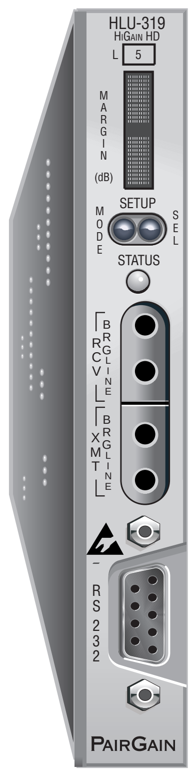
HIGAIN LINE UNIT

Model	List Number	Part Number	CLEI Code
HLU-319	5	150-1140-05	T1L2B20AAA



PAIRGAIN TECHNOLOGIES, INC.
ENGINEERING SERVICES TECHNICAL PRACTICE

SECTION 150-319-105-03

PAIRGAIN

Revision History of This Practice

Revision	Release Date	Revisions Made
01	May 6, 1998	Initial release
02	June 1, 1998	Modified alarm diagnostics; miscellaneous edits
03	April 21, 1999	Additional diagnostic commands

USING THIS TECHNICAL PRACTICE

The following conventions are used in this manual:

- `Monospace type` indicates screen text, including text you type at a screen prompt.
- Keys you press are indicated by small icons such as ENTER. Key combinations to be pressed simultaneously are indicated with a plus sign as follows: CTRL + ESC.
- Two types of messages, identified by icons, appear in text.

Notes contain information about special circumstances.

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

For a list of abbreviations used in this document, refer to "Appendix E - Glossary" on page 60.

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 located on the inside back cover. If you must store the equipment for a prolonged period, store the equipment in its original container.

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OVERVIEW

The PairGain® HiGain® HLU-319 List 5 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. The CSA includes loops up to 12,000 feet of 24 AWG or 9,000 feet of 26 AWG wire, including bridged taps. This line unit can be used with HiGain Doubler Units (HDUs) to extend reach.

FEATURES

Product Enhancements

In addition to standard HLU capabilities, the HLU-319 List 5 features:

- 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
- Grounded loop detection on High-bit-rate Digital Subscriber Line (HDSL)
- Bipolar Violation Transparency (BPVT) options
- Bit Error Rate (BER) alarm options
- HRU Loopback screen
- Inventory Screen (displays Circuit ID and model number)
- Loss of Signal/Alarm Indicator Signal (LOS/AIS) payload alarm option
- Remote Loss of Signal (RLOS) disable alarm option
- 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
- Front panel features:
  - Four-character status display
  - DS1 splitting and bridge access
  - Status LED
  - RS-232 craft port for connection to a maintenance terminal
- 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

The HLU-319 List 5 is designed to mount in 3192 mechanics shelves. For a list of compatible shelves see "Appendix C - Compatibility" on page 56.

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 "HiGain Doubler Circuit Deployment" on page 56.

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.

In general, HiGain systems:

- 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.

HiGain Doubler Applications

For applications without doublers, the HLU-319 is directly connected to the HRU by the two HDSL cable pairs. The HLU-319 List 5 is compatible with all HiGain HRUs.

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

- The HLU-319 List 5 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 compatibility guidelines on mixing newer doublers with older HRU and HLU models, refer to **"HiGain Doubler Circuit Deployment" on page 56.**

For additional information about associated HiGain equipment, refer to the respective HiGain technical practice (see **"Appendix D - Service and Support" on page 58.)**

Personal Communications System Applications

The HLU-319 List 5 is required for Personal Communications System (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 HLU recognizes the HRU-411 (if 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 56.**

FRONT PANEL

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

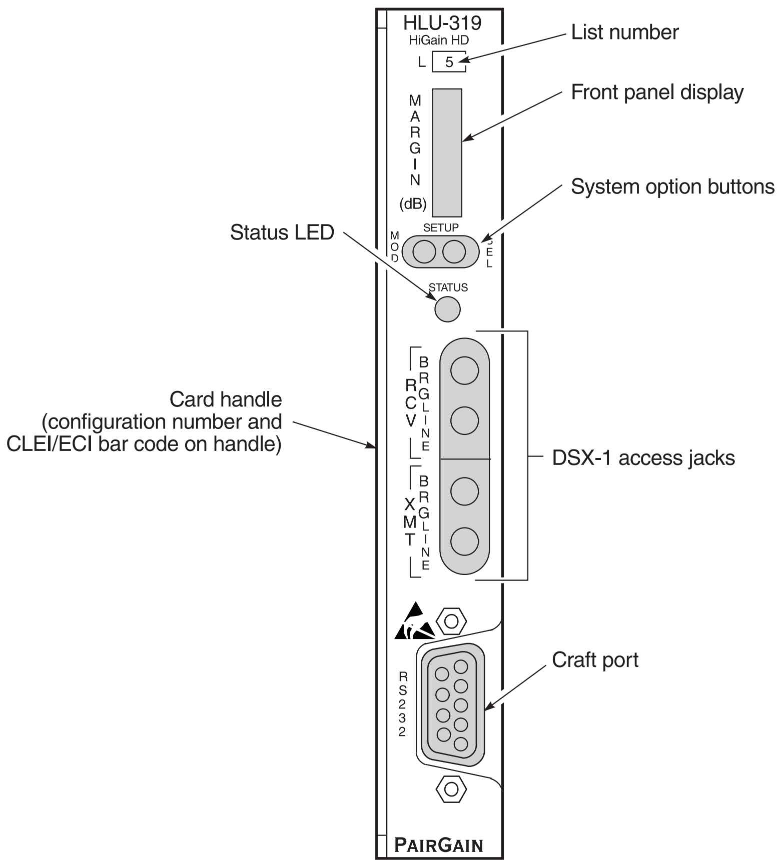


Figure 1. *HLU-319 List 5 Front Panel*

Table 1. *Front Panel Description*

Front Panel Feature	Function
Front panel display	Displays four-character status, provisioning, and alarm system messages. The front panel display illuminates when power is initially applied. To conserve power the display only remains on for 4 minutes. Using the MODE or SEL buttons reactivates the display and restarts the 4-minute timer. Refer to Table 2 on page 6 for a listing of the four-character messages.
System option buttons (MODE and SEL)	Permits the user options to be monitored and modified without the need of a maintenance terminal. Used to initiate all HiGain loopbacks and to display DSX-1 line parameters and line unit identity.
Status LED	The status LED can report the following conditions:
Green	Normal operation
Flashing green	HDSL acquisition
Red	Fuse Alarm
Flashing red	System alarm
Yellow	Self Test is in process or an HLU-319 List 8 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	
LINE	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.
BRG	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.
Craft (RS-232) port	Provides bidirectional communication between the unit and an external terminal to allow configuration and performance monitoring through the Maintenance Terminal screens.
List number	Identifies the version of the HLU-319.
CLEI and ECI bar code label	Provides the human-readable Common Language Equipment Identifier (CLEI) code number and the Equipment Catalog Item (ECI) bar code number.
Configuration Number	Contains either a five or six-digit warranty configuration number or a stand-alone two or three-digit configuration number as follows: Digit 1 - Last digit of shipment year Digit 2 and 3 - Shipment month Digits 4, 5, and 6 - 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.

Table 2. *Front Panel Display Messages*

Message	Full Name	Description
ALARM MESSAGES		
ACO	Alarm CutOff	A system alarm has occurred, and has been retired to an ACO condition by pressing the SEL button on the HLU front panel.
ALRM	Alarm Condition Exists	A system alarm condition is in effect.
BER	Bit Error Rate	A system BER alarm is in effect.
LLOS	Local Loss of Signal	Indicates that no signal is detected at the T1 input to the HLU. Causes a system alarm.
LOSW	Loss of Sync Word	Indicates that one of the HDSL loops has lost sync. Causes a system alarm.
MAL1(2)	Margin Alarm Loop 1 or 2	The margin on HDSL Loop 1 (2) has dropped below the threshold (1 to 15 dB) as set by the operator.
RLOS	Remote Loss of Signal	Indicates that no signal is detected at the T1 input to the HRU. Causes a system alarm.
LOOPBACK MESSAGES		
ARM	HiGain System ARMED	Armed to respond to Intelligent Repeater Loop Codes.
CD*n*?	Customer Doubler n Loopback	Query to initiate loopback at doubler *n* to CI, where *n* is the number of the doubler.
CLOC	Customer Local Loopback	Signal from Customer is looped back to the customer at the HRU.
CREM	Customer Remote Loopback	Signal from customer is looped back to the customer at HLU-319.
ND*n*?	Network Doubler n Loopback	Query to initiate loopback at doubler *n* to network, where *n* is the number of the doubler.
NLOC	Network Local Loopback	DSX-1 signal is looped back to DSX-1 at HLU.
NREM	Network Remote Loopback	DS1 signal is looped back to DS1 at the HRU.
SMJK	Remote SmartJack Loopback	Signal from DS1 is looped back at the HRU by the HRU SmartJack module.
TLOS	Transmit Loss Of Signal	HRU is in a logic loopback state caused by a loss of its T1 input from the CI, if enabled at the HRU by its TLOS switch option.
DIAGNOSTIC MESSAGES		
1=xx or 2=yy	HDSL Loop Margins	Indicates the power of the received HDSL signal on each loop relative to noise. Any value of 06 or greater is adequate for reliable system operation.
ACQ 1 or 2	Acquisition 1 or Acquisition 2	The multiplexers of the HLU and HRU or first doubler are trying to establish synchronization over Loops 1 or 2 of Span 1.
A*n*L1 or 2	Acquisition *n* Loop 1or 2	The multiplexers of the first doubler and either the HRU or second doubler are trying to establish synchronization with each other on Loops 1 or 2 of Span *n*, where *n* is the number of the span.
BAD RT?	No response from HRU	The HLU does not receive any response from the HRU. Thus, the integrity of the HRU or the two HDSL loops (they may be open) is questionable.
CODE	Line Code: AMI, B8ZS, AUTO	The line code that HLU-319 is receiving at its DSX-1 interface, if the DS1 option is set to Auto. Otherwise, it mimics either of the other two DS1 line code settings, Alternate Mark Inversion (AMI) or Bipolar with 8-zero Substitution (B8ZS). Displayed during System Settings review mode.
DS0	DS0 Blocked Channels	Indicates status of DS0 blocked channels. NONE indicates no channels are blocked. BLK indicates some channels are blocked.

Table 2. Front Panel Display Messages (Cont.)

Message	Full Name	Description
FERR	Framing Bit Error Occurred	Framing bit error occurred at HLU T1 input.
FRM	Frame: SF, ESF, UNFR, NONE	Defines the type of frame pattern being received from the DSX-1. Displayed during System Settings review mode.
H1(2)ES	HDSL CRC Error Channel 1 or 2	HLU HDSL Loop 1 or Loop 2 CRC error.
xHDU	Number of Doublers	This message indicates the number of doublers in the circuit.
INSL, then xxDB	Maximum Insertion Loss	The Maximum Insertion Loss message (INSL) appears followed by xxDB, where xx is the maximum insertion in dB of all spans and loops.
LBPV	Local Bipolar Violation	A bipolar violation has been received at the T1 input to the HLU-319.
LIST xxxx	HLU-319 list number	The software list number appears during the System Settings review mode. Press the MODE button for 3 seconds to display the list number.
MNGD	Managed	The HLU-319 is under control of the HMU-319 Network management unit. In this state, the front panel craft port and push buttons are disabled.
PWR FEED GND	Power Feed Ground	One of the HDSL loops has been grounded.
PWR FEED ON	Power Feed On	Indicates that the HDSL loops are not grounded or shorted.
PWR FEED OFF	Power Feed Off	HDSL span power has been turned off by setting the PWFD option to DIS, or HDSL span power has been turned off by use of the A1LB/A2LB/A5LB Intelligent Office Repeater (IOR) Power Down code.
PWR FEED SHRT	Power Feed Short	Indicates a short between the two HDSL pairs. This same message can occur with an HRU that is drawing the correct amount of power over good cable pairs but cannot communicate with the HLU.
SELF TEST	Self Test	The HLU is in a self-test mode. This occurs every power On/Off cycle.
SIG 1 or 2	Signal 1 or Signal 2	The transceivers of the HLU, HRU or first doubler are trying to establish contact with each other on Loop 1 or Loop 2 of Span 1.
S*n*L1 or 2	Signal *n* Loop 1 or Loop 2	The transceivers of the first doubler and either the HRU or second doubler are trying to establish contact with each other on Loop 1 or Loop 2 of Span *n*.
VER xxxx	HLU-319 software version number	The software version number appears during the System Settings review mode. Press the MODE button for 3 seconds to display the software version.

INSTALLATION

Upon receipt of the equipment, 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 Technologies.

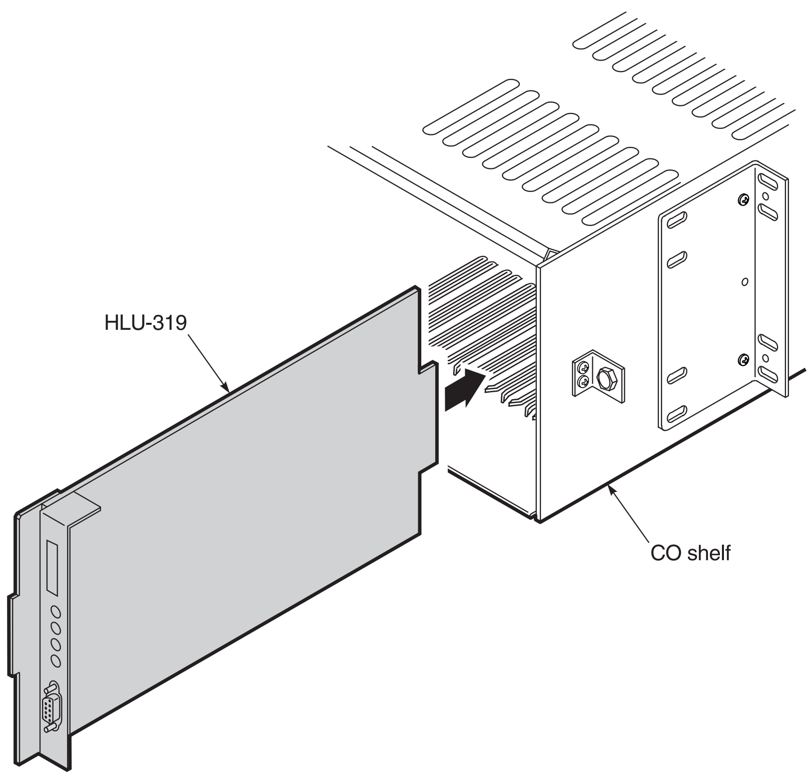


Figure 2. *Installing the HLU-319 into a Shelf*

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

1. Slide the HLU-319 into the card guides for the desired slot, then push the unit in until it touches the backplane card-edge connector.
2. Place your thumbs on the HLU-319 front panel and push the HLU into the card guides until properly seated.

VERIFICATION

Once the HLU-319 is installed, verify that it is operating properly. To do this, you need to monitor the following:

- Status LED
- Status messages reported by the front panel display (see Table 2 on page 6)

Verification without a Downstream Device

If there is no downstream device installed:

1 Verify that the HLU powers up. (The front panel display illuminates and reports various status messages. See Table 2 on page 6 for a list of messages.)

2 Verify that the HLU attempts to communicate with downstream devices. Even if a downstream device is not present, the following events should occur:

a The front panel display reports various four-character status messages.

b The HLU enters self-test mode (Status LED is yellow).

c Self-test completes (Status LED is a steady green).

d The HLU again attempts communication with downstream devices, repeating events a through c until a downstream device is detected.

Verification with a Downstream Device

If a downstream device has been installed:

1 Verify the HLU powers up. (The four-character display illuminates and reports various status messages.)

2 Verify the HLU attempts to communicate with downstream devices (status LED flashes green). One of the following occurs:

- If downstream devices are successfully identified and the HDSL loops synchronize, the HLU status LED will be a steady green. The HLU reports normal margin messages on the front panel display.
- If downstream devices are not successfully identified, the HLU reports four-character status messages and enters self-test mode. The HLU successively:

a enters self-test mode

b completes self-test mode

c attempts communication again

d reports four-character status messages.

The HLU repeats this cycle until a downstream device is detected.

3 If there is more than one span, verify that each subsequent span synchronizes normally by monitoring the display messages.

4 If a remote unit is installed, verify that the last span synchronizes normally. The HLU status LED should be a steady green, and the display reports normal margin messages.

5 Verify that a valid T1 signal has been applied to the HLU and the HRU.

- If no T1 signal is being applied to either the HLU or the HRU inputs, then the appropriate T1 alarms (LLOS or RLOS) are observed on the four-character display and the status LED flashes red.
- If a valid T1 signal is being supplied to the HLU and HRU, then T1 alarm indications should be absent and the status LED should be a steady green.

PROVISIONING

Refer to “Provisioning” on page 11 for information about using the MODE and SEL buttons or the Maintenance Terminal screens to configure the HLU. While the MODE and SEL buttons can be used to manually accomplish some provisioning tasks, such as setting system options, the Maintenance Terminal screens (available when you connect a PC to the craft port) can handle all provisioning tasks. Tasks that you need to complete are:Tasks that you need to complete are:

1 Set the time and date (see “Set Clock” on page 19).

2 Set the circuit IDs (see “View System Inventory Screen” on page 35).

Assuming that the HLU has been successfully installed and provisioned, you should do the following to ensure an accurate Alarm History and Performance History.

1 Clear the Alarm History screens (See “View Alarm History Screen” on page 33.)

2 Clear Performance Data screens (See “View Performance Data Screens” on page 29.)

3 Clear Performance History screens (See “View Performance History Screen” on page 31.)

PROVISIONING

This is a reference section for HLU provisioning. There are two methods for provisioning the HLU-319 List 5:

- Use the MODE and SEL buttons on the front panel of the HLU to:
  - set system options
  - reset the HLU to its factory default settings for system options
  - display system option settings (scroll mode)
  - select system loopbacks
- Use a maintenance terminal (ASCII terminal or a PC running terminal emulation software) connected to the HLU craft port to access the Maintenance Terminal Main Menu (Figure 3 on page 14). This gives you full access to all HLU status, history, inventory, and provisioning screens.

No dip switches or jumpers are required to provision the HLU-319 as it contains a non-volatile RAM (NVRAM) which stores the system option settings. System option settings are retained if shelf power is lost or if the HLU-319 is unplugged.

USING THE SEL AND MODE BUTTONS

Setting Options through SEL and MODE

To provision the HLU-319 List 5 through the MODE and SEL buttons on the front panel:

1. Press and release the MODE button. The message displayed on the front panel alternates between the first system parameter and its current setting.
2. Press the SEL button to step the display through all possible settings (one at a time) of the selected parameter.
3. After the desired setting has been selected, press the MODE button. This updates the current displayed parameter to the selected setting, and then advances to the next configurable parameter. After the last parameter has been selected, a `CONF NO` message appears on the front panel display.
4. Do one of the following:
   - To cancel the session without saving the requested parameter changes, press the MODE button or, do nothing. (After 30 seconds, the display returns to its normal mode without saving the new changes.)
   - To accept the requested parameter changes, press the SEL button. (A `CONF YES` message displays, and the display returns to its normal mode after saving the new changes.)

Resetting to Factory Default Values

All user options (Table 8 on page 21) can be set to the factory default values using the MODE and SEL buttons. To set the user options to their default values:

1 Press the SEL button for 6 seconds until the following message appears:

`DFLT NO`

2 Press the SEL button while the `DFLT NO` message is displayed.

The message changes to `DFLT YES` indicating the factory default values are now in effect and the display returns to the normal mode.

To terminate the DFLT mode without setting the factory default values, do one of the following:

- Press the MODE button to return to the normal display mode
- Wait 30 seconds for the unit to return to the normal display mode.

Displaying System Parameter Settings

To scroll through the current settings of all system parameters, press the MODE button for 3 or more seconds. The following parameters are displayed:

- HLU software version number
- HLU List number
- Type of frame pattern being received from the DSX-1
- Line code of the signal being received from the DSX-1
- HDSL power level setting
- All user-configured parameter settings

The line code parameter is the actual DSX-1 line code being received by the HLU if the DSX-1 code pattern is set to AUTO. Otherwise, the line code parameter mimics either of the other two line code settings, Alternate Mark Inversion (AMI) or Bipolar with 8-Zero Substitution (B8ZS).

Disabling an Alarm

If the system is in a Minor alarm state, the alarm relay can be disengaged by pressing the SEL button. This turns off the Alarm Cut-off (ACO) indication.

Loopback Modes

See “Loopback Operation” on page 38 for instructions on using the MODE and SEL buttons to activate loopbacks.

USING A MAINTENANCE TERMINAL

Connecting to a Maintenance Terminal

The craft port on the front panel allows you to connect the HLU-319 to a maintenance terminal (ASCII terminal or PC running a terminal emulation program). Once connected to a maintenance terminal, you can access the maintenance, provisioning, and performance screens.

To connect to a maintenance terminal:

1 Connect a standard 9-pin terminal cable to the RS-232 craft port (Figure 1 on page 4) on the HLU-319 front panel.

2 Connect the other end of the cable to the serial port on the maintenance terminal.

3 Start a terminal emulation program such as ProComm (emulating a VT-100 terminal).

4 Configure the maintenance terminal to the following communication settings:

- 1200 to 9600 baud (9600 baud is recommended)
- no parity
- 8 data bits
- 1 stop bit
- hardware flow control to OFF

5 Press the SPACEBAR several times to initiate the autobaud connection and to initialize the Maintenance Terminal screens.

Accessing the Maintenance Terminal Screens

The following sections describe how to use the Maintenance Terminal screens to view, provision and diagnose an HLU-319 List 5 system.

Navigation Keys

Table 3 lists keys you can use on the maintenance terminal to navigate the Maintenance Terminal screens.

Table 3. *Navigational Keys on the Maintenance Terminal*

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

Maintenance Terminal Main Menu

Figure 3 shows the Maintenance Terminal Main Menu from which you can access system administration screens. The function of each screen selection is listed in Table 4. To access a screen, type the letter shown next to the menu item.

```
HI-GAIN HLU-319     MAINTENANCE TERMINAL MAIN MENU   (ver V7.0L-5)
                         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 3. *Maintenance Terminal Main Menu*

Table 4. *Maintenance Terminal Screens*

Press Key	To View Screen	Screen Description	See page:
A	View Span Status	Provides access to subscreens that allow you to monitor the HDSL and T1 line status between the HLU and the HRU.	15
B	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.	19
C	System Settings	Allows you to set all user options.	20
D	Loopback Mode	Provides access to a subscreen that allows you to enable and disable loopbacks at both the network and customer side.	26
E	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 4-hour time period per screen for a total of 24 hours (6 screens).	29
F	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.	31
G	View Alarm History	Provides access to subscreens that allow you to view alarm conditions between the HLU and the HRU.	33
H	View System Inventory	Allows you to enter a unique circuit ID (up to 24 alpha-numeric characters).	35

Selecting a Maintenance Terminal Function

To perform a function within the Maintenance Terminal screens, you can:

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

System Spans

As shown in Figure 4, the HLU can support up to four doublers with five HDSL spans. The Span Status, Performance Data, and Performance History may display as many five screens to depict an HLU-319 List 5 system.

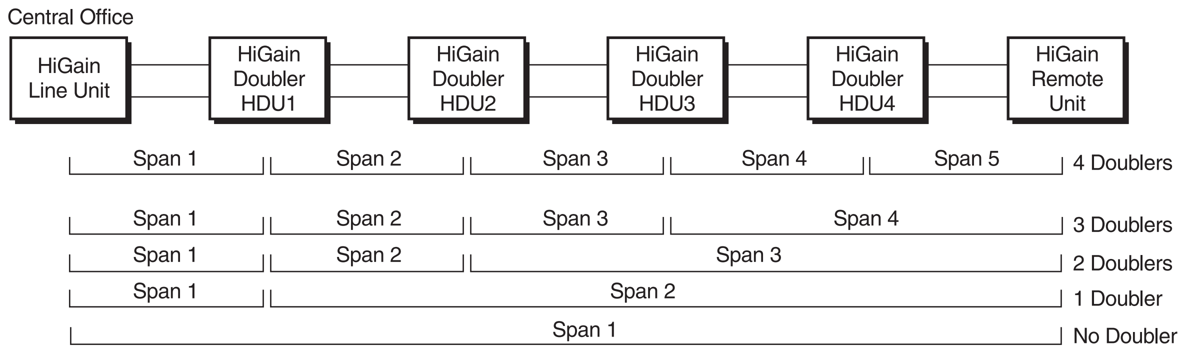


Figure 4. *System Spans*

USING THE MAINTENANCE TERMINAL SCREENS

View Span Status Screen

The View Span Status option allows you to view up to five 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.

Press A from the Maintenance Terminal Main Menu to open the Span Status screen (Figure 5 on page 16). If no doubler (HDU) is present, the screen reports span status for the subscriber lines between the HLU and the HRU.

If there are additional doublers, the Span Status screen reports status on each span. Figure 6 on page 16 shows status between HDU4 and the HRU in a system with four doublers. Refer to Table 5 on page 17 for an explanation of the Span Status fields.

From each Span Status screen you can:

- Press C to clear the cur (current), min (minimum) and max (maximum) numeric counts.
- Press A to automatically update status screens. (Press A again to turn off auto update.)
- Press U to update cur (current) values.
- Press S to view the next available span (for doubler applications).
- Press E to exit and return to the previous screen.
- Press 1, 2, 3, 4, or 5 to select a specific span (for doubler applications).

Span Status Screen without Doublers

```
                              SPAN STATUS
TIME: 12:06:04
DATE: 04/06/99              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:         23/23/23     23/21/23     24/20/25     24/21/24   dB
PULSE ATTN:        07           07           07           07      dB
INS LOSS:          08           08           08           08      dB
24 HOUR ES:       00010        00008        00001        00002    seconds
24 HOUR UAS:      00021        00020        00004        00002    seconds

                                   DS1 STATUS
                             HLU                  HRU
24 HOUR ES Count:           00000                00017
24 HOUR UAS Count:          00000                00012
Frame type:                  ESF                  ESF
Code type:                   AMI                  AMI

                             (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. Span Status can have up to five screens, depending on the number of HDUs.

```
                              SPAN 5 STATUS
TIME: 12:06:04
DATE: 4/06/99               Circuit ID#:
ALARMS:   NONE
LOOPBACK: OFF
POWER LEVEL: HIGH
                        HDU4                          HRU
                 HDSL-1       HDSL-2       HDSL-1       HDSL-2
              cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:         23/23/23     23/21/23     24/20/25     24/21/24   dB
PULSE ATTN:        07           07           07           07      dB
INS LOSS:          08           08           08           08      dB
24 HOUR ES:       00010        00008        00001        00002    seconds
24 HOUR UAS:      00021        00020        00004        00002    seconds

                                   DS1 STATUS
                             HLU                  HRU
24 HOUR ES Count:           00000                00017
24 HOUR UAS Count:          00000                00012
Frame type:                  ESF                  ESF
Code type:                   AMI                  AMI

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

Figure 6. *Span Status Screen: Four Doublers (Span 5)*

Table 5 lists the Span Status fields and descriptions.

Table 5. *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 6 on page 18.
Loopback	Indicates Off condition or identifies specific active loopback. See Table 7 on page 18.
Power Level	Indicates the HDSL line voltage in its Low (-135 V) or High (±220 V) state.
Margin	Indicates the excess signal to noise ratio at all HDSL ports, relative to a 10^{-7} Bit Error Rate. • First value is current margin. • Second value is minimum margin since last cleared. • Third value is maximum margin since last cleared. • N/A means that the margin is 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 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 seconds in which at least one error was detected on the DS1 input over a 24-hour period. Errors included are: DS1 Frame errors; and UAS, BPV, and ESF CRC errors.
24-Hour UAS Count	The number of seconds during which the DS1 input signal was absent (125 or more consecutive zeroes) 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 indicate the code type that is being received when HiGain line is set to ZBTS1 mode. When set to AMI or B8ZS, the HLU displays the selected code rather than the code type that is actually being received.

The Span Status screens shown on the previous page display a four-character code under the Alarms entry. These codes are described in Table 6 on page 18.

The following codes are reported with a RCV or XMT prefix that indicates the signal is being transmitted or received: 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 6. *HDSL System Alarms*

Code	Name	Description
LLOS	Local Loss of Signal	Loss of the DSX-1 input signal.
RLOS	Remote Loss of Signal	Loss of the HRU T1 input signal.
LOSW	Loss of Sync Word	One of the HDSL loops has lost synchronization.
BER	Bit Error Rate Exceeded	The Total System Error Count (TSEC) has exceeded the user-selected threshold.
R(L)AIS	Remote (Local) Alarm Indicating Signal	Indicates an AIS pattern (all ones) is being transmitted from the remote (or local) T1 output port.
MAL1(2)	Margin Alarm 1(2)	The margin on the HDSL loop 1(2) has dropped below the threshold (1 to 15 dB) set by the user. Setting the threshold to zero inhibits the margin alarm.
NONE	No Alarm	No alarm is indicated.

Table 7 lists loopback messages displayed on the Span Status screens. For information about loopback codes, see "GNLB Loopback Test Procedures" on page 42.

Table 7. *Loopback Messages*

Message	Full Name	Description
ARM	Armed	The HiGain system has detected the Intelligent Repeater (IR) loopback arming code (2-in-5).
CDU*n*	Customer Doubler *n* Loopback	Loopback at Doubler (*n*) to Customer Installation (CI) initiated by an Intelligent Line Repeater (ILR) code, the Manual Loopback buttons on HLU-319 front panel, or by the maintenance terminal.
CHREV-SPx	Channels Reversed	The Loop 1 and Loop 2 HDSL pairs are reversed at Span x. Loop 1 is specified to carry the (-) simplex DC voltage, and Loop 2 is specified to carry the (+) simplex DC voltage. SPx indicates that the first occurrence of a reversed span is on Span x, where x is the number of the span.
CLOC	Customer Local Loopback	Loopback at HRU (local) to CI initiated from Customer Premises Equipment (CPE) by the ILR code or the Manual Loopback buttons on the HLU-319 front panel or by the maintenance terminal.
CREM	Customer Remote Loopback	Loopback at HLU-319 (remote) to customer initiated by Intelligent Office Repeater (IOR) code or the Manual Loopback buttons on the HLU-319 front panel, or by the maintenance terminal.
(HG)	HiGain	The loopback was initiated from a HiGain front panel or by a HiGain maintenance terminal loopback command.
NDU*n*	Network Doubler *n* Loopback	Loopback at Doubler (*n*) to network initiated by IOR code or by Manual Loopback buttons on the HLU-319 front panel or by the maintenance terminal.
NLOC	Network Local Loopback	Loopback HLU-319 (local) to network initiated from CO by IOR code, the HLU-319 front panel Manual Loopback buttons or maintenance terminal.
NREM	Network Remote Loopback	Loopback at HRU to network initiated from CO (network) by ILR #2 code, Manual Loopback buttons on the HLU-319 front panel, HRU front panel button, or by the maintenance terminal.
(PL)	Pay Load	The loopback was initiated by a command that was embedded in the T1 data path.
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.
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).

```
                              SET CLOCK

TIME: 00:14:33
DATE: 04/06/99
CIRCUIT ID#:

Format: HH:MM
        MM/DD/YY

NEW TIME:
NEW DATE:



(U)PDATE REMOTE?
```

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 instead of just one.

Update the HRU Time and Date

The remote unit date and time is set by using this option. Do one of the following:

- To update the HRU to the same date and time set as the HLU-319, press **U**.
- To bypass the `U)PDATE REMOTE` prompt and update only the HLU-319, press **ENTER**.

System Settings

The options set from the System Settings screen are the same as the options set through the HLU-319 front panel Mode and SEL buttons (except for Margin Alarm Threshold and DS0 Blocking, which can only be set at this screen). Refer to Table 8 on page 21 for a listing of system setting options.

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

```
                                   SYSTEM SETTINGS

TIME: 12:46:06
DATE: 04/06/99                         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*

You have the following options with the Systems Settings screen:

- Press the desired option letter to change setting.
- Press **D** to set all user options to the factory default values.
- If changes were made, press **C** to confirm, or press any other key to ignore changes.
- Press **E** to exit and return to the main menu.

Table 8 describes the System Settings screen options and their counterpart codes for the front panel display. Selections in bold typeface are the factory default settings.

Table 8. *HLU-319 List 5 System Settings Screen Options*

System Settings Screen Options	Front Panel Display Code	Selection	Description
Equalization	EQL	**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	LBPK	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	SPLB	**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	PWRF	DIS	Disables powering to the HDSL pair.
(See "HDSL Line Voltage Options" on page 25.)		LOW	Keeps the HDSL line voltage at -135 V maximum for all applications.
		AUTO	Allows the HDSL line voltage to automatically switch between -135 V maximum for non-doubler applications and ±220 V for doubler applications.
		HIGH	Forces the HDSL line voltage to ±220 V for all applications.
ZBTSI	ZBTS	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	BERT	1E-6	Activates (closes) the system alarm relay contact on pin H and flashes the red Status LED when the BER exceeds 10^{-6}.
(See "BER Option" on page 24 and "System Alarm Output Pin" on page 53.)		1E-7	Activates (closes) the system alarm relay contact on pin H and flashes the red Status LED when 10^{-6} > BER >10^{-7}.
		NONE	Prevents generation of a system alarm due to BER.

Table 8. *HLU-319 List 5 System Settings Screen Options (Cont.)*

System Settings Screen Options	Front Panel Display Code	Selection	Description
Loopback Timeout	LBTO	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	ALM	**DIS**	Disables the generation of the output alarm on pin H when a system alarm condition occurs.
		ENA	Enables the generation of the output alarm on pin H when a system alarm condition occurs.
DSX-1 Line Code (See "DS1 Line Code Option" on page 24.)	DS1	AUTO	The HLU-319 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.
Framing	FRMG	**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 ensures 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 (See "HAIS Option" on page 25.)	HAIS	**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	SAIS	**ENA**	Causes the HRU to transmit the AIS signal towards the Customer Interface (CI) when in NREM or SmartJack loopback.
		DIS	Causes the HRU to either transmit the signal from the network towards the CI RCV 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 (See "DS0 Blocking Option" on page 24.)	DS0	BLK	The DS0 blocking option can only be set through a maintenance terminal connected to the craft port. The four-character front panel display only shows the status of the blocking option. BLK indicates at least one channel is blocked.
		NONE	Indicates no channels are blocked.
Margin Alarm Threshold (See "Margin Alarm Threshold Option" on page 25.)	MARG	0 to 15 dB	The Margin Alarm Threshold can only be set through a maintenance terminal connected to the craft port. It determines the minimum allowable margin below which a system alarm can occur. Zero disables the alarm.
		4dB	Default value.

Table 8. *HLU-319 List 5 System Settings Screen Options (Cont.)*

System Settings Screen Options	Front Panel Display Code	Selection	Description
RLOS Alarm	RDA	**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	ALMP	**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.
Bipolar Violation Transparency	BPVT	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.
(See "BPVT Option" on page 23.)		**DIS**	Disables BPV Transparency.
Confirm Settings	CONF	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.

BPVT Option

The HLU-319 List 5 improves HiGain's compatibility with Digital Loop Carrier (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 T1 BPVs at the input and thus prevent them from being detected by the 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 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.

BER Option

The BER option also uses this (BPV/CRC) TEC to generate an Alarm if enabled. The HLU combines the 1-second TEC counts in both directions for the last 60 seconds. It uses this 1-minute Total System Error Count (TSEC) to generate an alarm if it exceeds the selected BER threshold 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 errors, the alarm can come and go in intervals as short as 1 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 other versions of HiGain modules in the circuit. When connected to an HRU, other than the HRU-402 or HRU-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 20).
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 **C** to (Confirm) and then **E** for (Exit). 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 DSX-1 output of the HLU-319. The HRU DS1 output is not 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 any of the unused DS0 channels of a fractional T1 service are filled 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 idle code of all ones.

Blocking the idle code results in a mismatch between the CRC checksum delivered to the remote end (when the payload is in the ESF format) and 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). This is because 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 Option

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 zero, choosing 0 (zero) for the margin threshold turns the margin alarm off.

HAIS Option

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 PWRF option has four settings for HDSL line power feed: DIS, LOW, AUTO, and HIGH.

- **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 products (HDU-409, HDU-404 or HDU-407 and HRU-402 or HRU-411) are used along with the HLU-319 List 5. These HiGain units are the only ones that have sufficiently low power consumption to allow their doubler circuits to be line-powered from -135 V. The HRU-411 must have the CPE power option disabled if it is used in a -135 V doubler circuit.
- **AUTO** is the conventional mode in which the HLU automatically maintains the HDSL like voltage at -135 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, PWRF option should be set to AUTO. The HLU automatically detects the need to switch to the HIGH power feed made when it receives a request from the HRU to do so.

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 (0 V and -135 V). The circuit is constantly active during high (±220 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 and displayed. 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 again when the GFD circuit detects such a 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 Mode Screen

The Loopback Menu permits you to issue loopbacks to the HiGain system. Depending upon the number of doublers, there can be up to five loopback screens.

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 shows an example when four doublers are present.

The following options are available:

- Type **A** to select the Disable Loopbacks option.
- Type **B** to select HLU Network Loop.
- Type **C** to select HRU Network Loop.
- Type **G** to select HLU Customer Loop.
- Type **H** to select HRU Customer Loop.
- For doubler applications, additional loopback selections appear on the screen.
- Type **E** to exit and return to the previous menu.

Table 9 lists the HLU-319 Loopback field messages and descriptions.

Table 9. *Loopback Field Messages and Descriptions*

Messages	Full Name	Description
NREM	Network Remote Loopback	Loopback at HRU (remote) towards network.
NLOC	Network Local Loopback	Loopback at HLU (local) towards network.
CLOC	Customer Local Loopback	Loopback at HRU (local) towards CI.
CREM	Customer Remote Loopback	Loopback at HLU (remote) towards CI.
NDU*n*	Network Doubler *n* Loopback	Loopback at n^{th} doubler towards network.
CDU*n*	Customer Doubler *n* Loopback	Loopback at n^{th} doubler towards CI.

Loopback Menu without Doubler

```
                                 LOOPBACK MENU

TIME: 00:15:34
DATE: 04/06/99
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 Mode for Doubler Applications

```
                               LOOPBACK MENU

TIME: 00:03:33
DATE: 04/06/99
CIRCUIT ID#:


     A. DISABLE LOOPBACKS
     B. NETWORK LOOP HLU        (NLOC)      M. NETWORK LOOP DOUBLER 4   (NDU4)
     C. NETWORK LOOP HRU        (NREM)      N. CUSTOMER LOOP DOUBLER 4  (CDU4)
     D. NETWORK LOOP DOUBLER 1  (NDU1)
     F. NETWORK LOOP DOUBLER 2  (NDU2)
     G. CUSTOMER LOOP HLU       (CREM)
     H. CUSTOMER LOOP HRU       (CLOC)
     I. CUSTOMER LOOP DOUBLER 1 (CDU1)
     J. CUSTOMER LOOP DOUBLER 2 (CDU2)
     K. NETWORK LOOP DOUBLER 3  (NDU3)
     L. CUSTOMER LOOP DOUBLER 3 (CDU3)

                               (E)xit
```

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 four-letter loopback 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.

```
HI-GAIN HLU-319     MAINTENANCE TERMINAL MAIN MENU   (ver V7.0L-5)
                         CIRCUIT ID#: HLU-319 L5

                    A. VIEW SPAN STATUS
                    B. SET CLOCK
                    C. SYSTEM SETTINGS
                    D. LOOPBACK MODE:  NLOC
                    E. VIEW PERFORMANCE DATA
                    F. VIEW PERFORMANCE HISTORY
                    G. VIEW ALARM HISTORY
                    H. VIEW SYSTEM INVENTORY
```

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

Disabling a Loopback

The Disable Loopbacks option (Figure 9 on page 27) 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 where the Loopback Mode is identified as None.

View Performance Data Screens

The Performance Data screens (Figure 12 and Figure 13 on page 30) show the Errored (ES) and Unavailable Seconds (UAS) for both HDSL loops and each T1 input at 15-minute intervals over a 4-hour time interval. (The ES and UAS data is separated by a slash mark.) Earlier and later data, in 4-hour time periods on different span screens, can be accessed by pressing P (Previous) or N (Next) respectively.

Errored and Unavailable seconds are defined in Table 10.

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 S to view the next available span (for doubler applications).
- Press 1, 2, 3, 4, or 5 to select a specific span (for doubler applications).
- Press E to exit.

All Performance Data counters can be set to zero by pressing C (Clear) from the HLU-319 Span Status screen shown in Figure 5 on page 16. The HLU-319 is considered the master module; it clears all performance data screens at both the HLU-319 and the HRU. Counters can not be cleared by accessing the HRU craft port.

Table 10. *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, FRAM error, or LOS has occurred.
DS1 Unavailable Second	A second in which at least one T1 LOS condition (175 ± 75) zeroes has occurred.

Performance Data Screen without Doubler

Figure 12 shows a single non-doubler span. This screen shows the Errored and Unavailable Seconds for the HDSL span between the HLU-319 and the HRU.

```
Date: 04/06/99       PERFORMANCE DATA
CIRCUIT ID#:

                  ERRORED SECONDS/UNAVAILABLE SECONDS

                DS1             HDSL-1            HDSL-2
           HLU      HRU      HLU      HRU      HLU      HRU
00:00        /        /        /        /        /        /
00:15        /        /        /        /        /        /
00:30        /        /        /        /        /        /
00:45        /        /        /        /        /        /
01:00        /        /        /        /        /        /
01:15        /        /        /        /        /        /
01:30        /        /        /        /        /        /
01:45        /        /        /        /        /        /
02:00        /        /        /        /        /        /
02:15        /        /        /        /        /        /
02:30        /        /        /        /        /        /
02:45        /        /        /        /        /        /
03:00        /        /        /        /        /        /
03:15        /        /        /        /        /        /
03:30        /        /        /        /        /        /
03:45        /        /        /        /        /        /

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

Figure 12. *Performance Data Screen: No Doubler*

Performance Data Screen for Doubler Applications

Figure 13 is an example of a Performance Data screen that lists performance data for the fifth span (HDU4 to the HRU).

```
Date: 04/06/99               SPAN 5 PERFORMANCE DATA
CIRCUIT ID#:
                          ERRORED SECONDS/UNAVAILABLE SECONDS

                DS1             HDSL-1            HDSL-2
           HLU      HRU     HDU4      HRU     HDU4      HRU
00:00        /        /        /        /        /        /
00:15        /        /        /        /        /        /
00:30        /        /        /        /        /        /
00:45        /        /        /        /        /        /
01:00        /        /        /        /        /        /
01:15        /        /        /        /        /        /
01:30        /        /        /        /        /        /
01:45        /        /        /        /        /        /
02:00        /        /        /        /        /        /
02:15        /        /        /        /        /        /
02:30        /        /        /        /        /        /
02:45        /        /        /        /        /        /
03:00        /        /        /        /        /        /
03:15        /        /        /        /        /        /
03:30        /        /        /        /        /        /
03:45        /        /        /        /        /        /

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

Figure 13. *Performance Data Screen: Four Doublers*

View Performance History Screen

The Performance History screen shows the daily occurrences of ES and UAS over a 31-day period in 24-hour increments. Errored Seconds and Unavailable Seconds for both HDSL loops and each of the two DS1 inputs are listed for the current and previous period.

Press **F** at 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** from the Performance History screen to advance through the history screens for the various spans (for doubler applications).
- From the 31-day Performance History screen press **N** (Next) for a continued history.
- From the 31-day Performance History screen press **P** (Previous) for the previous screen.
- Press **E** to exit from the Performance History screen.

All Performance History counters can be set to zero by pressing C (Clear) from the HLU-319 Span Status screen shown in Figure 5 on page 16. The HLU-319 is considered the master module; it clears all performance data screens at both the HLU-319 and the HRU. Counters can not be cleared by accessing the HRU craft port.

Performance History Screen without Doubler

Figure 14 shows a non-doubler application.

```
Time: 00:27:46              PERFORMANCE HISTORY - 31 DAY
CIRCUIT ID#:
                         ERRORED SECONDS/UNAVAILABLE SECONDS

                  DS1                   HDSL-1                  HDSL-2
            HLU         HRU         HLU         HRU         HLU         HRU
01/17         /           /           /           /           /           /
01/18         /           /           /           /           /           /
01/19         /           /           /           /           /           /
01/20         /           /           /           /           /           /
01/21         /           /           /           /           /           /
01/22         /           /           /           /           /           /
01/23         /           /           /           /           /           /
01/24         /           /           /           /           /           /
01/25         /           /           /           /           /           /
01/26         /           /           /           /           /           /
01/27         /           /           /           /           /           /
01/28   00001/      00002/00002 00004/00014 00006/      00003/00013 00007/00001
01/29         /           /           /           /           /           /
01/30   00001/      00002/00002 00004/00014 00006/      00003/00013 00007/00001
01/31   00001/      00002/00002 00004/00014 00006/      00003/00013 00007/00001
current 00001/      00002/00002 00004/00014 00006/      00003/00013 00007/00001

                        (E)xit (P)revious
```

Figure 14. 31-Day Performance History Screen: No Doubler

Performance History Screen for Doubler Applications

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

```
Time: 00:26:29            SPAN 5 PERFORMANCE HISTORY - 31 DAY
CIRCUIT ID#:
                          ERRORED SECONDS/UNAVAILABLE SECONDS

                  DS1                  HDSL-1                  HDSL-2
            HLU         HRU         HDU4        HDRU        HDU4        HRU
01/17         /           /           /           /           /           /
01/18         /           /           /           /           /           /
01/19         /           /           /           /           /           /
01/20         /           /           /           /           /           /
01/21         /           /           /           /           /           /
01/22         /           /           /           /           /           /
01/23         /           /           /           /           /           /
01/24         /           /           /           /           /           /
01/25         /           /           /           /           /           /
01/26         /           /           /           /           /           /
01/27         /           /           /           /           /           /
01/28         /           /           /           /           /           /
01/29   00001/            /      00005/00415      /      00035/00492      /
01/30         /           /           /           /           /           /
01/31   00001/      00002/00002 00004/00014 00006/      00003/00013 00007/00001
current 00001/            /      00005/00415      /      00035/00492      /

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

Figure 15. *31-Day Performance History Screen: Four Doublers (Span 5)*

View Alarm History Screen

Press G at the Maintenance Terminal Main Menu to open the Alarm History screen. This screen allows you to view alarms that are currently active. In the Alarm History screen (Figure 16 and Figure 17 on page 34) the:

- 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. (The 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 1, 2, 3, 4, or 5 to select a specific span (for doubler applications).
- Press E to exit from the Alarm History screen.

Table 11 lists the Alarm History fields and descriptions. These descriptions apply to the Alarm History for doubler applications as well.

Table 11. *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 *n* LOSW, HDSL1	First and last instance of LOSW on HDSL1; Current condition, number of alarms
Span *n* LOSW, HDSL2	First and last instance of LOSW on HDSL2; Current condition, number of alarms
Span *n* Margin L1	First and last instance of exceeded margin on Loop 1; Current condition, number of alarms
Span *n* 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:	Last time Alarm History cleared; Current condition, number of alarms

Alarm History Screen without Doubler

```
                              ALARM HISTORY

TIME: 00:11:01
DATE: 04/06/99
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             000

LAST CLEARED:  04/06/99-00:11

                         (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. 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: 13:59:20
DATE: 04/06/99
CIRCUIT ID#:

Type               First               Last                Current        Count
LOS, DS1-HLU                                               OK             000
LOS, DS1-HRU                                               OK             000
BER                                                        OK             000
SPAN4 LOSW, HDSL1                                          OK             000
SPAN4 LOSW, HDSL2                                          OK             000
SPAN4 MARGIN L1                                            OK             000
SPAN4 MARGIN L2                                            OK             000
PWR-SHRT                                                   OK             000
PWR-GND                                                    OK             000

LAST CLEARED:  04/06/99-13:49

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

Figure 17. *Alarm History Screen: Four Doublers (Span 5)*

View 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 at the Maintenance Terminal Main Menu to display the System Inventory screen (Figure 18 and Figure 19 on page 36).

From each System Inventory screen (depending on the number of doublers), you can do the following:

1. Select the unit for which you want to set the circuit ID by pressing the letter that precedes the unit name.
2. Type the circuit ID, then press ENTER.

   You can use up to 24 alphanumeric characters for the circuit ID. If more than 24 characters are entered, a warning beep is emitted and only the first 24 characters are accepted.
3. To set the circuit ID for another unit, repeat Step 1 and Step 2.
4. Press E to exit the System Inventory screen.

   The system prompts you to confirm the circuit ID.
5. Press C to confirm the circuit ID and exit the System Inventory screen.

Executing the default option from either the front panel or System Settings screen has no effect on the ID values.

System Inventory Screen without Doubler

```
                                      SYSTEM INVENTORY
TIME: 18:16:37
DATE: 4/06/99                          A. CIRCUIT ID#:



        UNIT       PRODUCT              UNIT ID

        HLU     HLU-319 L5   V7.0     NOT REQUIRED
     B. HRU     HRU-402 L1   V1.3
     C. DB1     N/A
     D. DB2     N/A
     F. DB3     N/A
     G. DB4     N/A



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

Figure 18. *System Inventory Screen: No Doubler*

System Inventory Screen for Doubler Applications

```
                                      SYSTEM INVENTORY
TIME: 18:16:37
DATE: 04/06/99                         A. CIRCUIT ID#:



        UNIT       PRODUCT              UNIT ID

        HLU     HLU-319 L5   V7.0    NOT REQUIRED
     B. HRU     HRU-402 L1   V1.3
     C. DB1     HDU-404 L2   V1.1
     D. DB2     HDU-404 L2   V1.1
     F. DB3     HDU-404 L2   V1.1
     G. DB4     HDU-404 L2   V1.1



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

Figure 19. *System Inventory Screen: Four Doublers*

TROUBLESHOOTING

SYSTEM ALARMS

Table 12 on page 37 lists possible HLU-319 List 5 alarm states. The accompanying front panel message is listed in the Alarm column. 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 12. *HDSL System Alarms*

Front-Panel Message	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 R(L)AIS	Remote (or Local) Alarm Indicating Signal	Indicates an AIS (all ones) pattern is being transmitted (XMT) from the remote (or local) T1 output port.	Set LBPK option to ENA or DIS.
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 and the ALRM RLOS message displays 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 current alarm condition.	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 and the SELF TEST message displays instead of the ALRM message.

Alarm Option for DLC Feed

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 = lL

Retiring System Alarms

To retire a system alarm, press the SEL button and execute an Alarm Cut Off (ACO). An ACO turns the alarm off and replaces the `ALRM` message with an `ACO` message. The second part of the `ALRM` message, which defines the cause of the alarm, remains. Both parts of the message remain until the alarm condition clears or another higher priority alarm occurs.

Self Test

The Self Test mode that occurs when both HDSL loops are not in sync has been enhanced to include the input DS1 transceiver chip. The Self Test procedure can cause the all ones pattern, that is normally transmitted from the HLU-319 during these out of sync intervals, to exhibit occasional BPVs.

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 and 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 either the front panel MODE and SEL buttons or through 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 42 for the test procedures that apply when using the GNLB mode.

Addressable Repeater Loopback Functions

The A1LB loopback selection, described in “A1LB, A2LB, and A5LB Test Procedures” on page 43, 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.

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 8 on page 21 and Figure 20 on page 41 (non-doubler applications).

A1LB through A5LB are five special, addressable, repeater loopback functions which are supported by the HLU-319 List 5. These loopbacks provide the HiGain system with sophisticated maintenance and trouble shooting tools. A1LB, 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 five 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 HLU, 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.

Initiating Manual Loopback Sessions

A manual loopback session allows you to select one of four HiGain system loopbacks.

Any of the HiGain loopbacks can be executed using the MODE and SEL buttons.

In general, to execute a manual loopback session using the MODE and SEL buttons:

- **The next loopback option can be presented by pressing the MODE button, however, the previously executed loopback remains active until the SEL button is pressed and a different loopback is activated.**
- **If neither button is pressed for a period of 30 seconds and no loopback is in effect, the manual loopback session terminates and the normal margin displays reappear.**
- **If any loopback is in effect, the 30-second timeout is inhibited. The active loopback and the manual loopback session continue until the loopback times out in accordance with the LBTO setting.**
- **Only the SMJK loopback can exist with other networks at any given time.**
- **Pressing both buttons, again for 3 seconds, terminates any active loopback, ends the Manual loopback session and returns the display to normal mode.**

Setting the Loopback Timeout Option

Before initiating a loopback session, verify that the Loopback Time-out option is set to the desired parameter. The Loopback Time-out option is user-selectable from the System Settings screen. To set the time-out option:

1 Select C from the Maintenance Terminal Main Menu.

2 Select I from the System Settings screen.

3 Enter the desired parameter:

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

4 Type C to confirm the setting.

Initiating a Manual Loopback Session

To initiate a manual loopback session:

1 Press both the MODE and SEL buttons on the front panel for at least 3 seconds. The following message appears on the front panel display:

`MAN LPBK`

followed by the message:

`NLO?`

2 Do one of the following:

- To execute an NLOC loopback, press the SEL button. The message changes from `NLO`? to `NLOC`.
- To execute an NREM loopback:
  - Press the MODE button. The message changes from `NLO?` to `NRE`?.
  - Press the SEL button to execute the NREM loopback.

3 To execute a CRE loopback, press the MODE button again.

4 To execute a CLO loopback, press the MODE button a third time.

These same loopbacks can be initiated from the RS-232 craft port by choosing the Loopback Mode, option D, from the Main Menu. This displays the Loopback Menu (Figure 9 on page 27) from which any of the loopbacks can be initiated or terminated.

All loopbacks, except the SMJK loopback, can be initiated by either in-band commands in the T1 payload or by a command from HiGain itself (front panel buttons or maintenance screen selections). Thus, whenever a loopback is active, the method by which it was activated is indicated in the Loopback and Status screens by inserting either HG (HiGain) or PL (Payload) adjacent to the identified loopback, for example NREM (HG).

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.

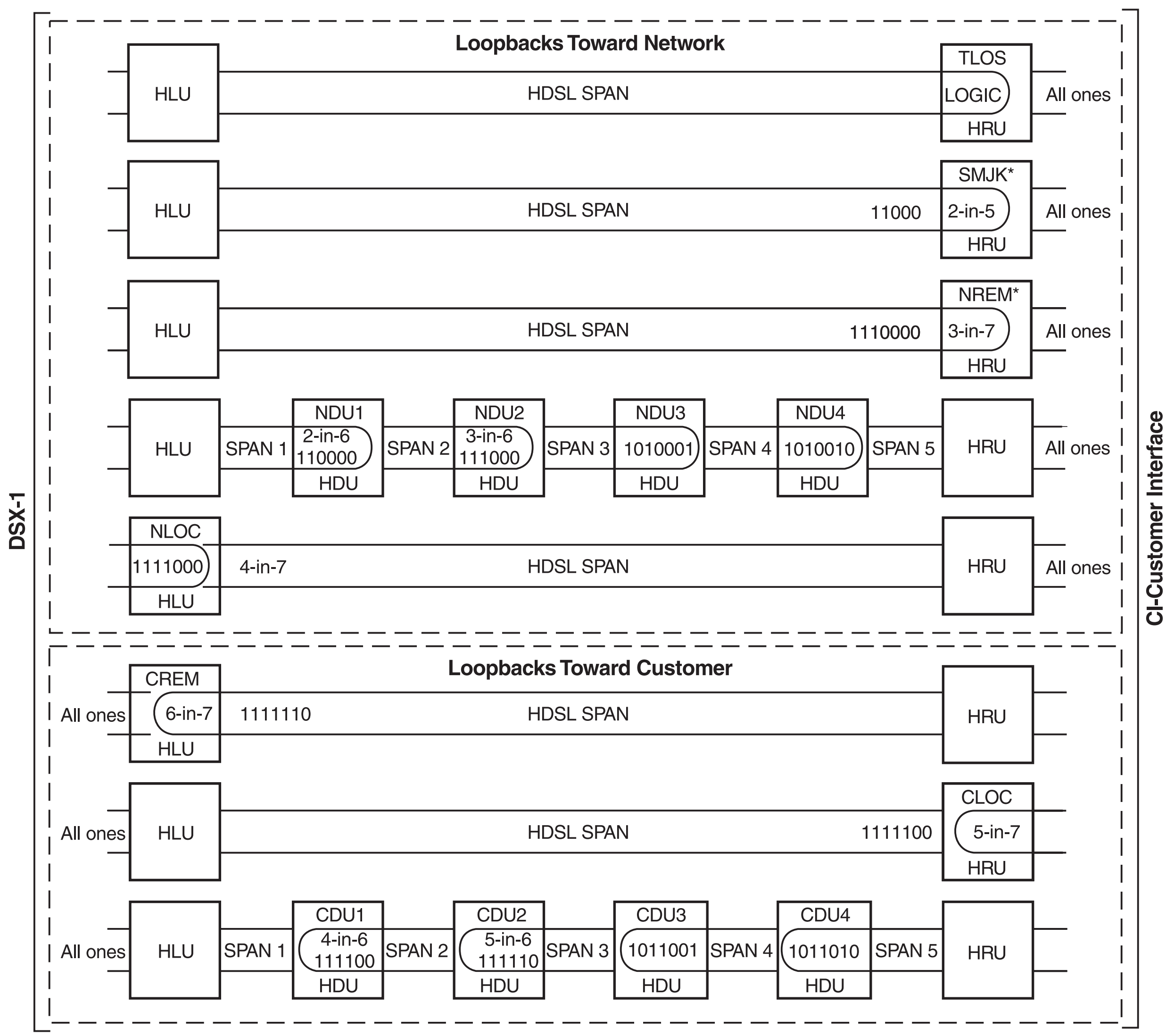
If trouble is encountered on the HLU-319 DSX-1 interface, verify that the HLU is making a positive connection with its mounting assembly (shelf) connector. Also, verify that the HLU internal equalizer is set to the correct distance range per Table 8 on page 21. All equalizers should be set to the distance 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 Configurations

Loopbacks can be initiated from a maintenance terminal connected to the HLU craft port, the HLU front-panel MODE and SEL buttons, or from a family of Special Loopback (SPLP) in-band loopback commands.

The loopbacks that a HiGain system equipped with the HDU-409 can execute is shown in Figure 20. Eight of those loopbacks (NDU1, NDU2, NDU3, NDU4; CDU1, CDU2, CDU3, CDU4) occur in the doubler.



* 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 20. *Loopback Configurations*

The more common generic, SPLB inband loopback commands for doubler loopbacks are listed in Table 13. The commands are very specific combinations of either 6 or 7 bits that continuously repeat. All NDUx loopbacks are towards the network. All CDUx loopbacks are towards the customer.

Table 13. *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. You should be able to see that an HRU NREM loopback is in effect by observing the NREM message on the front panel display. (Loopback states are indicated by the yellow Status LED on the front panel, and also on 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 yellow Status LED on the front panel, and also on 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 List 5 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 List 5 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 and HRU-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 HLU-319 List 5 DS1 input port.
- Doubler #4 can engage loopback form the remote location (CDU4) by issuing the 1 0 1 1 0 0 1 loopback command at the HRU DS1 input port (only supported by HRU-402 and HRU-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 List 5 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 that:

- either the HRU has looped up (if the SMJK Loopback option is Enabled).
- or that an external NI has looped up (if the SMJK Loopback option is Disabled) and that the HLU-319 List 5 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
- 30 errors, if ILR-3 (Doubler 3) was sent
- 40 errors, if ILR-4 (Doubler 4) 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 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 14 on page 45, a network tester can activate loopbacks NLOC or NREM or SMJK (if enabled). A customer tester can activate loopbacks CLOC or CREM. All loopbacks shown in Table 14 can also be initiated from the HLU-319 front panel MODE and SEL buttons (see “Setting Options through SEL and MODE” on page 11).

Information specific to HiGain doublers is shown in bold in Table 14.

Table 14. *Addressable 1, 2, 5 (A1LB, A2LB, A5LB) Repeater Loopback Commands*

Name	Description	Code [(a)]
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)
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 Table 15. The automatic time-out mode is restored during subsequent loopback sessions.

Table 15 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 15 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 15.

Table 15. Addressable 3 and 4 (A3LB and A4LB) Repeater Loopback Commands

Position	Name	Code [a]
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)0100(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**	**1111(F)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
HDSL Output	+13.5 dBm ±0.5 dB at 135 Ω
HDSL Line Impedance	135 Ω
Maximum Provisioning Loss	35 dB at 196 kHz, 135 Ω
Line Clock rate	Internal “Stratum 4” clock
HDSL Start-up Time	30 sec. (typical), 60 sec. (maximum) per span
One-way DS1 Delay	<200 µs per span without doublers. Doubler delay <80 µs
DSX-1 Line Impedance	100 Ω
DSX-1 Pulse Output	6 V $^{pk-pk}$, pre-equalized for 0-655 feet of ABAM cable
DSX-1 Input Level	+1.5 to -7.5 dBDSX
DS1 Line Rate	1.544 Mbps ±200 bps
DS1 Line Format	AMI, B8ZS or ZBTSI
DS1 Frame Format	ESF, SF or UNFR
Maximum Heat Dissipation	See “Power Consumption” on page 48.
Fusing	Internal; connected to “FUSE ALARM” output on pin H
HDSL Span Voltage	-135 V to ± 220 Vdc
Electrical Protection	Secondary surge and power cross protection on HDSL ports. Requires external primary protection
Operating Temperature	-40 °F to +149 °F (-40 °C to +65 °C)
Operating Humidity	5% to 95% (non-condensing)
Mounting	STS high density slot
Dimensions	
Height:	4.75 in. (12.1 cm)
Width:	0.625 in. (1.59 cm)
Depth:	10 in. (25.4 cm)
Weight:	8 oz. (.23 kg)
Wander (Looped)	0.3 UI maximum (1 UI = 648 ns)
WB Jitter (Looped)	0.2 UI maximum
NB Jitter (Looped)	0.1 UI maximum

HDSL INSERTION LOSS GUIDELINES

Each loop has no more than 35 dB of loss at 196 kHz, with driving and terminating impedances of 135Ω. Table 16 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 16. *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

The maximum power consumption and heat dissipation depends upon the type of remote and doubler units in the system and the CPE power setting.

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.

Table 17 describes line-powered circuits on 9 kft, 26 AWG loops without a doubler.

Table 17. *HLU-319 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 18 through Table 24 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 18 through Table 20 shows power parameters for single doubler, line-powered circuits on 9 kft, 26 AWG loops.

Table 18. *HLU-319 Power Parameters—Single Doubler (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 19. *HLU-319 Power Parameters—Single Doubler (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 20. *HLU-319 Power Parameters—Single Doubler (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 21 through Table 23 show power parameters for two doubler, line-powered circuits on 9 kft, 26 AWG loops.

Table 21. *HLU-319 Power Parameters—Two Doublers (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 22. *HLU-319 Power Parameters—Two Doublers (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 23. *HLU-319 Power Parameters—Two Doublers (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 24 shows power parameters for three doubler, line-powered circuits or four doubler, locally-powered circuits on 9 kft, 26 AWG loops.

Table 24. *HLU-319 Power Parameters—Three and Four Doublers (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 HMS-317 shelf is 7.024 square feet. Thus, the maximum bay dissipation is limited to 946 watts. Use this limit and the parameters in Table 17 through Table 24 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.

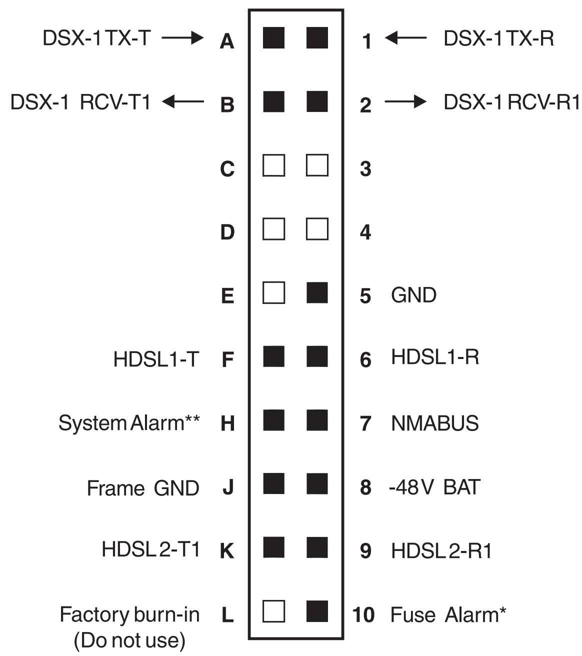
The 42.5 V Power Consumption is the maximum total power that the HLU-319 consumes or draws from the shelf power source. This parameter is needed when the HLU-319 is in a location remote to the CO it is serving. It determines the battery capacity required to maintain an 8-hour, stand-by battery reserve for emergency situations. Battery capacity, therefore, limits the maximum number of line units which can be installed in a remote enclosure. Use the data in Table 17 through Table 24 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 17 through Table 24 to determine the shelf fusing requirements for your particular HLU applications.

HLU-319 LIST 5 CARD CONNECTOR

Figure 21 shows the card-edge connectors on the HLU-319 List 5. Active pins are highlighted in black.



* Fuse Alarm
Normal = Floating (0 to -60 Vdc Maximum)
Activated = -48 Vdc, 10 mA Maximum

** System Alarm
Normal = Floating (+5 to -60 Vdc Maximum)
Activated = +5 V, 10 mA Maximum

Figure 21. *HLU-319 List 5 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. Whenever the HLU-319 is under management, the `MNGD` message displays periodically on the front panel display.

Some HLU-319 List 5 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 21) 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 +5V (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 ALM option to DIS only prevents the system alarm bus on Pin H from being activated for a system alarm event. The Status LED still flashes red and the ALRM message still displays.

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

CRAFT PORT

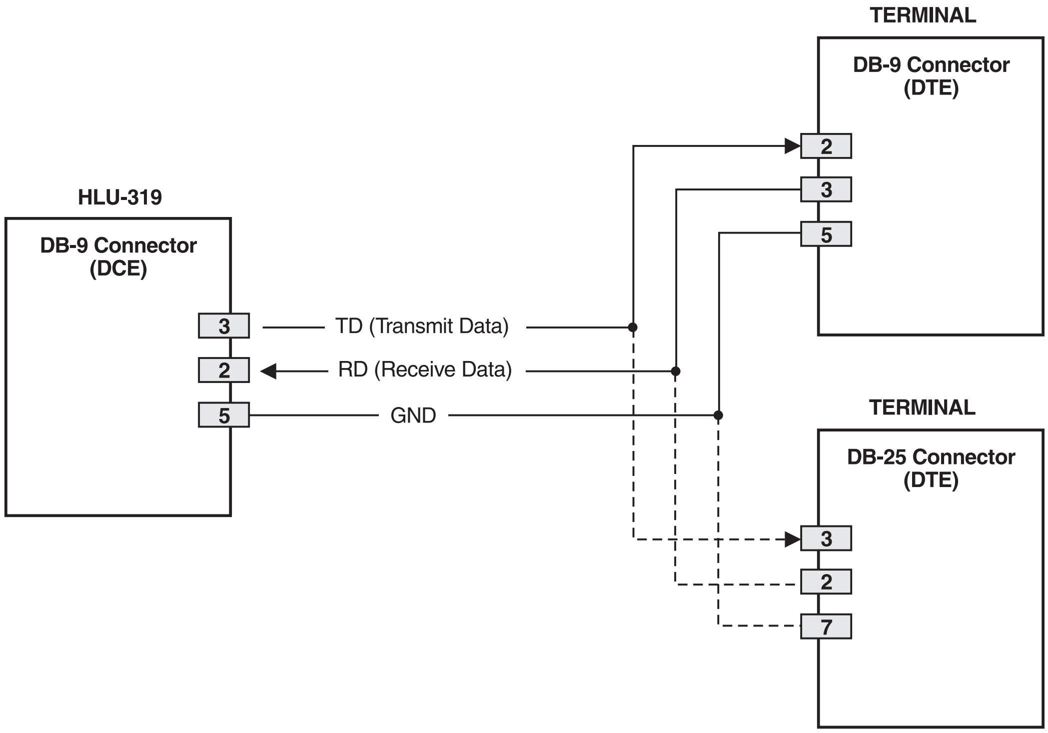


Figure 22. *RS-232 Craft Port Pinouts*

APPENDIX B - FUNCTIONAL OPERATION

PairGain HDSL technology provides full-duplex services at standard T1 rates over copper wires between an HLU and an HRU, which comprise 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 23. 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.

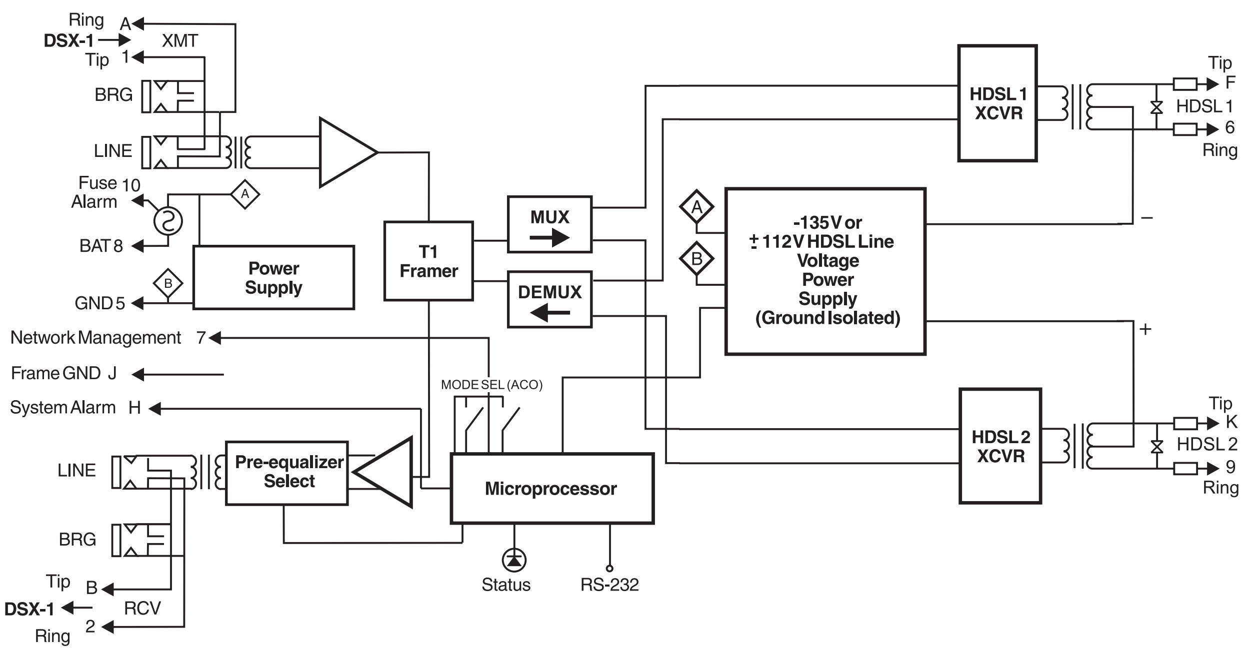


Figure 23. *HLU-319 List 5 Block Diagram*

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 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.

T1 REPEATER SHELVES AND RELATED EQUIPMENT

The HLU-319 List 5 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 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 List 5 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.

HIGAIN DOUBLER CIRCUIT DEPLOYMENT

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 25 on page 57 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 25. *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	*I*-CPE ON	*I*-CPE ON	*I*-CPE ON	*I*-CPE ON	*I*-CPE ON	*I*-CPE ON	*I*-CPE ON	*I*-CPE ON	CPEI ON	*I*-CPE ON	*I*-CPE ON	*I*-CPE ON
HLU-231 List 3D/6D	1	1	2	2	1	1	2	2	1	2	2	2
HLU-319 List 2X; HLU-388 List 2X	1	1	2	2	1	1	2	2	1	2 [b]	2	2
HLU-231, List 7X; HLU-431, List 1X	1	1	2	2	1	2 [b]	2	2	1	2	2	2
HLU-231, Lists 8/8D/8E; HLU-319, Lists 5/5D/5E; HLU-388 Lists 5/5D/5E	1	2 [c]	2	2	1	2	2	2	2	3 [c]	2	4 [d]
HLU-431 List 1F	0	0	1	1	0	0	1	1	1	1	1	2

(a) HRU-411 applications with *I*-CPE “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 or List 8A or HRU-402 or HRU-411.
(c) Requires HRU-402 or 411.
(d) Requires HRU-402.

APPENDIX D - SERVICE AND SUPPORT

PairGain Customer Service Group provides expert pre-sales and post-sales support and training for all its products.

TECHNICAL SUPPORT

Technical assistance is available 24 hours a day, 7 days a week by contacting PairGain Customer Service Group at:

Telephone:	(800) 638-0031 or (714) 832-9922 The 800 telephone support line is toll-free in the U.S. and Canada.
Fax:	(714) 832-9924
Email	support@pairgain.com

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.

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.

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.
- The purchase order number provided to Customer Service when the RMA number was requested.
- A 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.
- The shipping address to which PairGain should return the repaired equipment.
- The reason for the return:
  - The equipment needs an ECO/ECN upgrade.
  - The 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.

  - If there is another reason for returning the equipment, please let us know so we can determine how best to help you.

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
CDI	Customer Disconnect Indicator
CI	Customer Installation
CLEI	Common Language Equipment Identifier
CLOC	Customer Local Loopback
CO	Central Office
COM	Communications
CPE	Customer Premises Equipment
CRC	Cyclic Redundancy Check
CREM	Customer Remote Loopback
CSA	Carrier Service Area
CSU	Channel Service Unit
DCE	Data Circuit-Terminating Equipment
DDS	Digital Data Service
DIS	Disabled
DLC	Digital Loop Carrier
DS0	Digital Signal, level 0
DS1	Digital Signal, level 1
DSX-1	DS1 Cross-connect Frame
ECI	Equipment Catalog Item
ENA	Enabled
ENFT	Enable Fractional T1
ES	Errored Seconds
ESF	Extended SuperFrame
ESF DL	Extended SuperFrame Data Link
HCDS	High Capacity Digital Service
HCS	HiGain Central Office Shelf
HDSL	High-bit-rate Digital Subscriber Line
HDU	HiGain Doubler Unit
HLU	HiGain Line Unit
HMS	HiGain Management Shelf
HMU	HiGain Management Unit
HRE	HiGain Remote Enclosure
HRU	HiGain Remote Unit
I-CPE	Current (amperes) requirements for Customer Premises Equipment
ILR	Intelligent Line Repeater
IOR	Intelligent Office Repeater
IR	Intelligent Repeater
LED	Light Emitting Diode
LOS	Loss of Signal
LOSW	Loss of Sync Word
NEBS	Network Equipment Building System
NEC	National Electric Code
NI	Network Interface
NID	Network Interface Device
NIU	Network Interface Unit
NLOC	Network Local Loopback

NMA Network Management and Administration

NREM Network Remote Loopback

NVRAM Non-Volatile Random Access Memory

ORB Office Repeater Bay

PCS Personal Communication Services

PL Payload

POTS Plain Old Telephone Service

PPM Pulse Position Modulation

PWRF Power Feed

RCV Receive

RDA Remote DS1 Alarm

RLOS Remote Loss of Signal

RMA Return Material Authorization

SAIS SmartJack AIS

SF Super Frame

SMJK SmartJack

SNR Signal-to-Noise Ratio

SPLB Special Loopback

STS Span Terminating Shelf

TEC Total Error Count

TLOS-LB Transmit Loss of Signal-Loopback

TSEC Total System Error Count

TSGR Transport System Generic Requirements

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 LISTING

The HLU-319 List 5 is listed with the Underwriters Laboratory.

Use caution when installing or modifying telephone lines. Dangerous voltages may be present. Do not install telephone wiring during a lightning storm. Always disconnect telephone lines and power connections from wall outlets before servicing or disassembling this equipment.

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

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

Refer to the instructions under *"Returns"* on page 58 for complete return instructions.

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 5 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

For technical assistance, refer to *"Appendix D - Service and Support"* on page 58.

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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DNV
DNV Certification, Inc.
Certificated Firm

PairGain