU                          HRU
                HDSL-1        HDSL-2        HDSL-1        HDSL-2
              cur/min/max   cur/min/max   cur/min/max   cur/min/max
MARGIN:         21/17/21      20/17/21      21/18/21      20/18/21 dB
PULSE ATTN:        19            19            19            19    dB
INS LOSS:          23            23            23            23    dB
24 HOUR ES:       00002         00004         00005         00007  seconds
24 HOUR UAS:      00016         00013         00002         00001  seconds
                                   DS1 STATUS
                              HLU                  HRU
24 HOUR ES Count:            00000                00000
24 HOUR UAS Count:           00000                00000
Frame type:                   ESF                  ESF
Code type:                    B8ZS                 B8ZS

                         (E)xit (C)lear (A)uto(U)pdate
```

Figure 5. *Span Status Screen (No Doubler)*

Span Status Screen for Doubler Applications

If doublers have been added, status is also reported for these. After pressing **A** to access the Maintenance Terminal Main Menu, press **S** to navigate through the span status screens. Span Status can have up to six screens, depending on the number of HDUs. Figure 6 shows status between an HLU and its first doubler (HDU1). If there is only one doubler, the next screen shows status between HDU1 and the HRU. If there are additional doublers the Span Status screen will report status on each span.

```
                          SPAN 1 STATUS
TIME: 12:06:04
DATE: 04/13/99            Circuit ID#:
ALARMS:   NONE
LOOPBACK: OFF
POWER LEVEL: HIGH
                        HLU                       HDU1
                HDSL-1       HDSL-2       HDSL-1       HDSL-2
              cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:         21/21/21     21/21/21     21/21/21     21/21/21 dB
PULSE ATTN:        19           19           20           19    dB
INS LOSS:          23           23           25           23    dB
24 HOUR ES:     00000        00000        00000        00000  seconds
24 HOUR UAS:    00000        00000        00000        00000  seconds

                              DS1 STATUS
                             HLU                HRU
24 HOUR ES Count:           00000              00000
24 HOUR UAS Count:          00000              00000
Frame type:                  ESF                ESF
Code type:                   B8ZS               B8ZS

              (E)xit (C)lear (A)uto(U)pdate (S)pan(1)(2)(3)(4)(5)
```

Figure 6. *Span 1 Status Screen*

Highlighted text in the Span Status screens (Figure 5 and Figure 6) will change depending on system configuration.

Table 4 lists the Span Status fields and descriptions. Table 5 on page 13 lists all possible alarms and their descriptions.

Table 4. *Span Status Fields and Descriptions*

Field	Description
Time	Time of day when Span Status was checked.
Date	Date when Span Status was checked.
Circuit ID	Shows the user-defined circuit ID.
Alarms	Presence or absence of alarm conditions. See Table 9 on page 32.
Loopback	Indicates Off condition or identifies specific active loopback. See Table 10 on page 36.
Power Level	Indicates the HDSL line voltage in its Low (-140 V) or High (±112 V) state.
Margin	Indicates the excess signal-to-noise ratio, at either the HLU or HRU, relative to a 10^{-7} Bit Error Ratio. The first value is the current margin, the second is the minimum margin, and the third is the maximum value. NA means “Not Available.” The minimum and maximum margins are cleared and updated every time the Span Status screen is cleared and every time the system clock passes 12:00 AM midnight.
Pulse Attenuation (ATTN)	Indicates the attenuation of the 2B1Q pulse from the distant end. The value is related to the 196 kHz loss of the cable pair. The pulse attenuation is a more direct indication of the loop attenuation to the 2B1Q signal than is the 196 kHz loss. The normal HiGain ATTN operation range is from 0 to 28 dB.
INS Loss	Indicates the approximate attenuation of the HDSL loop at 196 kHz. It is generated by multiplying the pulse attenuation by 1.25.
24-Hour ES	The number of one second intervals that contained at least one CRC error. This value is a running total of the last 24 Hours.
24-Hour UAS	The number of seconds the HDSL loop was out of sync.
24-Hour ES Count	The number of errored seconds derived by DS1 BPVs, frame errors, UAS, and ESF CRC errors.
24-Hour UAS Count	The number of seconds during which the DS1 input signal was absent (125 or more consecutive 0s) over a 24-hour period.
Frame type	Type of DS1 framing used on the input stream (SF or ESF).
Code type	Type of DS1 line coding used (AMI, B8ZS, AMI: ZBTSI or B8ZS: ZBTSI). The latter two conditions indicate the code type that is being received when HiGain is set to its ZBTS1 mode. In either the AMI or B8ZS DS1 code mode, it displays the selected code as opposed to the code type that is actually being received.
(DP)	DP = Data Path. The loopback was initiated by a command that was embedded in the T1 data path.
(HG)	HG = HiGain. The loopback was initiated by a maintenance terminal loopback command.

The Status Menu displays a four-character code that identifies the signal being transmitted or received, where the code is one of the following: LLOS, RLOS, LAIS, or RAIS.

RCV (xxxx) - Signal received (xxxx) at the T1 input to either the HLU or HRU.

XMT (xxxx) - Signal transmitted (xxxx) at the T1 output of either the HLU or HRU.

Table 5. *Status Menu Messages: Alarms*

Message	Full Name	Description
LLOS	Local Loss of Signal	No signal from HLU-319 local T1 input.
RLOS	Remote Loss of Signal	No signal from HRU T1 input.
LOSW1 LOSW2	Loss of Sync Word 1 or 2	One of the HDSL loops has lost synchronization.
BER	Bit Error Rate	The total system error count (TSEC) has exceeded the user-selected threshold.
R(L)AIS	Remote (Local) Alarm Indicating Signal	Indicates an AIS (all ones) pattern is being transmitted (XMT) from the remote (local) T1 output port.
MAL1	Margin Alarm 1	The margin on the HDSL Loop 1 has dropped below the threshold (1 to 15 dB) set by the user. Setting the threshold to zero inhibits the margin alarm.
MAL2	Margin Alarm 2	The margin on the HDSL Loop 2 has dropped below the threshold (1 to 15 dB) set by the user. Setting the threshold to zero inhibits the margin alarm.
CHREV-SPx	Channels Reversed	The Loop 1 and Loop 2 HDSL pairs are reversed. SPx indicates the span with channel reversed.
SMJK	SmartJack Loopback	Loopback from HRU to network initiated by (2-in-5) in-band loopback code or out-of-band ESF data link code.
NREM	Network Remote Loopback	Loopback at HRU to network initiated from CO (network) by Intelligent Line Repeater (ILR) #2 code or by the maintenance terminal.
NLOC	Network Local Loopback	Loopback HLU-319 (local) to network initiated from CO by IOR code or from the maintenance terminal.
NDU1	Network Doubler 1 Loopback	Loopback at Doubler #1 to network initiated by IOR code or by the maintenance terminal.
NDU2	Network Doubler 2 Loopback	Loopback at Doubler #2 to network initiated by IOR code or by the maintenance terminal.
NDU3	Network Doubler 3 Loopback	Loopback at Doubler #3 to the network initiated by IOR code or by the maintenance terminal.
NDU4	Network Doubler 4 Loopback	Loopback at Doubler #4 to the network initiated by IOR code or by the maintenance terminal.
CLOC	Customer Local Loopback	Loopback at HRU (local) to CI initiated from CPE by the ILR code or by the maintenance terminal.
CREM	Customer Remote Loopback	Loopback at HLU-319 (remote) to customer initiated by IOR code or by the maintenance terminal.
CDU1	Customer Doubler 1 Loopback	Loopback at Doubler #1 to CI initiated by ILR code or by the maintenance terminal.
CDU2	Customer Doubler 2 Loopback	Loopback at Doubler #2 to CI initiated by ILR code or by the maintenance terminal.
CDU3	Customer Doubler 3 Loopback	Loopback at Doubler #3 to CI initiated by ILR code or by the maintenance terminal.
CDU4	Customer Doubler 4 Loopback	Loopback at Doubler #4 to CI initiated by ILR code or by the maintenance terminal.
ARM	Armed	The HiGain system has detected the IR loopback (2-in-5) arming code.
TLOS	Transmit Loss of Signal Loopback	HRU is in a logic loopback state caused by a loss of its T1 input from the CI (if enabled at the HRU through its TLOS switch option).

SET CLOCK

Press **B** from the Maintenance Terminal Main Menu to open the Set Clock screen (Figure 7).

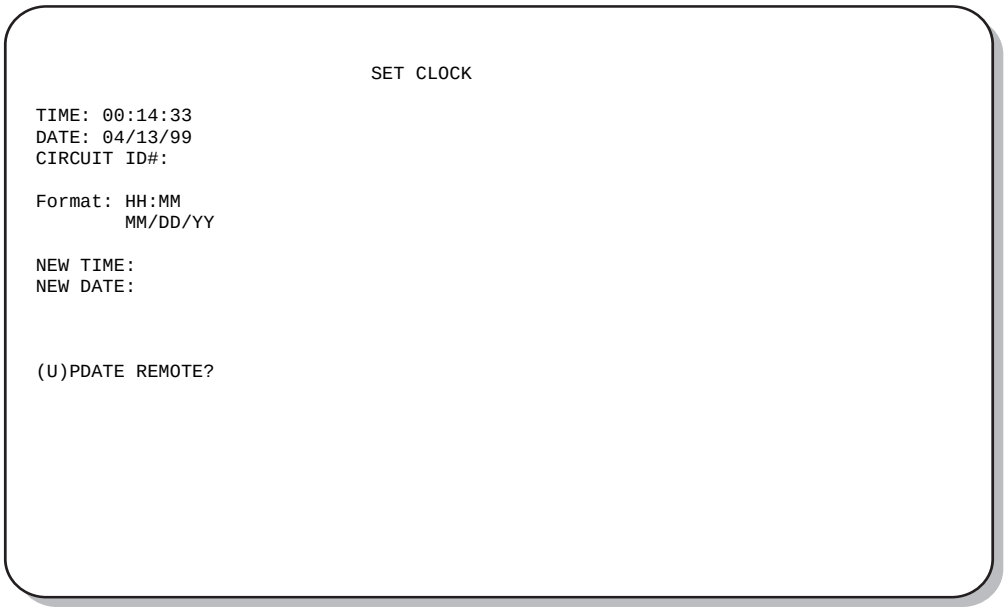


Figure 7. *Set Clock Screen*

All time information is lost when power is removed. The last date, however, is retained in NVRAM and reappears when power is restored.

Set Time

The cursor defaults to the New Time field. To set the system time, type the hour and minute in the 24-hour format of **hh:mm:ss** (setting the seconds is optional), then press **ENTER**. The New Date field displays.

Set Date

To set the system date, type the month, day and year in a **mm/dd/yy** format, then press **ENTER**. The Update Remote field displays.

When editing entries in the Clock screen and when using the Terminal emulation program in Windows 3.1, pressing the BACKSPACE key deletes two characters at a time.

Update the HRU Time and Date

The remote unit date and time is set by using this option. To update the remote, do one of the following:

- Press **U** to update the HRU to the same date and time set for the HLU-319 *or*
- Press **ENTER**. (The remote unit is not updated.)

All time information is lost when power is removed. The last date, however, is retained in NVRAM and reappears when power is restored.

SYSTEM SETTINGS

Press **C** from the Maintenance Terminal Main Menu to open the System Settings screen (Figure 8).

```
                                  SYSTEM SETTINGS

TIME: 12:46:06
DATE: 04/13/99                      CIRCUIT ID#:

A. EQUALIZATION....: 0                    P. MARGIN ALARM THRESH : 4
B. SMARTJACK LPBK..: ENABLED              Q. RLOS (DS1 LOS) ALARM: ENABLED
C. SPECIAL LPBK....: GNLB                 R. ALARM PATTERN.......: AIS
F. POWER...........: AUTO                 S. BPVT................: DISABLED
G. ZBTSI...........: OFF
H. BER ALARM THRESH: NONE
I. LOOPBACK TIMEOUT: 60
J. ALARM...........: DISABLED
K. DS1 LINE CODE...: AMI
L. FRAMING.........: AUTO
M. AIS ON HDSL LOSW: 2 LOOPS
N. AIS ON SMJK/NREM: ENABLED

                    O. DS0 BLOCKING: xx = Blocked Channels
   01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

                             (D)efaults, (E)xit
                  Enter the option letter to change setting

(C)onfirm
```

Figure 8. *System Settings Screen*

To change any option:

1. Enter its character key. This causes the screen to refresh with the new settings.
2. After all parameters have been selected, press **E** to exit, then **C** to confirm. The newly selected parameters are now activated.

Table 6 describes the System Settings screen options. Factory default settings are shown in bold.

Table 6. *HLU-319 System Settings Screen Options*

System Settings	Selection	Description
Equalization	**0**	Sets the Equalizer to DSX-1 for 0 to 133 feet.
	133	Sets the Equalizer to DSX-1 for 133 to 266 feet.
	266	Sets the Equalizer to DSX-1 for 266 to 399 feet.
	399	Sets the Equalizer to DSX-1 for 399 to 533 feet.
	533	Sets the Equalizer to DSX-1 for 533 to 655 feet.
SmartJack Loopback	DIS	Configures the HiGain system to ignore all in-band SmartJack loopback commands.
	ENA	Enables the HiGain system to recognize all in-band SmartJack loopback commands.
Special Loopback	**GNLB**	Configures the HiGain system to respond to the generic (3/4 in 7) in-band loopback codes.
	A1LB and A2LB	Configures the HiGain system to respond to the in-band loopback codes of the Teltrend addressable repeater.
	A3LB	Configures the HiGain system to respond to the in-band loopback codes of the Wescom addressable repeater.
	A4LB	Configures the HiGain system to respond to the in-band loopback codes of the Wescom Mod 1 addressable repeater.
	A5LB	Configures the HiGain system to respond to the in-band loopback codes of the Teltrend Mod 1 addressable repeater.
Power	DIS	Disables powering to the HDSL pair.
	LOW	Keeps the HDSL line voltage at -140 V maximum for all applications.
	AUTO	Allows the HDSL line voltage to automatically switch between -140 V maximum for non-doubler applications and ±112 V for doubler applications.
	HIGH	Forces the HDSL line voltage to ±112 V for all applications.
ZBTSI	ON	Tells the HiGain system that the ESF frame is operating in its Zero-Byte Time Slot Interchange (ZBTSI) mode.
	OFF	Tells the HiGain system that the ESF frame is operating in its normal non-ZBTSI mode.
BER Alarm Threshold	1E-6	Activates (closes) the SmartJack alarm relay contacts on pins 20 and 21 and flashes the red STATUS LED when the BER exceeds 10^{-6}.
	1E-7	Activates (closes) the system alarm relay contacts on pins 20 and 21 and flashes the red STATUS LED when 10^{-6} > BER >10^{-7}.
	NONE	Prevents generation of a system alarm due to BER.
Loopback Timeout	NONE	Disables automatic time-out cancellation of all loopbacks.
	20	Sets automatic cancellation of all loopbacks to 20 minutes after initiation.
	60	Sets automatic cancellation of all loopbacks to 60 minutes after initiation.
	120	Sets automatic cancellation of all loopbacks to 120 minutes after initiation.
Alarm	**DIS**	Opens the system alarm relay contacts if closed, and disables activation of the system alarm relay when a system alarm condition occurs.
	ENA	Enables activation of the system alarm relay when a system alarm condition occurs.
DSX-1 Line Code	AUTO	The HLU-319 List 5C and HRU monitor the incoming T1 bit streams for the B8ZS code. If the HRU detects this code, the HLU enters B8ZS output mode. The HLU reverts back to AMI output mode if no B8ZS codes are received at the HRU input for 5 seconds. Similarly, when the HLU detects the B8ZS code, the HRU enters the B8ZS mode and returns to AMI mode if no B8ZS code is received at the HLU input for 5 seconds.
	B8ZS	Places both the HLU-319 and HRU into their B8ZS modes.
	AMI	Places both the HLU-319 and HRU into their AMI modes.

Table 6. *HLU-319 System Settings Screen Options (Cont.)*

System Settings	Selection	Description
Framing	**AUTO**	Configures the HiGain system to operate in an auto-framing (AUTO) mode in which it continuously searches the input T1 bit stream for a valid SF or ESF frame pattern. This feature is required for fractional T1 applications (DS0 blocking) where it insures proper channel time slot alignment. While the HiGain system can also process unframed data in this AUTO mode, it is recommended that the unframed (UNFR) mode be used for all unframed applications. Using the AUTO mode for unframed applications runs the risk of detecting "pseudo-valid" frame sequences, which can affect the data integrity.
	UNFR	Configures the HiGain system to operate in an unframed mode. This mode disables the auto framing process and forces the HiGain system to function as a transparent bit pipe.
AIS On HDSL LOSW	**2LP**	Causes the HiGain system to transmit the AIS signal at both the HLU-319 and HRU T1 output ports when both of the HDSL loops are not in sync (LOSW).
	1LP	Causes the HiGain system to transmit the AIS signal at both the HLU-319 and HRU T1 output ports when either of the two HDSL loops is not in sync (LOSW) or if a Margin alarm occurs.
AIS On SMJK/NREM	**ENA**	Causes the List HRU to transmit the AIS signal towards the Customer Interface (CI) when in NREM or SmartJack loopback (see Figure 5).
	DIS	Causes the HRU to either transmit the signal from the network towards the CI RCU port or to open and terminate its RCV CI port when an HRU NREM or SmartJack loopback is executed. The AIS signal is not sent (towards the CI).
DSO Blocking	BLK	The DS0 blocking option can only be set through the craft port with a terminal. BLK indicates at least one channel is blocked.
	NONE	Indicates no channels are blocked.
Margin Alarm Threshold	0 to 15 dB	The Margin Alarm Threshold can only be set through the craft port with a terminal. It determines the minimum allowable margin below which a system alarm can occur. Zero disables the alarm.
	4dB	Default value
RLOS Alarm	**ENA**	Enables a remote DS1 LOS condition at the input to the HRU to generate an LOS alarm. AIS or LOS (depending on ALMP) is sent towards the network.
	DIS	Prevents a remote DS1 LOS condition at the input to the HRU from causing an LOS alarm. The front panel Status LED still flashes red and the ALRM RLOS message is displayed but the alarm relay contacts do not close and LOS is sent towards the network from the HLU instead of AIS.
Alarm Pattern	**AIS**	Enables HiGain to output an AIS payload at its T1 ports for LOSW, T1 LOS and Margin alarms.
	LOS	Enables HiGain to output an LOS condition at its T1 ports for LOSW, T1 LOS and Margin alarms.
BPV Transparent	ENA	Enables input T1 BPVs and HDSL CRC errors to be converted into T1 BPVs at the distant end's T1 output. This makes HiGain transparent to BPVs.
	DIS	Disables.
Confirm Settings	YES	Confirms that all operating modes are to be updated to their current selections.
	NO	Prevents the most recently selected operating mode selections from being updated. They remain as they were before the system option settings mode was entered.

BPV and BER Options

The HLU-319 improves HiGain's compatibility with DLC feeder applications because of its ability to transmit T1 BPV occurrences between its T1 interfaces. This feature is required to support protection switching in DLC applications. Each DLC terminal must be able to monitor the integrity of its Receive T1 payload and then switch to the protect line when the integrity of the path drops below specific user selected limits. An essential requirement of this feature is the need for each DLC terminal to detect BPVs in its T1 input. Standard HDSL systems correct input T1 BPVs and thus prevent them from being detected by DLC terminals to which they are connected. The HLU-319 and its associated remote units remove this limitation and become BPV transparent by detecting and counting input BPVs at each end and then by replicating them at the distant end's T1 output port.

This BPV Transparency (BPVT) option is controlled by the BPVT user option, which allows it to be Enabled (ENA) or Disabled (DIS).

When BPVT is enabled in systems with four or less doublers, the response time to an HDSL LOSW is approximately 70 ms, which gives DLC terminals time to react and avoid dropped calls.

In addition, the CRCs in each direction of every HDSL loop of each span are also counted and added in with the BPV count to produce a Total Error Count (TEC) that indicates the integrity of both the T1 and HDSL paths. A TEC in each direction is calculated each second by adding the number of BPVs to the number of HDSL CRCs in that direction. The maximum TEC count is 12000. This TEC number is converted into BPVs at the distant end during the following second at a rate of 1 BPV every 128 T1 bits up to a maximum of 12000 (BER=7.7 x 10^{-3}). This maximum rate is more than adequate since it exceeds the maximum 10^{-3} BER required by most DLC systems. This BPV transparency feature is controlled by the BPVT option which can be Enabled or Disabled (factory default setting). The BPVT option is only available on an HRU-402 or HRU-411. It is suppressed when older HRUs are used with the Line Unit.

The BER option also uses this (BPV/CRC) TEC to generate an Alarm if enabled. The HLU combines the one second TEC counts in both directions for the last 60 seconds. It uses this one minute Total System Error Count (TSEC) to generate an alarm if it exceeds the selected BER threshold setting of 1E-6 or 1E-7 as follows:

- BER option = 1E-6. Alarm is generated if TSEC > 92
- BER option = 1E-7. Alarm is generated if TSEC > 9

Once initiated, the alarm clears when the TSEC drops below its associated threshold count. For dribbling type of errors, the alarm can come and go in intervals as short as one second. Alarms due to bursty impulse noise transients usually require the full 60 seconds or longer to clear depending on the frequency of the transients. This BER option is always present in any Line Unit circuit since it is independent of the versions of the other HiGain modules in the circuit. When connected to an HRU, other than the HLU-402, HLU-406 or HLU-411, only the BVPs detected by the HLU are included in the TBC. The BPVs at the HRU are not counted.

DS0 Blocking Option

To set the DS0 Blocking option from the Main screen:

1 Press C to select the Systems Settings screen (see Figure 8 on page 15).

2 Press O for the DS0 blocking selection. The DS0 channels are blocked or unblocked by entering each channel number. Multiple channels can be selected by inserting a space between each entry.

3 After all the new settings have been made, press E for (Exit) then C to (Confirm). The new choices are now installed.

If DS0 blocking is invoked in a HiGain system that has an earlier version HRU that does not support the blocking option, blocking only occurs at the DS1 output of the HLU-319. The HRU DS1 output will not be blocked. Also, all blocked channels are temporarily unblocked for all HiGain system loopback tests for all DS1 blocking settings. This allows the standard full bandwidth T1 loopback tests to be performed for all DS0 blocking settings.

If a customer of a fractional T1 service fills any of the unused DS0 channels with information other than an idle code of all ones, the HiGain system blocks this information from reaching the remote end of the circuit and replaces those DS0 channels with an all ones idle code.

The result of blocking the idle code is that the CRC checksum delivered to the remote end (when the payload is in the BSF format) 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 should fill the unused time slots 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.

DS1 Line Code Option

The DS1 line code option should always be set to conform to the type of DS1 service (AMI or B8ZS) being provided by the HiGain system. The AUTO mode, which can adapt to either AMI or B8ZS, should only be used in applications that require it (such as when HiGain acts as a standby circuit to DS1 circuits whose line codes are not known or may be both AMI and B8ZS) since it has the following limitation. The AUTO mode induces one BPV in the DS1 bit stream whenever it switches from AMI to B8ZS. The AUTO mode allows both the HLU and the HRU to set its T1 output code to that which is being received at the opposite end's T1 input. This forces the input and the output codes in each direction of transmission to be identical. In the AUTO mode of older HiGain units, the output code was determined by the input code being received at the local T1 input port instead of at the distant end. The HLU reverts to this older code setting technique when it is not connected to an HRU-402 or HRU-411.

Margin Alarm Threshold

To set the Margin Alarm Threshold:

1 Select P from the System Settings Main Menu screen.

2 Enter the desired minimum acceptable alarm threshold from the 0 to 15 dB range. This causes a system alarm to occur if either the margin on HDSL Loop 1 (MAL1) or Loop 2 (MAL2) drops below the selected threshold value.

Since the margin can never drop below 0, choosing 0 for the margin threshold turns the margin alarm off.

HAIS Selections

The HAIS option provides two selections for the T1 transmit outputs at both the HLU-319 and HRU for HDSL loss of sync conditions.

- **1LP** causes the AIS (LOS if ALMP is set to LOS) pattern to be transmitted at both T1 outputs when either of the two HDSL loops experience an out-of-sync (LOSW) condition or when a margin alarm occurs. 1LP causes the 12 channels on the surviving loop to be lost as they are replaced by the AIS/LOS pattern. However, it does notify downstream and upstream equipment of the loss of one HDSL loop or a loop with low margin. This is the preferred setting for initiating an AIS/LOS state with just one conductor open in either of the HDSL pairs. Short loops, below approximately 16 dB of loss at 200 kHz, can remain in sync with one conductor open. Since the loop is still in sync, no LOSW condition occurs. However, the margin on a one-conductor loop drops from 5 to 10 dB. Thus, if the Margin alarm is set to 5 dB below the normal margin at turn-up, when one conductor does open, a system alarm occurs and causes the AIS/LOS condition. This alerts the maintenance personnel of the problem.
- **2LP** requires both HDSL loops to be out of sync (LOSW) before the HAIS signal is transmitted. 2LP preserves the integrity of the 12 surviving channels when just one loop is lost.

HDSL Line Voltage Options

The HDSL Line power feed PWRF option has four settings, DIS, LOW, AUTO and HIGH, as described below.

- **DIS** disables any voltage from being applied to the HDSL cable pairs. It is useful to prevent craft personnel from being exposed to the HDSL line voltage when they are working on the cable pairs.
- **LOW** limits the HDSL simplex voltage to -135 V maximum. This is the standard voltage used in all non-doubler applications and has no effects in these applications. It can be chosen to limit line-powered, single-doubler circuits or locally-powered, two-doubler circuits up to 135 V, if the appropriate HiGain plugs (HDU-409, HDU-404 or HDU-407 and HRU-402 or HRU-411) are used along with the HLU-319. These HiGain units are the only ones that have sufficiently low power consumption to allow their doubler circuits to be line-powered from 140 V. The HRU-411 must have the CPE power option disabled if it is used in a 140 V doubler circuit.
- **AUTO** is the conventional mode in which the HLU automatically maintains the HDSL like voltage at 140 V maximum for non-doubler applications and ± 220 V for doubler applications.
- **HIGH** forces the HDSL line voltage to its high ± 220 V level for applications. It is needed to allow the HLU to power circuits that are providing power to remote Personal Communication Systems (PCS) sites.

If the HLU-319 is used with the HRU-411 to power PCS sites, set the PWRF option to AUTO. The HLU will automatically detect the need to switch to HIGH Power feed, when required by the HRU.

Ground Fault Detect

The HLU-319 has a Ground Fault Detect (GFD) circuit which detects a ground or a resistive path to ground on any wire of any loop of any span with a non-zero voltage. For low (135 V) applications, such a circuit is active during start-up by applying the bipolar voltage to the loops. It deactivates when going to the nominal operation mode of unipolar negative voltage (O V and -135 V). The circuit is constantly active during high (±112 V) applications.

When the circuit is active, the system is compliant with Class A2 requirements of GR-1089. When the circuit is not active, the system is compliant with Class A3 requirements of GR-1089.

Whenever the GFD circuit detects a grounded loop, the line power is immediately removed from the spans and a PWR FEED GND alarm is generated. The power is reapplied 30 seconds later as part of a new start-up procedure. If the ground condition persists on the span, the power is removed when the GFD circuit detects this condition.

The indication of the location of the ground fault can be obtained by monitoring the voltages on the spans on the HLU side as it sequentially powers devices in subsequent spans.

LOOPBACK MENU SCREEN

The Loopback Menu permits you to issue loopbacks to the HiGain system.

Press **D** from the Maintenance Terminal Main Menu to display the Loopback Menu. Figure 9 shows an example of a Loopback Menu when no doublers are present; Figure 10 on page 22 shows an example when four doublers are present.

Loopback Menu for Non-doubler Applications

```
                              LOOPBACK MENU

TIME: 00:15:34
DATE: 04/13/99
CIRCUIT ID#:

                        A. DISABLE LOOPBACKS
                        B. NETWORK LOOP HLU       (NLOC)
                        C. NETWORK LOOP HRU       (NREM)
                        G. CUSTOMER LOOP HLU      (CREM)
                        H. CUSTOMER LOOP HRU      (CLOC)

                               (E)xit
```

Figure 9. *Loopback Menu: No Doubler*

Loopback Menu for Doubler Applications

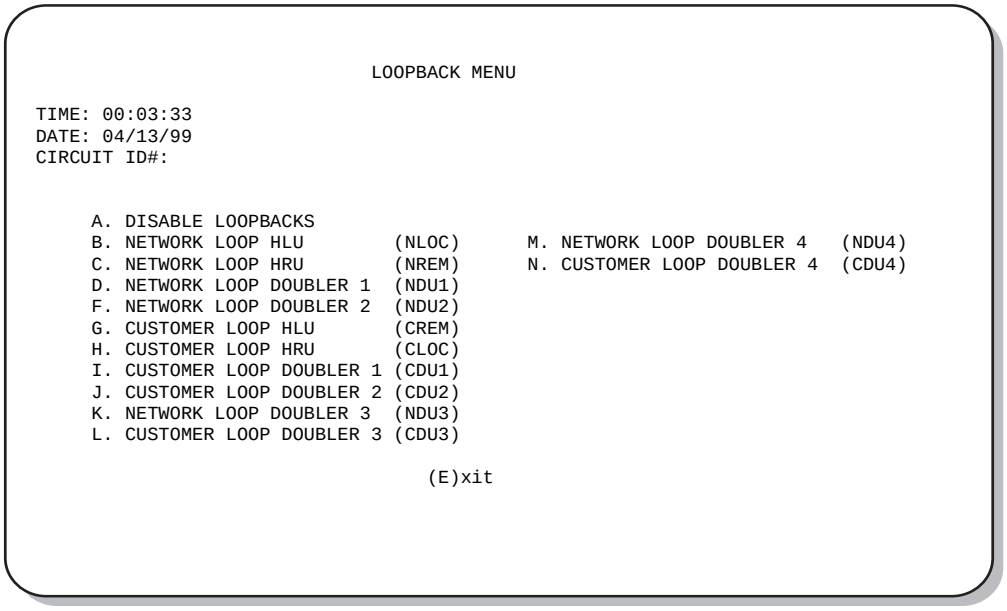


Figure 10. *Loopback Menu: Four Doublers*

Initiating a Loopback

To send one of the available loopbacks, press the appropriate letter in the Loopback Menu. The following prompt appears:

```
PLEASE WAIT.............
```

A series of dots moves from left to right indicating that the command has been issued. When this process completes, the system returns to the Maintenance Terminal Main Menu. The selected loopback four letter designation now appears in the Loopback Mode field in the Maintenance Terminal Main Menu (see Figure 11 in which an NLOC loopback is in progress). The loopback continues to cycle in the system depending upon your Loopback Timeout setting.

The Loopback Menu screen is also available at the HRU connected to the HLU-319, thus allowing all HiGain System loopbacks to be initiated from either end of the circuit.

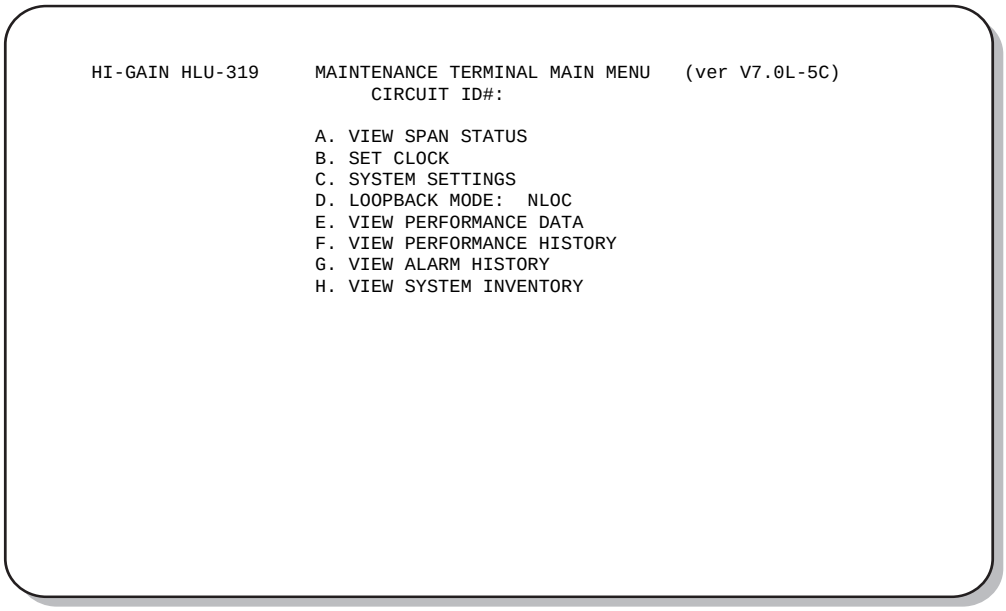


Figure 11. *NLOC Loopback Mode in the Maintenance Terminal Main Menu*

Disable Loopbacks

The Disable Loopbacks option allows you to disable (cancel) any of the loopbacks listed in the screen. To disable loopbacks, press **A** in the Loopback Menu. The following prompt appears:

```
PLEASE WAIT.............
```

A series of dots moves from left to right indicating that the command has been issued. When this process completes, the system returns to the Maintenance Terminal Main Menu in which the Loopback Mode will display as None.

PERFORMANCE DATA SCREENS

The Performance Data screens show the Errored Seconds (ES) and Unavailable Seconds (UAS) for both HDSL loops and each T1 input at 15-minute intervals over a 4-hour time interval. Earlier and later data, in 4-hour time periods on different span screens, can be accessed by pressing P (Previous) or N (Next) respectively. All Performance Data counters can be set to zero by pressing C (Clear) from the HLU-319 Span Status screen.

Errored and Unavailable seconds are defined in Table 7.

Press E at the Maintenance Terminal Main Menu to view the Performance Data screen. From each Performance Data screen you can do the following:

- Press P to view the previous 4-hour data screen.
- Press N to view the next 4-hour data screen.
- Press E to exit.
- Press S to view the next available span, or 1, 2, 3, 4, or 5 to access spans directly (for doubler applications).

Since the HLU-319 is considered the master module, this clears *all* performance data screens at both the HLU-319 and the HRU. The RS-232 interface at the HRU does not allow the counters to be cleared.

Errored and Unavailable seconds are defined in Table 7.

Table 7. *Errored and Unavailable Seconds Definitions*

ES and UAS	Definition
HDSL Errored Second	A second in which at least one HDSL CRC has occurred.
HDSL Unavailable Second	A second in which an HDSL loop has loss from sync at least once.
DS1 Errored Second	A second in which at least one BPV CRC, Frame Error, or LOS has occurred.
DS1 Unavailable Second	A second in which at least one T1 LOS condition (175 ± 75) zeros has occurred.

Performance Data Screen for Non-doubler Applications

```
Date: 04/13/99           PERFORMANCE DATA
CIRCUIT ID#:
                ERRORED SECONDS/UNAVAILABLE SECONDS

              DS1            HDSL-1           HDSL-2
         HLU      HRU     HLU      HRU     HLU      HRU
20:30     /        /       /        /       /        /
20:45     /        /       /        /       /        /
21:00     /        /       /        /       /        /
21:15     /        /       /        /       /        /
21:30     /        /       /        /       /        /
21:45     /        /       /        /       /        /
22:00     /        /       /        /       /        /
22:15     /        /       /        /       /        /
22:30     /        /       /        /       /        /
22:45     /        /       /        /       /        /
23:00     /        /       /        /       /        /
23:15     /        /       /        /       /        /
23:30     /        /       /        /       /        /
23:45     /        /       /        /       /        /
00:00     /        /       /        /       /        /
00:15     /        /       /        /       /        /

                    (E)xit (P)revious (N)ext
```

Figure 12. *Performance Data Screen: No Doublers*

Performance Data Screen for Doubler Applications

The Performance Data Screen displays information by span. With no doubler, there is only one span (Figure 12). With multiple doublers (up to four), there can be as many as five span screens. Figure 13 is an example of a Performance Data screen that lists performance data for the fifth span (Doubler #4 to the HRU).

```
Date: 04/13/99        SPAN 5 PERFORMANCE DATA
CIRCUIT ID#:
                ERRORED SECONDS/UNAVAILABLE SECONDS

              DS1            HDSL-1           HDSL-2
         HLU      HRU     HDU4     HRU     HDU4     HRU
20:30     /        /       /        /       /        /
20:45     /        /       /        /       /        /
21:00     /        /       /        /       /        /
21:15     /        /       /        /       /        /
21:30     /        /       /        /       /        /
21:45     /        /       /        /       /        /
22:00     /        /       /        /       /        /
22:15     /        /       /        /       /        /
22:30     /        /       /        /       /        /
22:45     /        /       /        /       /        /
23:00     /        /       /        /       /        /
23:15     /        /       /        /       /        /
23:30     /        /       /        /       /        /
23:45     /        /       /        /       /        /
00:00     /        /       /        /       /        /
00:15   001/       /    005/415     /    035/492     /

                    (E)xit (P)revious (N)ext (S)pan(1)(2)(3)(4)(5)
```

Figure 13. *Span 5 Performance Data Screen*

VIEW PERFORMANCE HISTORY

The Performance History screen shows the daily occurrences of ES and UAS over a 31-day period. Errored Seconds and Unavailable Seconds for both HDSL loops and each of the two DS1 inputs are listed for the current and previous period. For doubler applications, the available screen (one or more doublers) is dependent upon the span being viewed.

Press **F** from the Maintenance Terminal Main Menu to open the Performance History screen. This screen shows the ES and UAS for the HDSL loop between the HLU-319 and the HRU.

The following options are available:

- Press **S** to view the next available span, or **1**, **2**, **3**, **4**, or **5** to access spans directly (for doubler applications).
- Press **E** to exit from the Performance History screen.
- Press **N** (Next) for a continued history.
- Press **P** for the previous screen.

The counters on all History screens can be set to zero by pressing **C** (Clear), while in the View Span Status menu.

Performance History for Non-doubler Applications

Figure 14 displays a 31-day history for non-doubler applications.

```
Time: 00:26:29                    PERFORMANCE HISTORY—31 DAY
CIRCUIT ID#:
                          ERRORED SECONDS/UNAVAILABLE SECONDS

                 DS1                      HDSL-1                   HDSL-2
            HLU          HRU          HDU4         HRU          HDU4         HRU
03/17        /            /            /            /            /            /
03/18        /            /            /            /            /            /
03/19        /            /            /            /            /            /
03/20        /            /            /            /            /            /
03/21        /            /            /            /            /            /
03/22        /            /            /            /            /            /
03/23        /            /            /            /            /            /
03/24        /            /            /            /            /            /
03/25        /            /            /            /            /            /
03/26        /            /            /            /            /            /
03/27        /            /            /            /            /            /
03/28        /            /            /            /            /            /
03/29   00001/            /      00005/00415        /      00035/00492        /
03/30        /            /            /            /            /            /
03/31   00001/      00002/00002 00004/00014 00006/      00003/00013 00007/00001
current 00001/            /      00005/00415        /      00035/00492        /

                                    (E)xit (P)revious
```

Figure 14. *Performance History Screen: No Doubler*

Performance History for Doubler Applications

The Performance History screen displays information by span when doublers are used. With multiple doublers (up to four), there can be as many as five span screens.

Figure 15 lists data for the fifth span (Doubler #4 to the HRU).

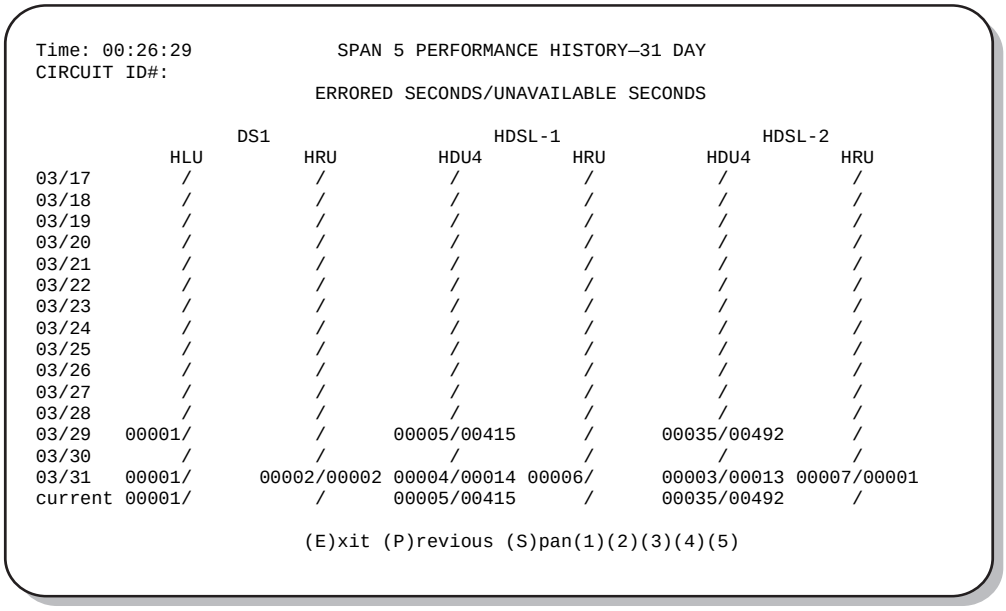


Figure 15. *Performance History Screen: Four Doublers (Span 5)*

VIEW ALARM HISTORY SCREENS

The View Alarm History screen allows you to view alarms that are currently active. The following explains some features of the View Alarm History screen:

- First and Last columns contain the time and date stamp of the first and last occurrence of each alarm.
- Current column shows the status of each alarm.
- Count column lists the number of times each alarm occurred.
- maximum non-overflowing count is 999.

From each Alarm History screen you can do the following:

- Press **U** to update the screen.
- Press **S** to view another span (for doubler applications).
- Press **C** to clear all data from the screen.
- Press **E** to exit from the Alarm History screen.

Table 8 lists the Alarm History fields and descriptions. These descriptions apply to the Alarm History for doubler applications as well.

Table 8. *Alarm History Fields and Descriptions*

Field	Description
Type	Identifies the type of alarm.
LOS, DS1-HLU	First and last instance of LOS at the HLU; Current condition, number of alarms.
LOS, DS1-HRU	First and last instance of LOS at the HRU; Current condition, number of alarms.
BER	First and last instance of a BER at the HRU; Current condition, number of alarms.
Span 1 LOSW, HDSL1	First and last instance of LOSW on HDSL1; Current condition, number of alarms.
Span 1 LOSW, HDSL2	First and last instance of LOSW on HDSL2; Current condition, number of alarms.
Span 1 Margin L1	First and last instance of exceeded margin on Loop 1; Current condition, number of alarms.
Span 1 Margin L2	First and last instance of exceeded margin on Loop 2; Current condition, number of alarms.
PWR-SHRT	Power short condition; Current condition, number of alarms.
PWR-GND	Power ground condition; Current condition, number of alarms.
Last Cleared: None	Last time Alarm History cleared; Current condition, number of alarms.

Alarm History Screen for Non-doubler Applications

Press **G** from the Maintenance Terminal Main Menu to view the Alarm History screen for an application without a doubler (Figure 16).

```
                                ALARM HISTORY

TIME: 00:17:18
DATE: 04/13/99
CIRCUIT ID#:

Type              First              Last              Current       Count
LOS, DS1-HLU                                           OK            000
LOS, DS1-HRU                                           OK            000
BER                                                    OK            000
SPAN1 LOSW, HDSL1                                      OK            000
SPAN1 LOSW, HDSL2                                      OK            000
SPAN1 MARGIN L1                                        OK            000
SPAN1 MARGIN L2                                        OK            000
PWR-SHRT                                               OK            000
PWR-GND                                                OK

                              (E)xit (C)lear (U)pdate
```

Figure 16. *Alarm History Screen: No Doubler*

Alarm History Screen for Doubler Applications

The Alarm History screen displays information by span. With no doubler, there is only one span (Figure 16). With multiple doublers (up to four), there can be as many as five span screens.

1 Press **H** from the Maintenance Terminal Main Menu to view the Alarm History screen.

2 Press **S** from the Alarm History screen to advance through the alarm history screens for the various spans.

Figure 17 is an example of an Alarm History screen that lists history for the fifth span (Doubler #4 to the HRU).

```
                                ALARM HISTORY

TIME: 03:49:13
DATE: 04/13/99
CIRCUIT ID#: HLU

Type              First               Last               Current        Count
LOS, DS1-HLU                                             OK             000
LOS, DS1-HRU                                             OK             000
BER                                                      OK             000
SPAN5 LOSW, HDSL1                                        OK             000
SPAN5 LOSW, HDSL2                                        OK             000
SPAN5 MARGIN L1   04/13/99-03:48      04/13/99-03:48     OK             001
SPAN5 MARGIN L2   04/13/99-03:48      04/13/99-03:48     OK             001
PWR-SHRT                                                 OK             000
PWR-GND                                                  OK             000

LAST CLEARED:  04/13/99-03:45


                        (E)xit (C)lear (U)pdate (S)pan(1)(2)(3)(4)(5)
```

Figure 17. *Alarm History Screen for Span 5*

SYSTEM INVENTORY SCREEN

The System Inventory screen lists the six possible units that can comprise one HiGain circuit: one HLU, one HRU and up to four doublers. The information in the System Inventory Screen is presented as follows:

- All six possible unit modules are always listed. The doublers are shown as: DB1, DB2, DB3, DB4.
- The model number, list number and software revision number of every unit that is present in the circuit is listed in the Product column. Units that are not detected are not considered to be present in the circuit and are labeled N/A.
- Each of the unit IDs is limited to 24-character alpha-numeric characters. To change an ID, select its line identifying letter. The IDs, like the system settings, are stored in NVRAM and thus remain when power is lost.
- The HLU has no unit ID number since it is usually identified by the Circuit ID number, which appears in every screen.
- All detected modules have the product number listed. Whenever the HLU-319 loses sync with Span 1, the product types are replaced by the N/A label until sync is reestablished and each module can in turn be reidentified. Only the Circuit ID appears in the other HLU-319 Terminal Maintenance screens.

Press **H** from the Main Menu to display the System Inventory screen (Figure 18).

```
                          SYSTEM INVENTORY
TIME: 18:16:37
DATE: 04/13/99               A. CIRCUIT ID#:


        UNIT       PRODUCT          UNIT ID

        HLU   HLU-319 L5C  V7.0     NOT REQUIRED
     B. HRU   HRU-402 L1   V1.0     CUSTOMER PLUG
     C. DB1   N/A
     D. DB2   N/A
     F. DB3   N/A
     G. DB4   N/A


Enter the item letter to change the ID, or (E)xit
```

Figure 18. *System Inventory Screen*

To set a Circuit ID, press **ENTER** after selecting the set of alpha-numeric ID characters. Choose **C** to confirm. If more than 24 characters are entered, a warning beep is emitted and only the first 24 characters are accepted.

On initial turn-up, the Circuit and Unit IDs are set to blanks. However, executing the default option from the or System Settings screen has no effect on the ID values.

TROUBLESHOOTING

SYSTEM ALARMS

Table 9 lists possible HLU-319 alarm states. More than one alarm condition can exist at any given time, but only one message can be displayed. For multiple alarms, only the highest priority alarm displays.

Table 9. *HDSL System Alarms*

System Alarm	Alarm	Description	To inhibit:
ALRM LOSW	Loss of Sync Word[(a)]	One of the HDSL loops has lost synchronization.	Cannot be inhibited.
ALRM LLOS	Local Loss of Signal	Loss of the DSX-1 input signal.	Cannot be inhibited.
ALRM RLOS	Remote Loss of Signal	Loss of the HRU DS1 input signal.	Disable the RDA (Remote DS1 Alarm) option. This prevents an LOS condition at the DS1 input to a HRU from activating Pin H. The front panel Status LED still flashes red to alert you of the LOS state. LOS is sent towards the network from the HLU. This option prevents the common occurrences of a CPE LOS condition from generating recurring alarms and AIS payloads.
ALRM MAL1 or ALRM MAL2	Margin Alarm Loop1 or Margin Alarm Loop2	The margin on HDSL Loop 1 or Loop 2 has dropped below the minimum threshold value set by the terminal MARGIN ALARM THRES.	Set the Margin Alarm Threshold option to 0 (zero).
ALRM BER	Bit Error Rate exceeded	The combined T1 and HDSL BER has exceeded you set threshold limits of 10^{-6} or 10^{-7}.	Select NONE for the BER system option.
NONE	No Alarm	No alarm is indicated.	Cannot be inhibited.

(a) When both HDSL loops lose sync word (LOSW), a system alarm condition exists. However, since the HLU-319 enters a self test cycling mode, the front panel LED lights yellow instead of red.

To improve HiGain compatibility with the switch-to-protect features used in DLC feeder applications, the HLU-319 has an Alarm Pattern Option (ALMP) that allows you to select either an AIS or LOS T1 output payload for the following alarms:

- LOSW on any loop
- T1 LOS
- Margin alarm if HAIS = l Loop

LOOPBACK OPERATION

HiGain has a family of loopback options. The most important of these is the SmartJack (SMJK) loopback, which enables an HRU response to the standard (2/3-in-5) SMJK in-band loopback codes in emulation of standard Network Interface Device (NID) functions. This option can be enabled or disabled from the System Settings screen.

Generic Loopback Code (GNLB)

The HiGain generic loopback code is GNLB. The GNLB allows in-band codes to loop-up either the HLU/NLOC (4-in-7) or HRU/NREM (3-in-7) towards the network. In addition, it allows in-band codes to loop-up the HLU/CREM (6-in-7) or HRU/CLOC (5-in-7) towards the customer. Either loop-up condition is terminated (looped-down) with the 3-in-5, loop-down code. Both in-band codes must be present for 5 seconds before the HiGain system responds. See “GNLB Loopback Test Procedures” on page 36 for the test procedures that apply when using the GNLB mode.

The A1LB loopback selection, Table 5, complies with that proposed for HDSL systems in the T1E1.4/92 recommendation with the following additions:

- Query loopback
- IOR (Intelligent Office Repeater) power-down
- Three loopback time-out choices
- Initiation from either end
- Repeating bit error signatures
- Alternate query loopback

These additions make A1LB identical to A2LB described below. It is given a separate identity to allow future T1E1 enhancements to be added without affecting A2LB.

Addressable Repeater Loopback Functions

In addition to the SMJK loopback, a HiGain system can be configured for one of five special in-band loopback (SPLB) command sequences. These are selected from the SPLB user option shown in Table 6 on page 16. Non-doubler and doubler loopback locations are shown in Figure 19 on page 35.

A2LB through A5LB are four special, addressable, repeater loopback functions which are supported by the HLU-319. These loopbacks provide the HiGain system with sophisticated maintenance and trouble shooting tools. A2LB and A5LB are patterned after the Teltrend addressable T1 repeater loopbacks. A3LB and A4LB are patterned after the Wescom addressable T1 repeater loopbacks. All four SPLBs have been enhanced to handle the specific requirements of the following HiGain system customers:

- A1LB (Teltrend) = Southwestern Bell
- A2LB (Teltrend) = Southwestern Bell
- A3LB (Wescom) = New England Telephone
- A4LB (Wescom Mod 1) = New York Telephone
- A5LB (Teltrend Mod 1) = Southern New England Telephone (SNET)

A5LB differs from A2LB in that A5LB does not block the arming code from exiting the HLU-319 into the network. A2LB can be configured to either block this arming code after two seconds, and replace it with the AIS code, or to unblock it by executing the FAR-END ACTIVATE code. Since A5LB never blocks the arming code from exiting the Line Unit, it does not need this FAR-END ACTIVATE code. A3LB differs from A4LB in that A3LB supports the additional (1 in 6) SMJK loopback command.

A HiGain system may take longer than normal to respond to in-band loopback commands when its framing mode is set to UNFR and the in-band commands are set in either an SF or ESF mode. The frame bits override the command bits and cause errors in the command sequence. These errors cause the HiGain system to reject some sequences. This can extend the detection interval.

Loopback Test Procedures

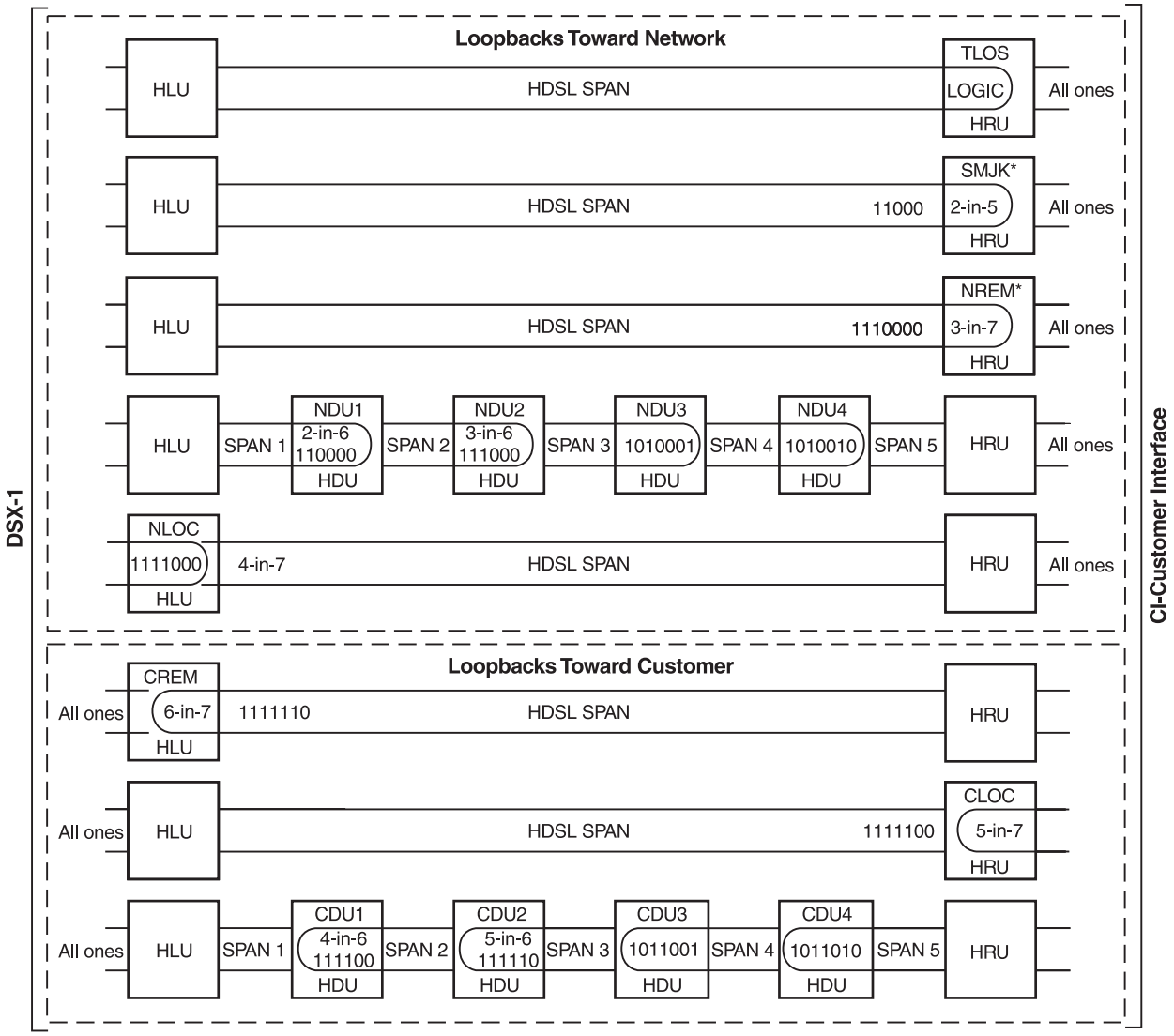
The following sections provide step-by-step test procedures for the HLU-319 as a function of the loopback option selected. These procedures allow verification of the integrity of the HDSL channels at every module location as well as the DS1 channels to the customer and the local DSX-1 interface.

If trouble is encountered on the HLU-319 DSX-1 interface, verify that the HLU is making a positive connection with its mounting assembly (shelf) connector. Also, verify that the HLU internal equalizer is set to the correct distance range per Table 6 on page 16. All equalizers should be set to the distance from the DSX-1 to the shelf.

The transmit and receive T1 DSX-1 ports have splitting access jacks and miniature, 210-series, bridging jacks as shown in Figure 1 on page 4. Connecting one cable between the two bridging jacks and another between the two SPAN jacks splits the XMT and RCV and creates metallic loopbacks towards both the DSX-1 and the HLU-319. If separate plugs are inserted into both SPAN jacks with the other end disconnected, the BRG jacks can be used to send and receive test patterns towards the DSX-1.

Loopback Operation

The complete family of loopbacks that a HiGain system equipped with the HDU-409 can execute is shown in Figure 19. Eight of those loopbacks, NDU1, NDU2, NDU3, NDU4; CDU1, CDU2, CDU3, CDU4 occur in the doubler. The loopbacks cab be initiated from the HiGain Management Unit (HMU-319) through TAO craft screens or TL-1 commands, or from a family of Special Loopback (SPLP) in-band loopback commands.



* Set the SAIS option to ENA to send the AIS (all ones) pattern to the CI during SmartJack loopback, NREM, and TLOS. Use the 3-in-5 code to loop down.

Figure 19. *Doubler Loopback Configurations*

The more common generic, SPLB in-band loopback commands for doubler loopbacks are listed in Table 10. The commands are very specific combinations of either 6 or 7 bits that continuously repeat. All NXXX loopbacks are towards the network. All CXXX loopbacks are towards the customer.

Table 10. *SPLB Loopback Command Set*

Loopback	Command
NDU1	1 1 0 0 0 0 (2-in-6)
NDU2	1 1 1 0 0 0 (3-in-6)
NDU3	1 0 1 0 0 0 1
NDU4	1 0 1 0 0 1 0
CDU1	1 1 1 1 0 0 (4-in-6)
CDU2	1 1 1 1 1 0 (5-in-6)
CDU3	1 0 1 1 0 0 1
CDU4	1 0 1 1 0 1 0

GNLB Loopback Test Procedures

To perform the GNLB loopback test procedure:

1 Have the CO tester send the HRU (3-in-7) in-band loopup code for 5 seconds. (Loopback states are indicated by the green LOOP LED on the front panel and also display in the Span Status screen.)

2 Have the CO tester transmit a T1 test signal into the HLU-319 and verify that the returned (looped) signal is error-free.

3 If step 2 fails, have the CO tester transmit the (3-in-5) in-band loopdown code.

4 Have the CO tester send the HLU-319 (4-in-7) in-band loopup for 5 seconds. You should be able to see that an NLOC HLU-319 loopback is in effect. (Loopback states are indicated by the green LOOP LED on the front panel and also display in the Span Status screen.)

5 Repeat Step 2. If the test passes, the problem is in the downstream direction. If it fails, the problem is in the upstream direction.

Notes on Non-doubler GNLB Loopback Test Procedures:

- The HLU-319 can be looped up from the remote location (CREM) by issuing the (6-in-7) command at the HRU DS1 input port.
- The HRU can be looped up from the remote location (CLOC) by issuing the (5-in-7) command at the HRU DS1 input port.

Notes on Doubler GNLB Loopback Test Procedures:

- Doubler #1 can engage loopback from the remote location (CDU1) by issuing the (4-in-6) loopback command at the HRU DS1 input port.
- Doubler #1 can engage loopback from the local location (NDU1) by issuing the (2-in-6) loopback command at the HLU-319 DS1 input port.
- Doubler #2 can engage loopback from the remote location (CDU2) by issuing the (5-in-6) loopback command at the HRU DS1 input port.
- Doubler #2 can engage loopback from the local location (NDU2) by issuing the (3-in-6) loopback command at the HLU-319 DS1 input port.
- Doubler #3 can engage loopback from the remote location (CDU3) by issuing the 1 0 1 1 0 0 1 command at the HRU DS1 input port (only supported by HRU-402, 406 and 411).
- Doubler #3 can engage loopback from the local location (NDU3) by issuing the l 0 1 0 0 0 1 loopback command at the HRU-231 List 8 DS1 input port.
- Doubler #4 can engage loopback form the remote location (CDU4) by issuing the 1 0 1 1 0 1 0 loopback command at the HRU DS1 input port (only supported by HRU-402, 406 and 411).
- Doubler #4 can engage loopback from the local location (NDU4) by issuing the 1 0 1 0 0 1 0 loopback command at the HLU-319 DS1 input port.

A1LB, A2LB, and A5LB Test Procedures

To perform the HLU A1LB, A2LB, and the A5LB test procedures:

1 Send into the HLU-319 the in-band ARMING and NI LPBK code 11000 for at least 5 seconds.

2 Monitor the output of the HLU-319 for the return of the pattern. Return of the pattern indicates one of the following:

- the HRU has looped up (if the SMJK Loopback option is Enabled).
- an external NI has looped up (if the SMJK Loopback option is Disabled) and that the HLU-319 and HRU units have been ARMED.

3 Verify, if possible, that the HRU Loopback LED is either flashing, indicating that the HRU is armed, or lights steadily, indicating that it is both armed and in loopback.

4 Once armed, the HLU-319 can be looped back by sending Intelligent Office Repeater (IOR) LPBK activation code 1101 0011 1101 0011 (D3D3) for at least 5 seconds. The tester observes, the following activation response, in the order presented:

a 2 seconds of AIS (all ones)

b 2 seconds of returning data pattern

c 231 logic errors (including the frame bit) occurring in the returned pattern comprising:

- 10 errors, if ILR-1 (Doubler 1) was sent
- 200 errors, if ILR-20 (Doubler 2) was sent
- 20 errors, if ILR-2 (HRU) was sent

d normal looped data

This error pattern repeats every 20 seconds as long as the IOR loopback pattern is being sent. This also applies to ILR, Time-out Override, and Query commands.

Some Intelligent Repeater (IR) test sets do not count frame errors as bit errors when the test pattern is framed and the HLU-319 is set to the AUTO framing mode. To improve compatibility with those test sets, the HLU-319 generates 201 (NDU2) and 232 (NLOC) ID bit errors. As a result, the HLU-319 may indicate one more or one less bit error, depending on the test set type and the number of frame bits contained in the block of errored bits. To avoid this uncertainty, PairGain recommends sending the IR commands unframed.

The HLU-319 is now in Logic Loopback. The Loopback Time-out option is user settable to:

- NONE (0 minutes)
- 20 minutes
- 60 minutes
- 120 minutes

These selections determine the duration of this loopback unless it is overridden by the Time-out Override command or a loop-down command is sent. If the Time-out Override code 1101 0101 1101 0110 (D5D6) is received, the activation sequence described in step 4, above, is repeated and the automatic timed expiration of the loopback is inhibited. If this Time-out Override is sent, then the only way to loop the HLU-319 down is to:

- issue the IR (Intelligent Repeater) LPDN (loop-down) code 1001 0011 1001 0011 (9393) *or*
- issue the NI LPDN and Disarm code 11100.

The automatic time-out timer is restored during subsequent loopback sessions.

5 Once the test is complete, do one of the following:

- If the system is to loopdown but remain ARMED, send the IR (Intelligent Repeater) LPDN code (universal loopdown).
- If all the equipment is to be looped down, disarmed and returned to normal operation, send the disarm code 11100.

The ARMED mode has an automatic time-out of 120 minutes but this timer is reset to 120 for any of the following events:

- **Loopback terminates (manually or time-out),**
- **Query**
- **Alternate query**
- **Far end activate**
- **Another ARM command.**

Using the codes listed in Table 11 on page 39, a network tester can activate loopbacks NLOC or NREM or SMJK (if enabled). A customer tester can activate loopbacks CLOC or CREM.

Information specific to HiGain doublers is shown in bold in Table 11.

Table 11. *Addressable 1, 2, 5 (A1LB, A2LB, A5LB) Repeater Loopback Commands[a]*

Name	Description	Code
ARMING or NI LPBK (in-band)	Arming code	11000 11000 …
ARMING or NI LPBK (ESF Data Link)	Arming code	1111(F)[b] 1111(F)0100(4)1000(8)
IR LPDN or DISARM (in-band)	Disarming code	11100 11100 …
DISARM (ESF Data Link)	Disarming code	1111(F)1111(F)0010(2)0100(4)
IOR LPBK (NLOC 230-232 bit errors) (CREM 229-231 bit errors)[c]	HLU Loopup	1101(D)0011(3)1101(D)0011(3) 1100C)0111(7)0100(4)0010(2)
ILR-1 LPBK (NDU1 and CDU1 10 bit errors)[d]	**DOUBLER-1 Loop up**	**1100(C)0111(7)0100(4)0001(1)**
LR-20 LPBK (NDU2 and CDU2 200 bit errors)	**DOUBLER-2 Loop up**	**1100(C)0111(7)0101(5)0100(4)**
ILR-3 LPBK (NDU3 and CDU3 30 bit errors)	**DOUBLER-3 Loop up**	**1100(C)0111(7)0100(4)0011(3)**
ILR-2 LPBK (NREM and CLOC 20 bit errors)	**HRU Loop up**	**1100(C)0111(7)0100(4)0010(2)**
ILR-4 LPBK (NDU4 and CDU4 40 bit errors)	**DOUBLER-4 Loop up**	**1100(C)0111(7)0100(4)0100(4)**
IR LPDN	Loopdown (HLU or HRU)	1001(9)0011(3)1001(9)0011(3)
IR QUERY LPBK	Query loopback	1101(D)0101(5)1101(D)0101(5)
IR ALTERNATE QUERY LPBK	Alternate Query loopback	1101(D)0101(5)1110(E)1010(A)
TIME-OUT OVERRIDE	Loopback Time-out Override	1101(D)0101(5)1101(D)0110(6)
FAR END NI ACTIVATE[e]	Unblock AIS and pass 2-in-5	1100(C)0101(5)0101(5)0100(4)
IOR POWER DOWN (HLU)	Removes HDSL line power	0110(6)0111(7)0110(6)0111(7)

(a) The left most bit arrives first in all sequences. The detection algorithm functions reliably with a random 10^{-3} Bit Error Ratio (BER) on the facility. The IOR POWER DOWN code must remain present for the duration of the power down mode. When this code is removed, the HiGain system returns to its normal unlooped and unarmed state. Note that the entire arming and loopback sequence can be initiated at the remote HRU location.
(b) This is the HEX number for the 4-bit group.
(c) The HRU identifies CREM with 231 bit errors, including the frame bits. When framed data is being sent in the AUTO framing mode, the number of the 231 bit errors detected by the test set varies from 229 to 231, depending on whether or not the test set counts frame errors as bit errors, and on the number of frame bits contained in the block of 231 error bits.
(d) The HRU generates this bit pattern in a series of discontinuous bursts containing 20-bit errors each, including frame bits. Those test sets that do not count frame error bits as data bit errors will indicate fewer bits than the HRU transmits for this CI loopback.
(e) Not supported by A5LB.

A3LB and A4LB Test Procedures

The HLU-319 can be looped back by sending the Addressable Office Repeater (AOR) LPBK activation code 1111(F) 1111(F) 0001(1) 1110(E) for at least 5 seconds. This causes the HLU-319 to enter the NLOC state. The Loopback Time-out option can be set by the user to:

- NONE (0 minutes)
- 20 minutes
- 60 minutes
- 120 minutes

These selections determine the duration of this loopback, unless it is overridden by the reception of a second identical 16-bit loop-up command before the timer expires. When this time-out override state exists, the only way to loop the HLU-319 down is to issue one of the three loopdown commands listed in Step 2. The automatic time-out mode is restored during subsequent loopback sessions.

Table 12 summarizes the codes required to execute Addressable 3 and 4 (A3LB and A4LB) repeater loopback commands. All code sequences must be present for at least 5 seconds. The abbreviations used in Table 12 are as follows:

- LU = LoopUp
- LD = LoopDown
- NI = Network Interface
- CI = Customer Interface
- ESF-DL = Extended Superframe Data Link

Information specific to HiGain doublers is shown in bold in Table 12.

Table 12. *Addressable 3 and 4 (A3LB and A4LB) Repeater Loopback Commands[a]*

Position	Name	Code
HLU-319 LU FROM NI	NLOC	1111(F)[b] 1111(F)0001(1)1110(E)
HLU-319 LU from CI	CREM	0011(3)1111(F)0001(1)1110(E)
HDU DOUBLER 1 FROM NI	**NDU1**	**1111(F)1111(F)0000(0)1000(4)**
HDU DOUBLER 1 FROM CI	**CDU1**	**0011(3)1111(F)0000(0)0100(4)**
HDU DOUBLER 2 FROM NI	**NDU2**	**1111(F)1111(F)0000(0)0110(6)**
HDU DOUBLER 2 FROM CI	**CDU2**	**0011(3)1111(F)0000(0)0110(6)**
HDU DOUBLER 3 FROM NI	**NDU3**	**1111(F)1111(F)0000(0)1000(8)**
HDU DOUBLER 3 FROM CI	**CDU3**	**0011(3)1111(F)0000(0)1000(8)**
HDU DOUBLER 4 FROM NI	**NDU4**	**0011(3)1111(F)0000(0)1010(A)**
HDU DOUBLER 4 FROM CI	**CDU4**	**0011(3)1111(F)0000(0)1010(A)**
HRU LU FROM NI	NREM	1111(F)1111(F)0000(0)0010(2)
HRU LU FROM CI	CLOC	0011(3)1111(F)0000(0)0010(2)
HRU LU FROM NI	SMJK	11000 11000 11000 …
HRU LU FROM NI[c]	SMJK	100000 100000 100000 …
HRU LU FROM NI (ESF-DL)	SMJK	1111(F)1111(F)0100(4)1000(8)
HLU and HRU LD FROM NI OR CI	Loopdown	11100 11100 11100 …
HLU and HRU LD FROM NI OR CI	Loopdown	100 100 100 …
HLU and HRU LD FROM NI OR CI (ESF-DL)	Loopdown	1111(F)1111(F)0010(2)0100(4)

(a) The left-most bit arrives first in all sequences. The detection algorithm functions reliably with a random 10^{-3} Bit Error Ratio (BER) on the facility. The entire arming and loopback sequence can be initiated at the remote HRU location.
(b) This is the HEX number for the 4-bit group.
(c) Not supported by A4LB.

APPENDIX A - SPECIFICATIONS

HDSL

Line Code	784 kbps 2B1Q
Output	+13.5 dBm ±0.5 dB at 135 Ω
Line Impedance	135 Ω
Span Voltage	-135 V to ± 220 Vdc
Start-up Time (per span)	30 sec. (typical), 60 sec. (maximum) per span

DS1

Line impedance	100 Ω
Pulse output	6 V^{pk-pk} pre-equalized for 0-655 feet of ABAM cable
Input level sensitivity	+1.5 to -7.5 dBDSX
Line rate	1.544 Mbps ±200 bps
Line format	AMI, B8ZS or ZBTSI
Frame format	ESF, SF or UNFR

Line Clock Rate

Internal “Stratum 4” clock

One-way DS1 Delay

<200 µs per span without doublers. Doubler delay <80 µs

Maximum Provisioning Loss

35 dB @ 196 kHz, 135 Ω

Heat Dissipation

5 W (without doubler), 7 W (with doubler) typical

Fusing

Internal; connected to “FUSE ALARM” output on pin 10

Wander and Jitter

Wander (looped)	0.3 UI maximum (1 UI = 648 ns)
WB Jitter (looped)	0.2 UI maximum
NB Jitter (looped)	0.1 UI maximum

Mounting

STS high density slot

Electrical Protection

Secondary surge and power cross protection on all HDSL ports. Requires external primary protection.

Environmental

Operating Temperature	-40 °F to +149 °F (-40 °C to +65 °C)
Operating Humidity	5% to 95% (non-condensing)

Dimensions and Weight

Height	4.75 in. (12.1 cm)
Width	0.625 in. (1.59 cm)
Depth	10 in. (25.4 cm)
Weight	8 oz.

HDSL INSERTION LOSS GUIDELINES

Each loop has no more than 35 dB of loss at 196 kHz, with driving and terminating impedances of 135 Ω. Table 13 provides a "loss" guide for the various cable gauges at 196 kHz and 135 Ω. The table applies to the HDSL cable pairs between the HLU, HRU, and HDU modules. In the absence of specific insertion loss measurement data, add 3 dB for each bridged tap and 1 dB for each cable gauge change.

Table 13. *HDSL Loss Over Cables*

Cable Gauge (AWG/mm)	Loop Loss at 196 kHz (dB/kft)	Loop Resistance (Ω per kft)
26 /0.4	3.88	83
24 /0.51	2.84	52
22 /0.61	2.18	32
19 /0.91	1.54	16

POWER CONSUMPTION

Power Consumption without Doublers

The three most important power parameters of an HLU are its maximum power consumption, its maximum power dissipation and its maximum current drain. The three parameters are listed in Table 14 as a function of the HRU model and its CPE power option setting.

Table 14 covers line-powered circuits on 9 kft, 26 AWG loops without a doubler.

Table 14. *Power Parameters: No Doubler*

HRU Model No.	HRU CPE Power	42.5 V Power Consumption (Watts)		Heat Dissipation (Watts)		42.5 V Current (mA)	
		Typical	Maximum	Typical	Maximum	Typical	Maximum
HRU-412 List 1, 2, 3, 4	ON	12.0	13.2	5.1	5.6	284	312
HRU-412 List 1, 2, 3, 4	OFF	11.0	12.1	5.0	5.5	260	286
HRU-412 List 6, 7, 8	ON	12.6	13.9	5.2	5.7	297	327
HRU-412 List 6, 7, 8	OFF	9.7	10.7	4.5	4.9	228	251
HRU-402	N/A	7.7	8.5	4.5	4.9	182	200
HRU-411[(a)]	ON	21.0	23.1	6.3	6.9	495	544
HRU-411	OFF	8.2	9.0	5.2	5.7	193	212

(a) HLU-319 PWRF option set to HIGH.

Power Consumption with Doublers

Table 15 through Table 21 list the power consumed and dissipated by the HLU-319 when it is used with any of the four basic doubler types in the HiGain family. The maximum current drawn by the CO supply is also listed.

Table 15 covers single doubler, line-powered circuits on 9 kft, 26 AWG loops.

Table 15. *Power Parameters: Single Doubler with HDU-451 List 1 or 2*

HRU Model No.	HRU CPE Power	42.5 V Power Consumption (Watts)		Heat Dissipation (Watts)		42.5 V Current (mA)	
		Typical	Maximum	Typical	Maximum	Typical	Maximum
HRU-412 List 1, 2, 3, 4	ON	27.5	30.3	7.6	8.4	646	711
HRU-412 List 1, 2, 3, 4	OFF	25.9	28.5	7.2	7.9	610	671
HRU-412 List 6, 7, 8	ON	27.7	30.5	7.6	8.4	651	716
HRU-412 List 6, 7, 8	OFF	24.3	26.7	7.1	7.8	571	628
HRU-402	N/A (OFF)	21	23.1	6.3	6.9	494	543
HRU-411	OFF	20	22.0	6.2	6.8	471	518

Table 16 covers single doubler, line-powered circuits on 9 kft, 26 AWG loops.

Table 16. *Power Parameters: Single Doubler with HDU-439 or HDU-437 Lists 1 and 1B*

HRU Model No.	HRU CPE Power	42.5 V Power Consumption (Watts)		Heat Dissipation (Watts)		42.5 V Current (mA)	
		Typical	Maximum	Typical	Maximum	Typical	Maximum
HRU-412 List 1, 2, 3, 4	ON	22.3	24.5	7.9	8.6	525	578
HRU-412 List 1, 2, 3, 4	OFF	21.4	23.5	7.8	8.5	502	552
HRU-412 List 6, 7, 8	ON	22.3	24.5	8.0	8.8	524	576
HRU-412 List 6, 7, 8	OFF	19.2	21.1	7.3	8.1	452	497
HRU-402	N/A (OFF)	16.0	17.6	6.7	7.4	376	414
HRU-411	OFF	15.6	17.2	6.7	7.4	367	404

Table 17 covers single doubler, line-powered circuits on 9 kft, 26 AWG loops.

Table 17. *Power Parameters: Single Doubler with HDU-409 List 2*

HRU Model No.	HRU CPE Power	42.5 V Power Consumption (Watts)		Heat Dissipation (Watts)		42.5 V Current (mA)	
		Typical	Maximum	Typical	Maximum	Typical	Maximum
HRU-412 List 1, 2, 3, 4	ON	18.8	20.7	7.0	7.7	442	486
HRU-412 List 1, 2, 3, 4	OFF	18.0	19.8	7.1	7.8	424	466
HRU-412 List 6, 7, 8	ON	18.4	20.2	6.9	7.6	433	476
HRU-412 List 6, 7, 8	OFF	15.7	17.3	6.8	7.4	370	407
HRU-402	N/A (OFF)	12.5	13.8	5.9	6.5	294	323
HRU-411	OFF	12.0	13.2	5.8	6.4	283	311

Table 18 applies to two doubler, line-powered circuits on 9 kft, 26 AWG loops.

Table 18. *Power Parameters: Two Doublers with HDU-451 List 3, 4, 3B or 4B*

HRU Model No.	HRU CPE Power	42.5 V Power Consumption (Watts)		Heat Dissipation (Watts)		42.5 V Current (mA)	
		Typical	Maximum	Typical	Maximum	Typical	Maximum
HRU-402	N/A (OFF)	28.3	31.1	8.3	9.1	665	732
HRU-411	OFF	28.1	30.9	8.2	9.0	661	727

Table 19 covers two doubler, line-powered circuits on 9 kft, 26 AWG loops.

Table 19. *Power Parameters: Two Doublers with HDU-439 or HDU-437 Lists 1 and 1B*

HRU Model No.	HRU CPE Power	42.5 V Power Consumption (Watts)		Heat Dissipation (Watts)		42.5 V Current (mA)	
		Typical	Maximum	Typical	Maximum	Typical	Maximum
HRU-412 List 1, 2, 3, 4	OFF	30.3	33.3	8.0	8.8	713	784
HRU-412 List 6, 7, 8	OFF	28.1	30.9	7.7	8.5	660	726
HRU-402	N/A (OFF)	24.8	27.3	7.2	7.9	584	642
HRU-411	OFF	27.7	30.5	7.5	8.3	652	717

Table 20 applies to two doubler, line-powered circuits on 9 kft, 26 AWG Loops.

Table 20. *Power Parameters: Two Doublers with HDU-409 List 2*

HRU Model No.	HRU CPE Power	42.5 V Power Consumption (Watts)		Heat Dissipation (Watts)		42.5 V Current (mA)	
		Typical	Maximum	Typical	Maximum	Typical	Maximum
HRU-412 List 1, 2, 3,4	ON	24.4	26.8	7.2	7.9	575	633
HRU-412 List 1, 2, 3,4	OFF	22.1	24.3	6.8	7.5	520	572
HRU-412 List 6, 7, 8	ON	25.9	28.5	7.4	8.1	609	670
HRU-412 List 6, 7, 8	OFF	20.2	22.2	6.4	7.0	476	524
HRU-402	N/A (OFF)	17.4	19.1	7.1	7.8	410	451
HRU-411	OFF	16.5	18.2	6.0	6.6	389	428

Table 21 applies to three doubler, line-powered circuits or four doubler, locally-powered circuits on 9 kft, 26 AWG loops.

Table 21. *Power Parameters: Three and Four Doublers with HDU-409 List 2*

HRU Model No.	HRU CPE Power	42.5 V Power Consumption (Watts)		Heat Dissipation (Watts)		42.5 V Current (mA)	
		Typical	Maximum	Typical	Maximum	Typical	Maximum
HRU-402, 3-doubler, line-powered	N/A (OFF)	22.9	25.2	8.1	8.9	539	593
HRU-402, 4-doubler, local power	N/A (OFF)	23.7	26.1	8.0	8.8	557	613

MAXIMUM POWER DISSIPATION

The Maximum Power Dissipation measures the power that is converted into heat that builds up within the unit. It contributes to the total heat generated in the space around the unit. It is used to determine the maximum number of fully loaded shelves per bay that does not exceed the maximum allowable power dissipation density in watts per square foot to comply with GR-63.

In COs, the maximum power dissipation for open-faced, natural convection-cooled mountings is limited to 134.7 watts per square foot per GR-63-CORE. The footprint of a standard 28-slot, 23-inch HLU-319 shelf is 7.024 square feet. Thus, the maximum bay dissipation is limited to 946 watts. Use this limit and the parameters in Table 14 through Table 21 to determine the maximum number of HLU circuits that can occupy one CO bay.

This is a worst case situation since it assumes the entire CO is subjected to the maximum power density. More favorable conditions would permit increasing the number of shelves per bay without jeopardizing the CO thermal integrity.

The thermal loading limitations imposed when using the HLU in a Controlled Environmental Vault (CEV) or other enclosures are determined by applying its power parameters to the manufacturer's requirements for each specific housing.

The 42.5 V Power Consumption is the maximum total power that the HLU-319 consumes or draws from the shelf power source. This parameter is needed when the HLU-319 is in a location remote to the CO it is serving. It determines the battery capacity required to maintain an 8-hour, stand-by battery reserve for emergency situations. Battery capacity, therefore, limits the maximum number of line units that can be installed in a remote enclosure. Use the data in Table 14 through Table 21 to perform this analysis on a case by case basis.

MAXIMUM CURRENT DRAIN

The Maximum Current Drain is the maximum current drawn from the shelf power supply when its at its minimum voltage (-42.5 V). This determines the shelf fusing requirements. Use the 42.5 V current data in Table 14 through Table 21 to determine the shelf fusing requirements for your particular HLU applications.

HLU-319 CARD CONNECTOR

Figure 20 shows the card-edge connectors on the HLU-319. Active pins are highlighted in black.

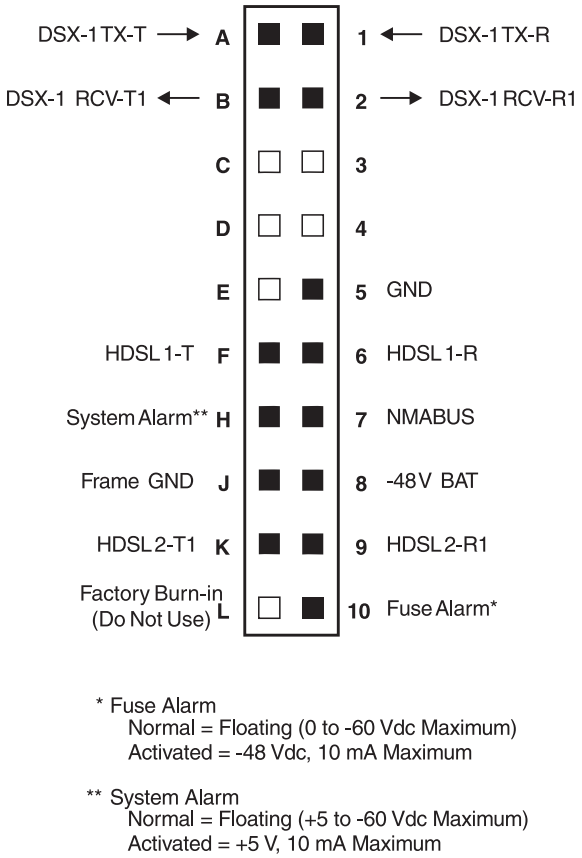


Figure 20. *HLU-319 Card-Edge Connector*

Network Management Control Bus

The HLU-319 provides a Network Management Control Bus on pin 7 of the card-edge connector. This allows the various PairGain Management System protocols to manage the HLU through the HMU-319 HiGain Management Unit.

Some HLU-319 features are affected when it is under management. Consult the management unit practice for further information.

Fuse Alarm

Pin 10 on the card-edge connector is a Fuse Alarm that is driven to -48 V whenever its onboard fuse opens. It emulates the function of the Fuse Alarm output from pin 10 on normal, high-density (HD) repeaters. Pin 10 is connected to pin 5 of the 1184 Alarm Card (slot 1 in the HD shelf) and causes the 1184 Fuse ALM LED to light when the pin 10 signal is activated. Its normally floating output must never be driven above ground or below -80 V. It can sink a current of 10 mA. The HLU-319 does not support the BPV function (Pin E) of normal HD repeaters.

System Alarm Output Pin

Pin H on the card-edge connector (see Figure 20) is the HLU-319 System Alarm output pin. The following notes apply to Pin H:

- Pin H replaces the Local Loss of Signal (LLOS) on normal high-density (3192) repeaters.
- The normally floating output of Pin H can connect to pin 1 of the 1184 or 3192-9F Alarm Card in position 29 of the High Density (HD) shelf.
- The HLU-319 forces pin H to +5 V (maximum of 10 mA) for a system alarm condition. Pin H then remains at +5 V for the duration of the alarm condition.
- If the Wescom 1184 Alarm Card is installed in the shelf, its LOS LED lights for every MNRALM.
- The HLU-319 Status LED flashes red for the duration of a system alarm condition.
- Setting the Alarm option to Disabled only prevents the system alarm bus on Pin H from being activated for a system alarm event. The STATUS LED still flashes red.

Pin H must never be taken above +5 V or below -60 V.

APPENDIX B - FUNCTIONAL OPERATION

FUNCTIONAL DESCRIPTION

PairGain HDSL technology provides full-duplex services at standard T1 rates over copper wires between an HLU and an HRU, that comprises one HiGain system. HiGain systems use PairGain 2-Binary 1-Quartenary (2B1Q) HDSL transceiver systems to establish two, full-duplex, 784 kbps data channels between the HLU-319 and a remotely located HDU or HRU. This provides a total capacity of 1.568 Mbps between the two units.

A block diagram of the HLU-319 is shown in Figure 21. The HLU-319 receives a 1.544 Mbps DSX-1 data stream from the DSX-1 digital cross connect interface. The HLU-319 contains a DS1 frame synchronizer controlled by an 8-bit microprocessor that determines the type of framing on the DS1 stream and synchronizes to it. The HLU-319 recognizes Superframe (SF), including D4, or Extended Superframe (ESF) framing. When the data is unframed, the HLU-319 arbitrarily defines a frame bit.

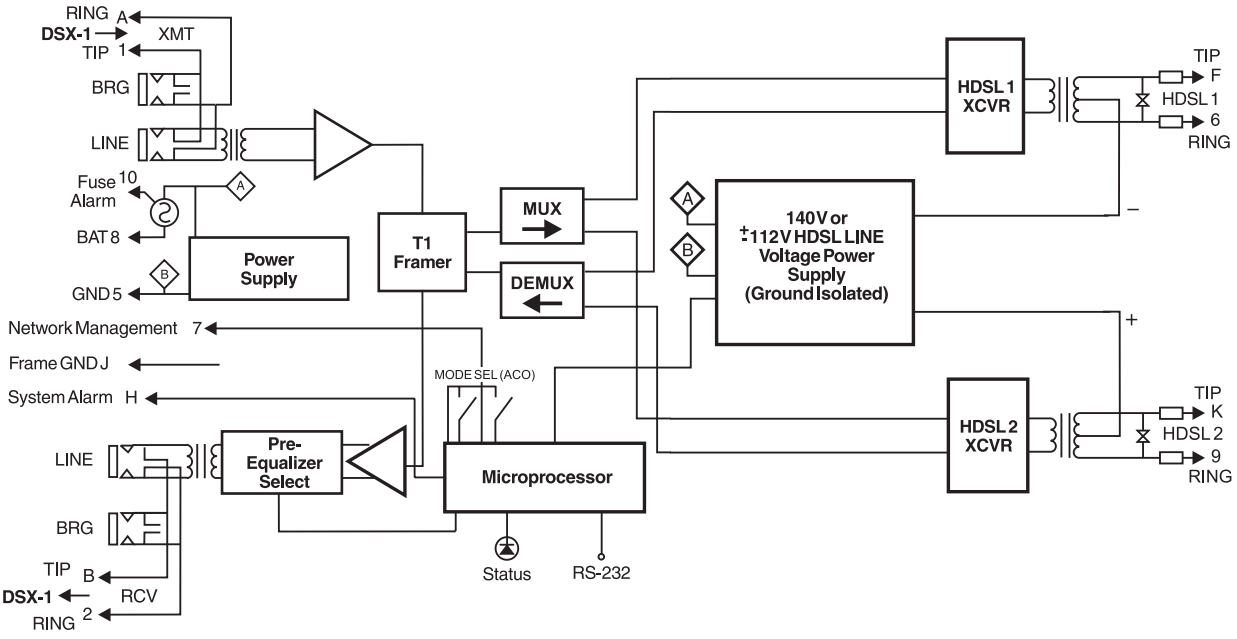


Figure 21. *HLU-319 Block Diagram*

TIMING

The low loop wander (0.3 UI max) of an HLU-319, when used with compatible doublers (HDU-409, HDU-404 or HDU-407) and remote units (HRU-402 or HRU-411), allows the circuit to be used in all critical timing applications, including those that are used to transport Stratum 1 timing.

APPENDIX C - COMPATIBILITY

The HLU-319 is compatible with the following T1 repeater shelves and associated equipment:

- PairGain HMS-317(28-slot, 23-inch shelf)
- PairGain HHS-319 (3-slot, 19-inch horizontal shelf)
- PairGain HMS-308 (8-slot, 3192 mechanics, remote enclosure)
- Charles Ind. #3192 (28-slot connectorized)
- Charles Ind. #3192-9F Alarm Card
- Larus #1185 (28-slot connectorized)
- Larus #1184 Alarm Card
- Charles Ind. #3192-WR (28-slot wire wrap)
- Charles Ind. #343-00 (12 to 14-slot wire wrap)
- Charles Ind. #319-02 (22-slot connectorized)
- Charles Ind. #319-04 (22-slot wire wrap)
- Charles Ind. #340-00 (9 to 11-slot wire wrap)

The Charles Ind. 343-00 and 340-00 shelves do not support the HLU-319 System Alarm output on pin H. Also, if slots 1 and 2 of these shelves were wired for the 3408 Fault Locate unit, they must be rewired to accept the HLU-319.

All generations of HiGain HLU and HRU modules are compatible with each other. Although all HiGain doublers are backward-compatible with all prior HLU and HRU models, some of the circuit application enhancements of newer doubler models require that all circuit modules be of the same vintage in order to realize these enhancements. Enhanced doubler applications preclude the mixing of newer doubler models with older models of the HRU and HLU.

Table 22 on page 52 provides a matrix of HiGain doubler deployment rules to achieve maximum circuit enhancement. It lists:

- Maximum number of doublers allowed for a given circuit, depending upon the doubler and line unit models used to implement the circuit.
- Any restrictions on the HRU models.

All spans are fully CSA-compliant unless otherwise specified. Circuits that use more than one type of doubler are governed by the most limiting doubler rules. For example, if the HDU-451 is used with the HDU-409, use the HDU-451 deployment rules.

Table 22. *HiGain Doubler Deployment Matrix*

	Maximum Number of Doublers Per Circuit[a]											
	HDU-451, List 3, 3B, 4, 4B				**HDU-437, 439**				**HDU-404, 407, 409**			
	Line Powered		*Local Powered*		*Line Powered*		*Local Powered*		*Line Powered*		*Local Powered*	
HLU Model	CPEI ON	CPEI OFF	CPEI ON	CPEI OFF	CPEI ON	CPEI OFF	CPEI ON	CPEI OFF	CPEI ON	CPEI OFF	CPEI ON	CPEI OFF
HLU-231 List 6D; HLU-231 List 2D; HLU-388 List 2D	1	1	2	2	1	1	2	2	1	2	2	2
HLU-231, List 7D & 7B; HLU-431, List 1D	1	1	2	2	1	2[b]	2	2	1	2	2	2
HLU-231, List 8X; HLU-231, List 5X; HLU-388 List L5X	1	2[d]	2	2	1	2	2	2	2	3[c]	2	4[d]

(a) HRU-411 applications with CPEI "on" are limited to single doubler circuits (HDU-404, HDU-407 or HDU-409). The HRU-412, HDU-451, HDU-437 and HDU-439 are limited to applications with one and two doublers only.
(b) 2000 Ω maximum loop resistance. Requires HRU-412, List 7A, L8A or HRU-402 or HRU-411.
(c) Requires HRU-402 or 411.
(d) Requires HRU-402.

APPENDIX D - PRODUCT SUPPORT

PairGain customer service group provides expert pre-sales and post-sales support for all its products.

PairGain Technical Assistance is available 24 hours a day, 7 days a week by contacting PairGain Customer Service Engineering group at:

Telephone: (800) 638-0031 or (714) 832-9922

Fax: (714) 832-9924

During normal business hours (8:00 AM to 5:00 PM, Pacific Time, Monday through Friday, excluding holidays), technical assistance calls are normally answered directly by a Customer Service Engineer. At other times, a request for technical assistance is handled by an on-duty Customer Service Engineer through a callback process. This process normally results in a callback within 30 minutes of initiating the request.

In addition, PairGain maintains a computer bulletin board system for obtaining current information on PairGain products, product troubleshooting tips and aids, accessing helpful utilities, and for posting requests or questions. This system is available 24-hours a day by calling (714) 730-2800. Transmission speeds up to 28.8 kbps are supported with a character format of 8-N-1.

BBS

In addition, PairGain maintains an on-line Bulletin Board System (BBS) for obtaining current information on PairGain products, product troubleshooting tips and aids, helpful utilities, and for posting requests or questions. This system is available 24-hours a day by calling (714) 730-2800. You can access the BBS if you have a Hayes-compatible modem with a 2400 to 28,800 baud rate. The following setup format is required: 8 Data Bits, No Parity, 1 Stop Bit.

WORLD WIDE WEB

PairGain product and company information can be found at http://www.pairgain.com using any Web browser.

DOCUMENTATION

The complete HLU-319 List 5C techncial practice can be download from the PairGain Technical Publications Web page at: www.pairgain.com. A password is required. If you do not have a password, contact your PairGain sales representative.

If you have any comments on any PairGain documentation, send email to technical_publications@pairgain.com. Type the product name and the section number of the document in the subject area of the email message.

RETURNS

To return equipment to PairGain:

1 Locate the number of the purchase order under which the equipment was purchased. You will need to provide this number to PairGain Customer Service to obtain a return authorization.

2 Call or write PairGain Customer Service to ask for a Return Material Authorization (RMA) number and any additional instructions. Use the telephone or fax number listed below:

- Telephone: (800) 370-9670
- Fax: (714) 730-2961

3 Include the following information, in writing, along with the equipment you are returning:

- company name, address, and the name of a person PairGain can contact regarding this equipment
- purchase order number provided to Customer Service when the RMA number was requested
- description of the equipment, as well as the number of units that you are returning (be sure to include the model and part number of each unit)
- shipping address to which PairGain should return the repaired equipment
- reason for the return, for example:

  equipment needs an ECO/ECN upgrade

  equipment is defective

If the equipment is defective, please tell us what you observed just before the equipment malfunctioned. Be as detailed in your description as possible.

4 Pack the equipment in a shipping carton.

5 Write PairGain's address and the Return Material Authorization number you received from Customer Service clearly on the outside of the carton:

PairGain Technologies, Inc.
14352 Franklin Ave.
Tustin, CA 92780-7013

Attention: **CRF RMA (Number)**

FCC and warranty information can be found on the inside back cover of this manual.

APPENDIX E - GLOSSARY

2B1Q	2 Binary,1 Quaternary
ACO	Alarm Cut Off
AIS	Alarm Indicator Signal
ALMP	Alarm Pattern
AMI	Alternate Mark Inversion
AWG	American Wire Gauge
B8ZS	Bipolar with 8-zero Substitution
BBS	Bulletin Board System
BER	Bit Error Rate
BPV	Bipolar Violation
BPVT	Bipolar Violation Transparency
BRG	Bridge
CI	Customer Installation
CLEI	Common Language Equipment Identifier
CLOC	Customer Local Loopback
CO	Central Office
CPE	Customer Premises Equipment
CRC	Cyclic Redundancy Check
CREM	Customer Remote Loopback
CSA	Carrier Service Area
DDS	Digital Data Service
DIS	Disabled
DLC	Digital Loop Carrier
DS1	Digital Signal, Level 1
DSX-1	DS1 Cross-connect Frame
ECI	Equipment Catalog Item
ENA	Enabled
ES	Errored Seconds
ESF	Extended SuperFrame
HCDS	High Capacity Digital Service
HDSL	High-bit-rate Digital Subscriber Line
HDU	HiGain Doubler Unit
HLU	HiGain Line Unit
HMS	HiGain Management Shelf
HMU	HiGain Management Unit
HRU	HiGain Remote Unit
I-CPE	Interface-Customer Premises Equipment
IOR	Intelligent Office Repeater
LED	Light Emitting Diode
LOS	Loss of Signal
LOSW	Loss of Sync Word
NEC	National Electric Code
NI	Network Interface
NID	Network Interface Device
NLOC	Network Local Loopback
NMA	Network Management and Administration
NREM	Network Remote Loopback
NVRAM	Non-Volatile Random Access Memory
PCS	Personal Communication Services
PL	Payload
POTS	Plain Old Telephone Service
PWRF	Power Feed
RCV	Receive
RDA	Remote DS1 Alarm
RLOS	Remote Loss of Signal
RMA	Return Material Authorization
SAIS	SmartJack AIS
SF	Super Frame

SNR	Signal-to-Noise Ratio
SPLB	Special Loopback
TEC	Total Error Count
TSEC	Total System Error Count
UAS	Unavailable Seconds
XMT	Transmit

CERTIFICATION AND WARRANTY

FCC COMPLIANCE

This unit complies with the limits for Class A digital devices pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, can cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Refer to the installation section of this manual for guidance on:

- Cabling
- Correct connections
- Grounding

UL COMPLIANCE

The HLU-319 List 5C is listed with the Underwriters Laboratories and meets all applicable Canadian safety standards of the CUL mark.

LIMITED WARRANTY

PairGain Technologies warrants this product to be free of defects and to be fully functional for a period of 60 months from the date of original shipment, given correct customer installation and regular maintenance. PairGain will repair or replace at Pairgain's option any unit without cost during this period if the unit is found to be defective for any reason other than abuse or incorrect use or installation.

Do not try to repair the unit. If it fails, replace it with another unit and return the faulty unit to PairGain for repair. Any modifications of the unit by anyone other than an authorized PairGain representative voids the warranty.

If a unit needs repair, call PairGain for a Return Material Authorization (RMA) number and return the defective unit, freight prepaid, along with a brief description of the problem, to:

PairGain Technologies, Inc.
14352 Franklin Avenue
Tustin, CA 92780
ATTN: Repair and Return Dept.
(800) 638-0031

PairGain continues to repair faulty modules beyond the warranty program at a nominal charge. Contact your PairGain sales representative for details and pricing.

MODIFICATIONS

Any changes or modifications made to this device that are not expressly approved by PairGain Technologies, Inc. may void the user's warranty.

All wiring external to the products should follow the provisions of the current edition of the National Electrical Code.

STANDARDS COMPLIANCE

The HLU-319 List 5C has been tested and verified to comply with the applicable sections of the following standards.

- GR 63-CORE - Network Equipment-Building System (NEBS) Requirements
- GR 1089-CORE - Electromagnetic Compatibility and Electrical Safety

Corporate Office

14402 Franklin Avenue
Tustin, CA 92780

Tel: (714) 832-9922
Fax: (714) 832-9924

For Technical Assistance:

(800) 638-0031

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Certificated Firm