HiGain Line Unit

Model	List Number	Part Number	CLEI Code
HLU-319	2E	150-1140-25	T1L1BH43AA

PairGain Technologies, Inc.
Engineering Services Technical Practice

Section 150-319-125-01

PairGain

Revision History of This Practice

Revision	Release Date	Revisions Made
01	September 15, 1998	Initial Release

USING THIS TECHNICAL PRACTICE

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

Notes contain information about special circumstances.

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

INSPECTING SHIPMENT

Upon receipt of the equipment:

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

ABBREVIATIONS

2B1Q	2Binary1Quaternary
AIS	Alarm Indication Signal
AMI	Alternate Mark Inversion
B8ZS	Bi-polar with 8-zero Substitution
BPV	Bipolar Violation
CI	Customer Interface
CO	Central Office
CLOC	Customer Local Loopback
CPE	Customer Premises Equipment
CRC	Cyclic Redundancy Check.
CSA	Carrier Service Area
DCE	Data Circuit-Terminating Equipment
DDS	Digital Data Service
DL	Data Link
DS1	Digital Service, Level 1
DSX-1	Digital System Cross-Connect frame.
ES	Errored Seconds
ESF	Extended Super Frame
ESF DL	Extended Super Frame Data Link
HCDS	High Capacity Digital Service
HDSL	High-bit-rate Digital Subscriber Line
HDU	HiGain Doubler Unit

HLU	HiGain Line Unit
HRU	HiGain Remote Unit
LOS	Loss of Signal
LOSW	Loss of Sync Word
NEBS	Network Equipment Building System
NI	Network Interface
NID	Network Interface Device
NMA	Network Management Administration
NREM	Network Remote Loopback
POTS	Plain Old Telephone System
PWRF	Power Feed
SAIS	SmartJack AIS
SF	Super Frame
S/N	Signal-to-Noise
SPLB	Special Loopback
STS	Span Terminating Shelf
TSGR	Transport System Generic Requirements
UAS	Unavailable Seconds
ZBTSI	Zero Byte Time Slot Interchange

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PRODUCT OVERVIEW

The PairGain® HiGain® HLU-319 List 2E 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 HLU-319 can be used in applications with or without HiGain Doubler Units (HDUs).

The CSA includes loops up to 12,000 feet of 24 AWG or 9,000 feet of 26AWG wire, including bridged taps. The HiGain system uses HDSL (High-bit-rate Digital Subscriber Line) transmission technology as recommended by Bellcore TA-TSY-001210. The HiGain system complies with TR-TSY-000063 (Network Equipment Building System (NEBS) Generic Equipment requirements) and TR-TSY-000499 (Transport System Generic Requirements—TSGR) common requirements.

HLU-319 FEATURES

- Selectable DS-1 pre-equalizer
- 130 to 200 Vdc HDSL line power for HDU and HRU
- Ground fault-detection circuit
- Front panel HDSL Signal/Noise (S/N) margin display
- Compatible with Span Terminating Shelf (STS) high-density shelves
- Selectable loopback activation codes
- Craft (RS-232) maintenance port
- Network Management Administration (NMA) interface
- Non-volatile front panel operator setup
- Front panel DS1 splitting and bridge access
- Lightning and power cross protection on HDSL interfaces
- 784 kbps full duplex 2B1Q HDSL transmission on two wire pairs
- Front panel status LED
- On/Off front panel display power cycling
- DS1 LOS detector (125 consecutive zeros)
- Margin threshold alarm
- HDSL AIS (Alarm Indicating Signal) and Smart-Jack AIS options
- Easy return to factory default user settings
- Circuit ID option
- Low power consumption

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.

Each loop must have no more than 35 dB of loss at 196 kHz, with driving and terminating impedances of 135 Ω. Table 1 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 1. *HDSL Loss Over Cables*

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

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 at a leisurely pace and cut-over from the installed HiGain system when convenient to do so. The installed HiGain system can then be easily removed and utilized elsewhere.

PRODUCT DESCRIPTION

The HLU-319 includes:

- A front panel featuring:
  - A status display
  - System option buttons
  - Status LED
  - DSX-1 access jacks
  - Craft port
  - CLEI and bar code numbers
  - Warranty Control number
- Card-edge connectors

FRONT PANEL

The HLU-319 front panel is shown in Figure 1. The front panel components are described in Table 2.

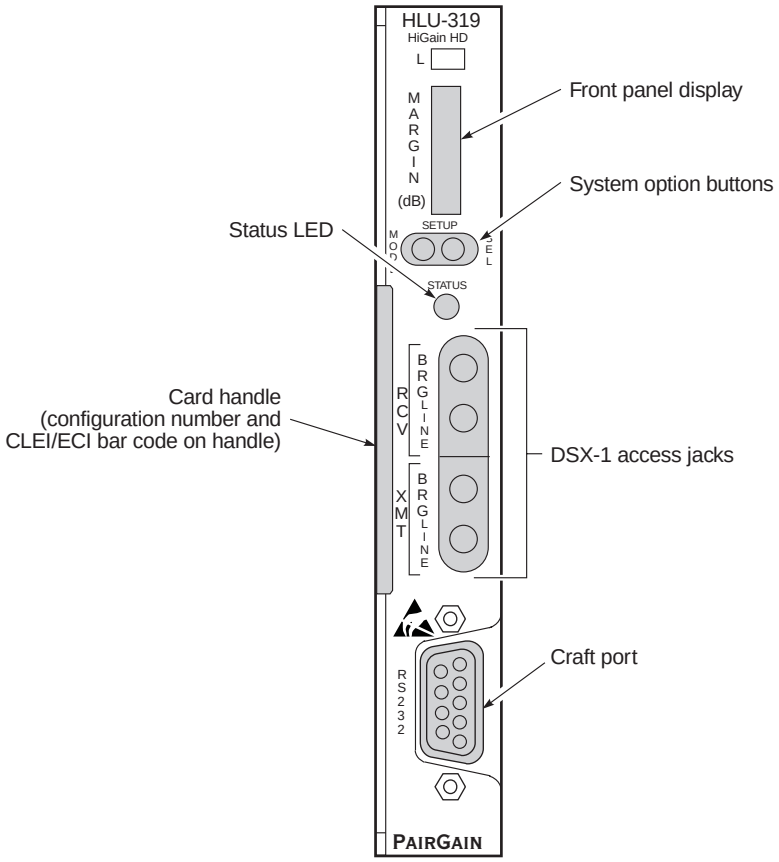


Figure 1. *HLU-319 Front Panel*

Table 2. *Front Panel Components*

Front Panel Feature	Function
Front panel display	Displays four-character status, provisioning, and alarm system messages.
System option buttons (MODE and SEL)	Permit the user options to be monitored and modified without using a maintenance terminal. Used to initiate all HiGain loopbacks and to display DSX-1 line parameters and line unit identity.
Status LED	See Table 3 for status descriptions.
DSX-1 access jacks	
LINE	Provides splitting jack access to (XMT) and from (RCV), the HDSL line at the DSX-1 interface. Breaks the XMT and RCV paths to permit test signal insertion and retrieval.
BRIDGE	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.
CLEI and bar code labels	Provides the human-readable Common Language Equipment Identifier (CLEI) code number and the Equipment Catalog Item (ECI) bar code number.
Configuration Number (warranty control number) and CLEI/ECI bar code	Indicates the beginning year and month of the warranty. Also indicates the unit's configuration number. For example, a configuration number of "80107" would indicate a warranty beginning in the year 1998 (8), during the month of January (01), and the unit's configuration number of 7 (07).

Status LED

Table 3 describes the functions of the Status LED on the front panel.

Table 3. *Status LED Descriptions*

LED Status	Description
Green	Normal operation.
Flashing green	HDSL acquisition.
Red	Fuse alarm.
Flashing red	Minor alarm.
Yellow	Self Test is in process or an HLU-319 Customer Remote Loopback (CREM) or a Network Local Loopback (NLOC) is in effect.
Flashing yellow	HLU-319 is in an Armed state.

Front Panel Display

The front panel display (Figure 1) is used with the MODE and SEL buttons to display system diagnostic messages. Refer to Table 4 for a listing of the four-character messages.

The front panel display turns on when power is initially applied to the HLU-319. To conserve power, the display only remains on for five minutes. The use of the MODE or SEL buttons activates the front panel display and restarts the five-minute, power-control timer.

Table 4. *HLU-319 Front Panel Display Messages*

Message	Full Name	Description
NONE	No Alarms	No alarms.
LLOS	Local Loss of Signal	No signal from HLU-319 local DSX-1 interface.
RLOS	Remote Loss of Signal	No signal from HRU- remote DS1 interface.
LOSW1	Loss of Sync Word 1	HDSL loop 1 has lost sync.
LOSW2	Loss of Sync Word 2	HDSL loop 2 has lost sync.
H1ES	HDSL Loop 1 Errored Second	Loop 1 CRCs have exceeded the user-selected ES threshold.
H2ES	HDSL Loop 2 Errored Second	Loop 2 CRCs have exceeded the user-selected ES threshold.
DS1	Digital Service 1	T1 input BPVs, at either the HLU-319 or HRU, have exceeded the user-selected ES threshold.
DS0	DS0 Blocked Channels: NONE or BLK	Indicates status of DS0 blocked channels. NONE indicates that no channels are blocked. BLK indicates that some channels are blocked.
MNGD	Managed	The HLU-319 is being managed by the HMU-319 management unit. In this state, the front panel Craft port is disabled.
RAIS	Remote Alarm Indicating Signal	Indicates an AIS (all ones) pattern is being transmitted from the remote T1 output port.
LAIS	Local Alarm Indicating Signal	Indicates an AIS (all ones) pattern is being transmitted from the local T1 output port.
MAL1	Margin Alarm 1	The margin on HDSL loop 1 has dropped below the threshold (0 to 15 dB) set by the user. Setting the threshold to 0 inhibits the margin alarm.
MAL2	Margin Alarm 2	The margin on HDSL loop 2 has dropped below the threshold (0 to 15 dB) set by the user. Setting the threshold to 0 inhibits the margin alarm.
CHREV	Channels Reversed	The loop 1 and 2 HDSL pairs are reversed at the HRU line input port. Loop 1 is specified to carry the (-) simplex dc voltage, and loop 2 is specified to carry the (+) simplex dc voltage.
ACO	Alarm CutOff	A minor alarm occurred and was retired to an ACO condition after pressing the SEL button on the HLU-319 front panel.
LBPV	Local Bipolar Violation	A bipolar violation was received at the DSX-1 input to the HLU-319.

Table 4. *HLU-319 Front Panel Display Messages (Cont.)*

Message	Full Name	Description
SIG1	Signal 1	The HLU-319 and the first doubler transceivers are trying to establish contact on loop 1 of span 1.
S2L1	Signal 2 Loop 1	The first doubler is trying to establish contact with either the HRU or the second doubler transceivers on loop 1 of span 2.
S2L2	Signal 2 Loop 2	The first doubler is trying to establish contact with either the HRU or the second doubler transceivers on loop 2 of span 2.
S3L1	Signal 3 Loop 1	The second doubler and HRU transceivers are trying to establish contact on loop 1 of span 3.
S3L2	Signal 2 Loop 2	The second doubler and HRU transceivers are trying to establish contact on loop 2 of span 3.
ACQ1	Acquisition 1	The HLU-319 and the first doubler multiplexers are trying to synchronize over loop 1 of span 1.
ACQ2	Acquisition 2	The HLU-319 and the first doubler multiplexers are trying to synchronize over loop 2 of span 1.
A2L1	Acquisition 2 Loop 1	The first doubler is trying to synchronize with either the HRU or the second doubler multiplexers on loop 1 of span 2.
A2L2	Acquisition 2 Loop 2	The first doubler is trying to synchronize with either the HRU or the second doubler multiplexers on loop 2 of span 2.
A3L1	Acquisition 3 Loop 1	The second doubler and the HRU multiplexers are trying to synchronize on loop 1 of span 3.
A3L2	Acquisition 3 Loop 2	The second doubler and the HRU multiplexers are trying to synchronize on loop 2 of span 3.
BAD RT?	No response from HRU	The HLU-319 is not receiving any HRU, and therefore the HRU's integrity is questionable.
LIST XXXX	HLU-319 List number	To display the List number, press the MODE button for three seconds.
VER XXXX	HLU-319 software version number	To display the software version, press the MODE button for three seconds.
FRM	Frame: SF, ESF, UNFR, None	Defines the type of frame pattern being received from the DSX-1. To display frame pattern, press the MODE button for three seconds.
SIG2	Signal 2	The HLU-319 and the first doubler transceivers are trying to establish contact on loop 2 of span 1.
FERR	Framing Bit Error	Framing bit error occurred at the HLU-319 input.
ARM	HiGain system is Armed	The HiGain system is Armed and ready to respond to Intelligent Repeater loop codes.
SMJK	Smart-Jack Loopback	The loopback at HRU (remote) toward network initiated by either the (2 in 5) in-band loopback code or the out-of-band ESF data link loopback code.

Table 4. *HLU-319 Front Panel Display Messages (Cont.)*

Message	Full Name	Description
NREM	Network Remote Loopback	The loopback at HRU (remote) toward network initiated from CO (network) by either the Intelligent Line Repeater (ILR) number 2 code, the HLU-319 front panel Manual Loopback push buttons, the HRU front panel push button, or the maintenance terminal.
NLOC	Network Local Loopback	The loopback at HLU-319 (local) toward network initiated from CO (network) by either the Intelligent Office Repeater (IOR) code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
CLOC	Customer Local Loopback	The loopback at HRU (local) toward CI initiated from CPE (customer) by either the ILR number 2 code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
CREM	Customer Remote Loopback	The loopback at HLU-319 (remote) toward customer initiated from CPE (customer) by either the IOR code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
ARM	Armed	The HiGain system detected the IR loopback (2 in 5) arming code.
TLOS	Transmit Loss of Signal (Loopback)	HRU is in a logic loopback state, caused by a loss of its DS1 input from the CI when ENAbled at the HRU-412, List 6 or List 7, via its TLOS switch option.
SELF-TEST	Self-test	The HLU-319 is in self-test mode, which occurs whenever the power is turned on.
ALRM	Alarm condition exists	A minor alarm has occurred.
1=xx	HDLS Loop 1 Margin	Indicates the power of the received HDSL signal on loop 1 relative to noise. Any value of 06 or greater is adequate for reliable system operation.
2=yy	HDSL Loop 2 Margin	Indicates the power of the received HDSL signal on loop 2 relative to noise. Any value of 06 or greater is adequate for reliable system operation.
PWR FEED SHRT	Power Feed Short	Indicates a short between the two HDSL pairs, or that an HRU that is drawing the correct amount of power over good cable pairs but cannot communicate with the HLU-319.
PWR FEED OPEN	Power Feed Open	Indicates an open circuit in the Tip and Ring of either HDSL pair.
PWR FEED OFF	Power Feed Off	HDSL span power has been turned off by setting the PWFD option to DIS.
CODE	Line Code: AMI, B8ZS	The line code that the HLU-319 is receiving at the DSX-1 interface, if the DS1 option is set to Auto. Otherwise, this code mimics either of the other two DS1 line code settings. To view the code, press the MODE button for three seconds.

HLU-319 CARD-EDGE CONNECTORS

Figure 2 shows the HLU-319 card-edge connectors. Active pins are highlighted in black.

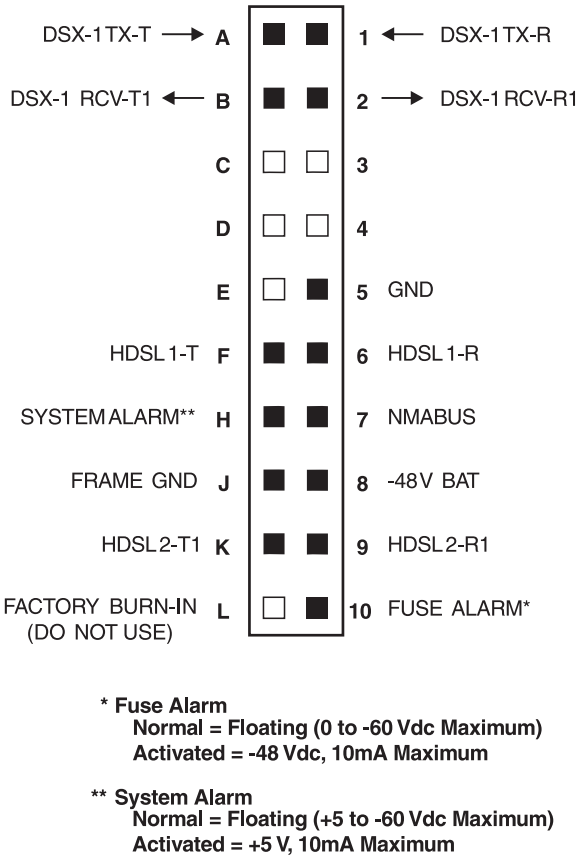


Figure 2. *HLU-319 Card-Edge Connectors*

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-319 through the HMU-310 HiGain Management Unit.

Fuse Alarm

Pin 10 on the card-edge connector is a Fuse Alarm that driven to -48 V whenever its on-board fuse opens. It emulates the function of the Fuse Alarm output from Pin 10 of normal HD (High Density) repeaters. Pin 10 is connected to Pin 5 of the 1184 Alarm Card (slot 1 in 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 is the HLU-319 System Alarm output pin. The following notes apply to Pin H:

- Pin H replaces the Local Loss of Signal alarm on normal HD (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 HD shelf.
- The HLU-319 forces pin H to +5V (maximum of 10 mA) for a system alarm condition. Pin H then remains at +5V for the duration of the alarm condition.
- If the Wescom 1184 Alarm Card is installed in the shelf, its LOS LED lights for every minor alarm.
- The HLU-319 Status LED flashes red for the duration of a minor alarm condition.
- Setting the ALM option to DIS only prevents the minor alarm output alarm bus on pin H from being activated when a system alarm occurs. The Status LED still flashes red and the ALRM message still displays.

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

INSTALLATION

This product contains static-sensitive components. Be sure to ground yourself properly before touching the HLU-319.

To install the HLU-319:

1 Slide the HLU-319 into the card guides for the desired slot, then push the unit back until it touches the backplane card-edge connector and the retaining latch on the front panel opens (Figure 3).

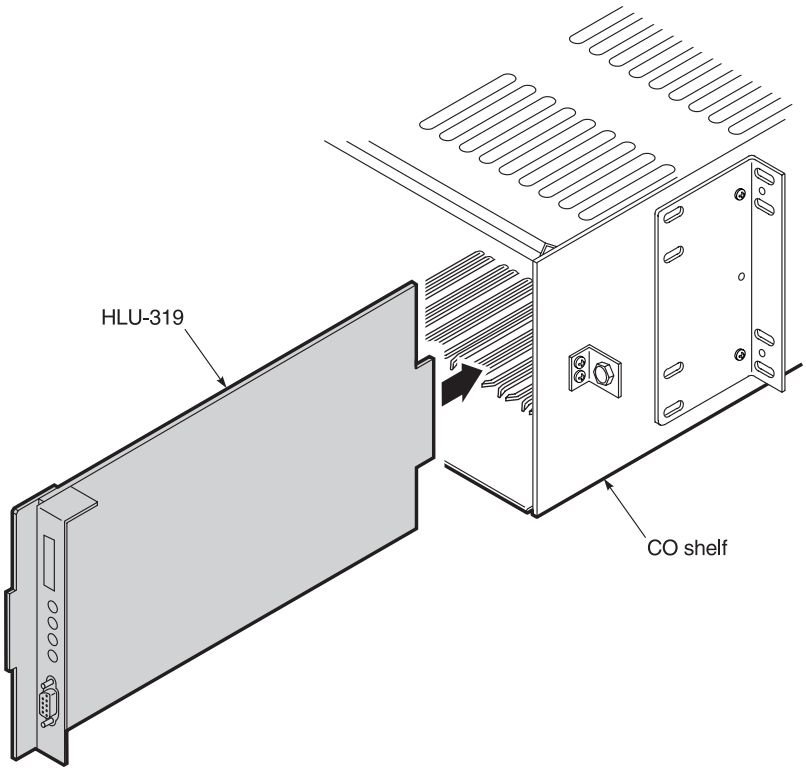


Figure 3. *Installing the HLU-319 into a Shelf*

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

PROVISIONING THE HLU-319

There are two methods for provisioning the HLU-319:

- Use the MODE and SEL buttons on the front panel.
- Access system settings screens through the Craft port.

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 settings are retained if shelf power is lost or if the HLU-319 is unplugged.

SETTING OPTIONS THROUGH SEL AND MODE

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

1 Press the MODE button and release it after one second.

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 mode to the selected setting, and then advances to the next configurable parameter.

After the last parameter has been selected, the following confirmation message appears on the front panel display:

`CONF NO`

4 Do one of the following:

- To cancel the session without saving the requested parameter changes, press the MODE button. (If there is no input for 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 `YES` message displays, and the display returns to its normal mode after saving the new changes.)

In either case the display returns to its normal mode.

Factory Default Values

All user options except setting the Circuit ID can be set to the factory default values using the SEL and MODE buttons. To set the user options to their default values:

1 Press the SEL button for six 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.

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

- Press the MODE button *or*
- Wait 30 seconds for the display to return to its normal state.

Displaying System Inventory

To scroll through an inventory of system parameters, press the MODE button for three or more seconds. The following parameters are displayed:

- HLU-319 software version number
- HLU-319 List number
- Type of frame pattern being received from the DSX-1
- Line code setting of the HLU-319
- All option settings

The line code parameter is the actual DS1 line code being received by the HLU if the DS1 code pattern is set to AUTO. Otherwise, the line code parameter mimics either of the other two line code settings, AMI or B8ZS.

CONNECTING TO A MAINTENANCE TERMINAL

The 9-pin Craft (RS-232) port on the front panel allows you to connect the HLU-319 to a maintenance 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 Craft port on the HLU-319 front panel.

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

3 If necessary, start a terminal emulation program.

4 Configure the maintenance terminal to the following communication settings:

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

The Craft port is a standard RS-232 (DB-9, female) connector on the front panel. See Figure 4 for pinouts.

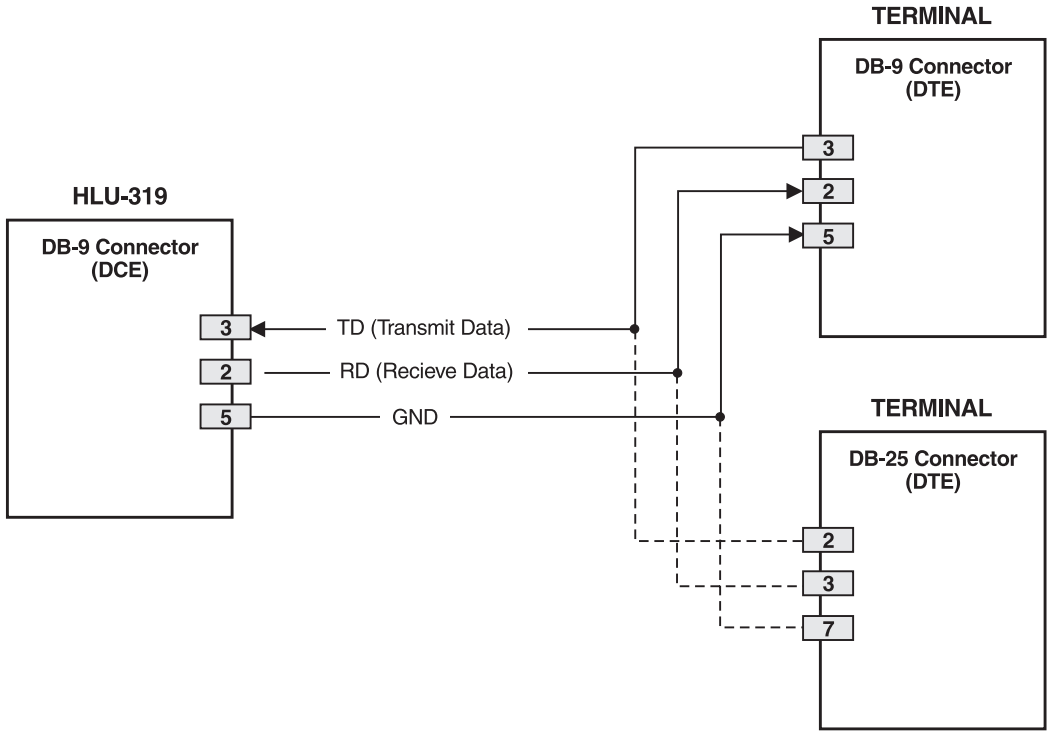


Figure 4. *DB-9 RS-232 I/O Pinouts*

MAINTENANCE

This section explains how to navigate through the Maintenance Terminal screens and describes the Main Menu and its various options.

NAVIGATING THE MAINTENANCE TERMINAL SCREENS

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

System Spans

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

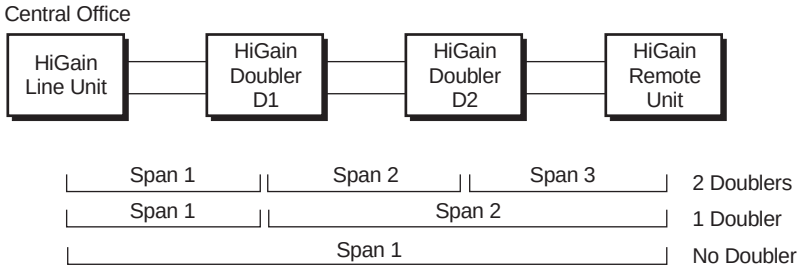


Figure 5. *System Spans*

Navigation Keys

Table 5 lists keys you can use on the maintenance terminal to navigate within the Maintenance Terminal screens.

Table 5. *Navigational Keys on the Maintenance Terminal*

Key	Function
U	Updates a report
C	Clears a report
S	Selects the next Span Status screen
P	Selects the previous page of a report
N	Selects the next page of a report
E	Exits the current screen
ESC	Exits the current screen

Selecting an Option

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

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

An invalid entry generates an audible beep.

INITIALIZING THE MAINTENANCE TERMINAL SCREENS

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

MAINTENANCE TERMINAL MAIN MENU

Figure 6 shows the Maintenance Terminal Main Menu, from which you can access eight system administration screens. The function of each menu selection is described in Table 6.

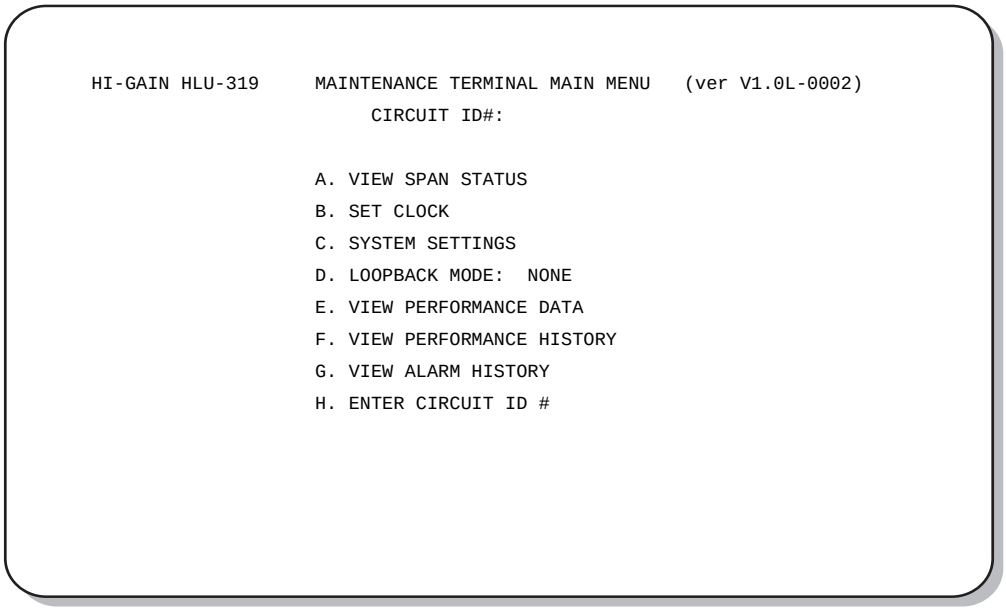


Figure 6. *Maintenance Terminal Main Menu*

Table 6. *Maintenance Terminal Screens*

Screen	Function	See page:
View Span Status	Provides access to subscreens that allow you to monitor the HDSL line between the HLU-319 and the HRU.	16
Set Clock	Allows you to set both the time and the date parameters at the HLU-319, and to update the same settings at the HRU.	18
System Settings	Allows you to set all user options.	20
Loopback Mode	Provides access to subscreens that allow you to issue and disable loopbacks from both the network and customer side.	26
View Performance Data	Provides access to subscreens that allow you to view the Errored Seconds (ES) and Unavailable Seconds (UAS) between the HLU-319 and the HRU in 15-minute intervals over a four-hour time period.	29
View Performance History	Provides access to subscreens that allow you to view the ES and UAS between the HLU-319 and the HRU in 24-hour intervals over a seven-day period.	32
View Alarm History	Provides access to subscreens that allow you to view alarm conditions between the HLU and the HRU.	33
Enter Circuit ID #	Allows you to enter a unique circuit ID (up to 24 characters).	26

VIEW SPAN STATUS

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

From each Span Status screen you can:

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

Span Status Screen: Non-Doubler Applications

Press **A** from the Maintenance Terminal Main Menu to open the Span Status screen (Figure 7). If no doubler (HDU) is present, the screen reports span status for the subscriber lines between the HLU-319 and the HRU.

Span Status Screen: Doubler Applications

If doublers have been added, status is also reported for these. After pressing **A** to access the Maintenance Terminal Main Menu, press **S** to navigate through the span status screens. Span Status can have up to three screens, depending on the number of HDUs. Figure 8 shows status between an HLU and its first doubler (HDU1). If there is only one doubler, the next screen (Figure 9) shows status between HDU1 and the HRU. If there are additional doublers the Span Status screen will report status on each span.

```
                          SPAN STATUS
                  (HLU/ver1.0-0002:  HRU/ver0.0-0000)
TIME: 00:15:40
DATE: 02/02/98            Circuit ID#:

ALARMS:   LAIS LOSW1 LOSW2
LOOPBACK: OFF
                       HLU                        HRU
                  HDSL-1       HDSL-2       HDSL-1       HDSL-2
               cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:            N/A          N/A          N/A          N/A   dB
PULSE ATTN:        N/A          N/A          N/A          N/A   dB
PPM OFFSET:        N/A          N/A          N/A          N/A   ppm
24 HOUR ES:      00005        00003        00006        00006   seconds
24 HOUR UAS:     00086        00087        00050        00009   seconds
                                  DS1 STATUS
                               HLU                  HRU
24 HOUR BPV Seconds:         00004                00010
24 HOUR UAS Count:           00214                00125
Frame type:                UNFRAMED                N/A
Code type:                    AMI                  AMI

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

Figure 7. *Span Status Screen: No Doubler*

```
                          SPAN STATUS
                  (HLU/ver1.0-0002:  HRU/ver0.0-0000)
TIME: 00:15:40
DATE: 02/02/98            Circuit ID#:

ALARMS:    CHREV
LOOPBACK:  OFF
                       HLU                        HDU1
                  HDSL-1       HDSL-2       HDSL-1       HDSL-2
               cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:         21/16/21     21/18/22     21/00/22     21/00/22 dB
PULSE ATTN:        01           01           00           00    dB
PPM OFFSET:        00           00          -07          -07    ppm
24 HOUR ES:      00008        00005        00007        00001   seconds
24 HOUR UAS:     00124        00124        00012        00013   seconds
                                  DS1 STATUS
                               HLU                  HRU
24 HOUR BPV Seconds:         00006                00015
24 HOUR UAS Count:           00218                00130
Frame type:                UNFRAMED             UNFRAMED
Code type:                    AMI                  AMI
                            (E)xit (C)lear (U)pdate (S)pan
```

Figure 8. *Span 1 Status Screen: With Doubler*

Highlighted text will change in Figure 7, Figure 8, and Figure 9, depending on system configuration.

```
                              SPAN STATUS
                    (HLU/ver1.0-0002:  HRU/ver0.0-0000)
TIME: 00:15:40
DATE: 02/02/98           Circuit ID#:

ALARMS:    NONE
LOOPBACK:  OFF
                        HDU1                        HRU
                  HDSL-1       HDSL-2       HDSL-1       HDSL-2
                cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:           22/00/22     21/00/22     22/21/23     22/20/23 dB
PULSE ATTN:         01           01           01           01     dB
PPM OFFSET:         00           00           13           14     ppm
24 HOUR ES:       00001        00003        00012        00010   seconds
24 HOUR UAS:      00006        00020        00053        00011   seconds
                                   DS1 STATUS
                                HLU                  HRU
24 HOUR BPV Seconds:          00006                00015
24 HOUR UAS Count:            00218                00130
Frame type:                 UNFRAMED             UNFRAMED
Code type:                     AMI                  AMI
                              (E)xit (C)lear (U)pdate (S)pan
```

Figure 9. *Span 2 Status Screen: One Doubler*

SET CLOCK

Press **B** from the Maintenance Terminal Main Menu to open the Set Clock menu (Figure 10).

```
                              SET CLOCK

TIME: 00:14:33
DATE: 02/02/98
CIRCUIT ID#:

Format: HH:MM
        MM/DD/YY

NEW TIME:
NEW DATE:



(U)PDATE REMOTE?
```

Figure 10. *Set Clock Menu*

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 menu 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

HRU-412 List 1 units with software versions 6.4 and above, and all HRU-412 units with list numbers greater than 5, can be automatically set to the same time and date as the HLU-319. Do one of the following:

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

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

SYSTEM SETTINGS

The options set from the System Settings menu are the same as the options set using the HLU-319 front panel Mode and SEL buttons. All 14 user options can be set from this menu.

Press **C** from the Maintenance Terminal Main Menu to open the System Settings menu (Figure 11).

```
                                SYSTEM SETTINGS

TIME: 12:46:06
DATE: 02/02/98                  CIRCUIT ID#:

E(Q)UALIZATION       : 0
SMART-JACK (L)B      : ENABLED
(S)PECIAL LPBK       : GNLB
(P)OWER              : ENABLE
(Z)BTSI              : OFF
ES ALARM TH(R)ESH    : NONE
LOOPBACK (T)IMEOUT   : NONE
(A)LARM              : DISABLE
(D)S1 LINE CODE      : AMI
(F)RAMING            : AUTO
AIS ON (H)DSL LOSW   : 2 LOOPS
AIS ON S(M)JK/NREM   : ENABLE
MAR(G)IN ALARM THRESH: 4
DS0 (B)LOCKING: 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

                                  (E)xit
               Enter the letter in parenthesis to change any setting
```

Figure 11. *System Settings Menu*

To change any option:

1 Type the character key shown inside the parentheses within each parameter description, then type the character key repeatedly to toggle through the available settings.

The screen refreshes with the new settings.

2 After all parameters have been selected, press **E** to exit, then **C** to confirm.

The newly selected parameters are activated.

DS0 Blocking Option

To set the DS0 Blocking option:

1 From the Main Menu, press **C** to select the System Settings menu.

2 Press **B** to select DS0 blocking.

The DS0 channels are blocked or unblocked by entering each channel number. Multiple channels can be selected by inserting a space between each entry.

3 After all the new settings have been made, press **E** for Exit, then press **C** to Confirm.

The new choices are installed.

All blocked channels are temporarily unblocked for all HiGain system loopback tests. This allows the standard full bandwidth T1 loopback tests to be performed.

DS1 Line Code Option

The DS1 line code option should always be set to conform to the type of T1 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 T1 circuits whose line codes are not known or may be both AMI and B8ZS), because it has the following two limitations:

- The Auto mode induces one BPV in the T1 bit stream whenever it switches from AMI to B8ZS.
- The Auto mode allows both the HLU-319 and HRU to set their DS1 mode to the code that is being receiving at the opposite end's T1 input. This makes each unit's code independent of the T1 code, which is sent from the distant T1 input port. Thus, if the line codes being received are different in each of the two T1 directions, the HiGain T1 output codes will not match their respective T1 input codes at the other end. This could cause the customer's received data to be AMI instead of B8ZS, and thus violate the one's density rules by having excessive zeroes.

Margin Alarm Threshold

To set the Margin Alarm Threshold:

1 Select **G** from the System Settings menu.

2 Press **G** until the desired minimum acceptable alarm threshold displays. The range is from 0 to 15 dB.

This causes a minor alarm to occur if either the margin on HDSL loop 1 (MAL1) or loop 2 (MAL2) of any span drops below the selected threshold value. Since the margin can never drop below 0, selecting **0** for the margin threshold turns the margin alarm off.

The new T1 transceiver chip in the HLU-319 List 2E allows the unit to process both B8ZS and AMI code inputs, regardless of the DS1 code setting (AMI or B8ZS). Earlier units caused input BPV, if B8ZS patterns were processed while in the AMI mode. When the newer units are in the AMI mode, they can receive B8ZS but can only transmit AMI. For this reason, mixed systems (those consisting of both HLU-319, List 2E and older Lists 1, 2, 3, 3A and 4 HRU-412 units) will respond differently in each direction for B8ZS inputs when in their AMI modes.

The Self-test mode, which occurs when both HDSL loops are not in-sync, has been enhanced to include the input DS1 transceiver chip in the self-test procedure. This process can cause the Alarm Indicating Signal (AIS) pattern, which is normally transmitted from the HLU-319 List 2E during these out-of-sync intervals, to exhibit occasional BPVs.

HAIS Selections

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

- **1LP -** causes the AIS pattern to be transmitted at both T1 outputs when either of the two HDSL loops experience a loss-of-sync (LOSW) condition or when a margin alarm occurs. This choice causes the 12 channels on the surviving loop to be lost as they are replaced by the AIS 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 state with just one conductor open in either of the HDSL pairs. Short loops, below about 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 opens a minor alarm occurs and causes the AIS condition. This alerts the maintenance personnel of the problem.
- **2LP -** requires both HDSL loops to be out-of-sync (LOSW) before the AIS signal is transmitted. This choice preserves the integrity of the 12 surviving channels when just one loop is lost.

All user options that affect the operation in both the HLU-319 and HRU-412, (such as HAIS, SAIS and DS0 blocking) are not available in older versions of the HRU-412, Lists 1, 2, 3, 3A, and 4 that do not support these newer options.

System Settings Screen Options

Table 7 describes the System Settings menu options and their counterpart front panel display codes.

Table 7. *HLU-319 System Options*

System Settings Screen Option	Mode	Selection	Description
E(Q)UALIZATION	EQL	0*	Sets the equalizer to DSX-1 for 0 to 132 feet.
		133	Sets the equalizer to DSX-1 for 133 to 265 feet.
		266	Sets the equalizer to DSX-1 for 266 to 398 feet.
		399	Sets the equalizer to DSX-1 for 399 to 532 feet.
		533	Sets the equalizer to DSX-1 for 533 to 655 feet.
SMART-JACK (L)B	LPBK	DIS	Configures the HiGain system to ignore the (2 in 5) in-band Smart-Jack loopback command.
		ENA*	Enables the HiGain system to recognize the (2 in 5) in-band Smart-Jack loopback command.

Table 7. *HLU-319 System Options (Cont.)*

System Settings Screen Option	Mode	Selection	Description
(S)PECIAL LPBK	SPLB	GNLB*	Configures the HiGain system to respond to the generic (3/4/5/6 in 7) in-band loopback codes.
		A1LB and A2LB	Configures the HiGain system to respond to the Teltrend addressable repeater in-band loopback codes.
		A3LB	Configures the HiGain system to respond to the Wescom addressable repeater in-band loopback codes.
		A4LB	Configures the HiGain system to respond to the Wescom Mod 1 addressable repeater in-band loopback codes.
		A5LB	Configures the HiGain system to respond to the Teltrend Mod 1 addressable repeater in-band loopback codes.
(P)OWER	PWRF	DIS	Disables powering to the HRU and doubler.
		ENA*	Enables powering to the HRU and doubler.
(Z)BTSI	ZBTS	ON	Tells the HiGain system that the ESF frame is operating in its Zero Byte Time Slot Interface (ZBTSI) mode.
		OFF*	Tells the HiGain system that the ESF frame is operating in its normal non-ZBTSI mode.
ES ALARM TH(R)ES	ESAL	17	Flashes the red Status LED when 17 Errored Seconds (ES) (17 HDSL cyclic redundancy check (CRC) errors on either HDSL loop or a total of 17 BPVs) occur within a 24-hour period.
		170	Flashes the red Status LED when 170 ES (170 HDSL CRC errors on either HDSL loop or a total of 170 BPVs) occur within a 24-hour period.
		NONE*	Prevents generation of a minor alarm due to excessive errored seconds.
LOOPBACK (T)IMEOUT	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.

Table 7. *HLU-319 System Options (Cont.)*

System Settings Screen Option	Mode	Selection	Description
(A)LARM	ALM	DIS*	Disables the activation the output alarm has on pin H when a minor alarm occurs.
		ENA	Enables the activation the output alarm has on pin H when a minor alarm occurs.
(D)S1 LINE CODE	DS1	AUTO	The HLU-319 and HRU independently monitor their incoming T1 bit streams for the Binary Eight Zero Substitution (B8ZS) pattern. If either unit detects this pattern, it enters its B8ZS mode. It reverts back to its Alternate Mark Inversion (AMI) mode if no B8ZS patterns are received for five 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.
(F)RAMING	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 insures proper channel time slot alignment. While the HiGain system can also process unframed data in this Auto mode, it is recommended that the unframed (UNFR) mode be used for all unframed applications. Using the Auto mode for unframed applications runs the risk of detecting “pseudo-valid” frame sequences, which can affect the data integrity.
		UNFR	Configures the HiGain system to operate in an unframed mode. This mode disables the auto framing process and forces the HiGain system to function as a transparent bit pipe.
AIS ON (H)DSL LOSW	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.

Table 7. *HLU-319 System Options (Cont.)*

System Settings Screen Option	Mode	Selection	Description
AIS ON S(M)JK/NREM	SAIS	ENA*	Causes the HRU-412 Lists 6 and 7 to transmit the AIS signal toward the Customer Interface (CI) when in NREM or Smart-Jack loopback.
		DIS	Causes the List 6, HRU-412 to transmit the signal from the network toward the CI when an HRU NREM or Smart-Jack loopback is executed. The AIS signal is off.
	CONF	YES	Confirms that all 12 operating modes (listed previously in this table) 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 options settings mode was entered.
MAR(G)IN ALARM THRESHOLD	MARG	0 to 15 dB	The Margin Alarm Threshold can only be set from the Craft port, using a terminal. It determines the minimum allowable margin below which a minor alarm can occur. Note that setting the threshold to "0" inhibits the margin alarm.
		4 dB*	(Default value)
DS0 (B)LOCKING	DS0	BLK	The DS0 blocking option can only be set from the Craft port using a terminal). The four-character HLU-319 front panel LED readout only displays the status of the blocking option. BLK indicates at least one channel is blocked.
		NONE*	No channels are blocked.

*Indicates factory default settings.

CIRCUIT ID OPTION

To set the Circuit ID option:

1 From the Main Menu, press **H**.

The message `ENTER CIRCUIT ID#`: displays.

2 Type a Circuit ID (24 characters maximum), then press **ENTER**.

If you type more than 24 characters, a “Beep” sounds and only the first 24 characters are accepted as the Circuit ID.

3 Press **C** to confirm.

The ID appears in all HLU-319 screens. The ID does not appear on the HRU screens when you access them from the remote unit maintenance port.

Note that the Circuit ID can not be set to its factory setting (all blanks) using the DFLT setting option (see "Factory Default Values", on Page 11).

LOOPBACK MENU

The Loopback Menu permits you to issue loopbacks to the HiGain system. There are three possible Loopback Menus:

- Loopback Menu: No doubler
- Loopback Menu: One doubler
- Loopback Menu: Two doublers

In all instances, press **D** from the Maintenance Terminal Main Menu to display the Loopback Menu. Figure 12 shows an example of a Loopback Menu when no doublers are present; Figure 13 shows an example when one doubler is present.

Loopback Menu: No Doubler

Figure 12 shows the Loopback Menu when no doublers are present.

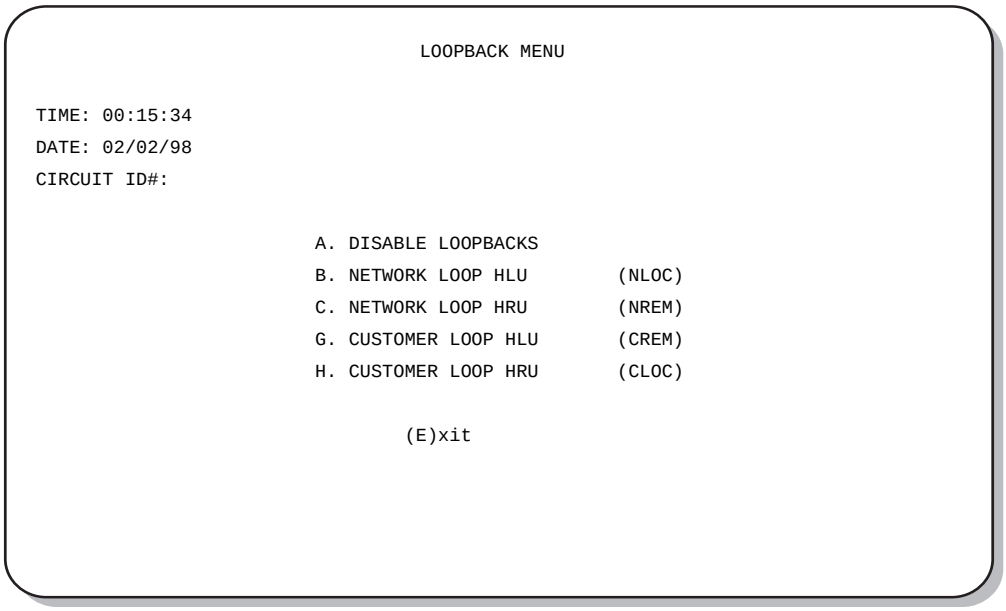


Figure 12. *Loopback Menu: No Doubler*

Loopback Menu: One Doubler

Figure 13 shows the Loopback Menu with one doubler.

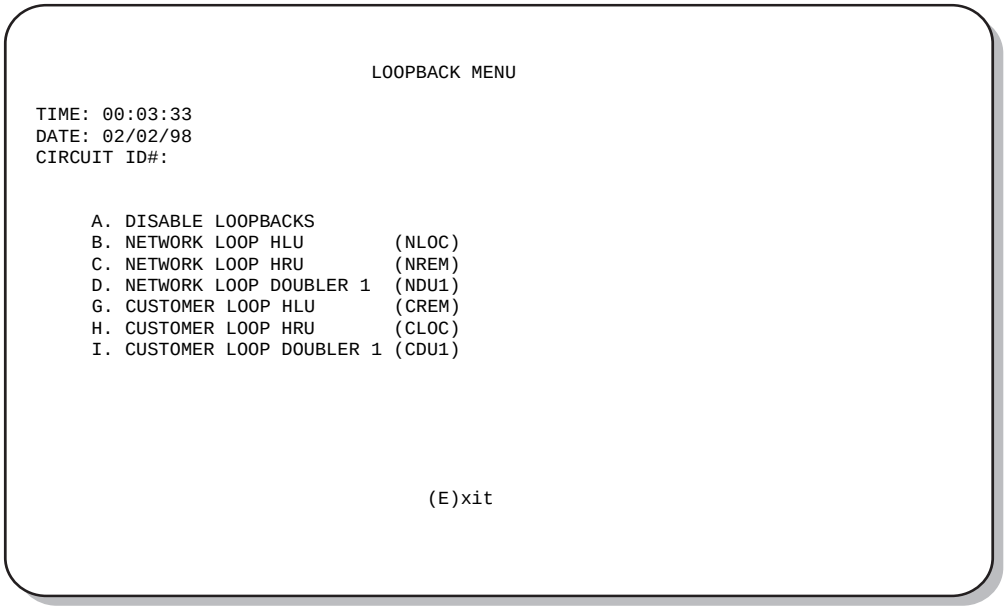


Figure 13. *Loopback Menu: One Doubler*

Initiating a Loopback

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

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

A series of dots moves from left to right indicating that the command has been issued. When this process completes, the system returns to the Maintenance Terminal Main Menu. The selected loopback four letter designation now appears in the Loopback Mode field in the Maintenance Terminal Main Menu (see Figure 14 in which an NLOC loopback is in progress). The loopback continues to cycle in the system depending upon the Loopback Timeout setting.

```
HI-GAIN HLU-319     MAINTENANCE TERMINAL MAIN MENU   (ver V5.1L-5)
                         CIRCUIT ID#:

                    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. ENTER CIRCUIT ID #
```

Figure 14. *NLOC Loopback Mode in the Maintenance Terminal Main Menu*

Disable Loopbacks

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

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

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

VIEW PERFORMANCE DATA

The Performance Data screens show the Errored Seconds (ES) and Unavailable Seconds (US) for both HDSL loops and each T1 input at 15-minute intervals over a four-hour time period. Earlier and later data, in four-hour time periods on different span screens, can be accessed by pressing P (Previous) or N (Next) respectively. All performance data counters can be set to zero by pressing C (Clear) from the HLU-319 Span Status screen, shown in Figure 7 on page 17.

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

Errored and Unavailable seconds are defined in Table 8.

Table 8. *Errored and Unavailable Seconds Definitions*

ES and UAS	Definition
HDSL Errored Second	A second in which at least one HDSL CRC has occurred.
HSDL 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 has occurred.
DS1 Unavailable Second	A second in which at least one T1 LOS condition (175 ± 75) zeros has occurred.

From each Performance Data screen you can do the following:

- Press P to view the previous four-hour data screen.
- Press N to view the next four-hour data screen.
- Press E to exit.
- Press S to view the next available span.

Performance Data Screen: No Doubler

Press **E** from the Maintenance Terminal Main Menu to view the Performance Data screen. Figure 15 shows the Errored and Unavailable Seconds for the HDSL span between the HLU-319 and the HRU.

```
Date: 02/02/98                PERFORMANCE DATA
CIRCUIT ID#:
                 ERRORED SECONDS/UNAVAILABLE SECONDS

                    DS1             HDSL-1            HDSL-2
               HLU      HRU      HLU      HRU      HLU      HRU
     20:30   000/000  000/000  000/000  000/000  000/000  000/000
     20:45   000/000  000/000  000/000  000/000  000/000  000/000
     21:00   000/000  000/000  000/000  000/000  000/000  000/000
     21:15   000/000  000/000  000/000  000/000  000/000  000/000
     21:30   000/000  000/000  000/000  000/000  000/000  000/000
     21:45   000/000  000/000  000/000  000/000  000/000  000/000
     22:00   000/000  000/000  000/000  000/000  000/000  000/000
     22:15   000/000  000/000  000/000  000/000  000/000  000/000
     22:30   000/000  000/000  000/000  000/000  000/000  000/000
     22:45   000/000  000/000  000/000  000/000  000/000  000/000
     23:00   002/214  009/125  005/063  006/046  003/064  006/005

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

Figure 15. *Performance Data Screen: No Doublers*

Performance Data Screen: With Doubler

The Performance Data Screen displays information by span. With no doubler, there is only one span. With multiple doublers (up to two), there can be as many as three span screens.

1 Press **E** from the Maintenance Terminal Main Menu to view the Performance Data screen.

2 Press **S** from the Performance Data screen to advance through the performance data screens for the various spans.

Figure 16 is an example of a Performance Data screen that lists performance data for Span #2 in a one-doubler system.

```
Date: 02/02/98        SPAN 2 PERFORMANCE DATA
CIRCUIT ID#:
                  ERRORED SECONDS/UNAVAILABLE SECONDS

               DS1             HDSL-1            HDSL-2
          HLU      HRU     HDU1      HRU     HDU1      HRU
00:00    000/000  000/000  000/000  000/000  000/000  000/000
00:15    000/000  000/000  000/000  000/000  000/000  000/000
00:30    000/000  000/000  000/000  000/000  000/000  000/000
00:45    000/000  000/000  000/000  000/000  000/000  000/000
01:00    000/000  000/000  000/000  000/000  000/000  000/000
01:15    000/000  000/000  000/000  000/000  000/000  000/000
01:30    000/000  000/000  000/000  000/000  000/000  000/000
01:45    000/000  000/000  000/000  000/000  000/000  000/000
02:00    000/000  000/000  000/000  000/000  000/000  000/000
02:15    000/000  000/000  000/000  000/000  000/000  000/000
02:30    000/000  000/000  000/000  000/000  000/000  000/000
02:45    000/000  000/000  000/000  000/000  000/000  000/000
03:00    000/000  000/000  000/000  000/000  000/000  000/000
03:15    000/000  000/000  000/000  000/000  000/000  000/000
03:30    000/000  000/000  000/000  000/000  000/000  000/000
03:45    001/003  004/004  000/004  004/002  001/003  002/002

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

Figure 16. *Span 2 Performance Data Screen*

VIEW PERFORMANCE HISTORY

The View Performance History option allows you to access the 7 Day History screens that show the number of ES and UAS occurrences in 24-hour increments for a seven-day period. Errored Seconds and Unavailable Seconds for both HDSL loops and each of the two DS1 inputs are listed for the current and previous seven days. The counters on all 7 Day History can be set to zero by pressing **C** (Clear).

Since the HLU-319 is considered the master module, pressing C from the View Performance History screen clears *all* performance data screens at both the HLU-319 and the HRU. The RS-232 terminal interface at the HRU does not allow the counters to be cleared.

The 7 Day History Screen: No Doubler

Press **F** (View Performance History) from the Maintenance Terminal Main Menu to open the 7 Day History screen (Figure 17) for applications without a doubler. The 7 Day History Span 1 screen shows the ES and UAS for the HDSL loop between the HLU-319 and the HRU.

```
Time: 00:16:55                    7 DAY HISTORY
CIRCUIT ID#:

                                    SPAN 1
                          ERRORED SECONDS/UNAVAILABLE SECONDS

                  DS1                    HDSL-1                  HDSL-2
            HLU          HRU          HLU          HRU          HLU          HRU
01/26   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/27   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/28   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/29   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/30   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/31   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
02/01   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00000/00015 00004/00001 00002/00016 00005/00002 00004/00013 00007/00001
                                       (E)xit
```

Figure 17. *7 Day History Screen for Span 1: No Doubler*

The 7 Day History Screen: With Doubler

The 7 Day History screen displays information by span. With no doubler, there is only one span. With multiple doublers (up to two), there can be as many as three span screens.

1 Press F (View Performance History) from the Maintenance Terminal Main Menu to open the 7 Day History screen.

2 Press S from the 7 Day History screen to advance through the history screens for the various spans.

Figure 18 is an example of a 7 Day History screen that lists performance data for the second span.

```
Time: 03:09:34                    7 DAY HISTORY
CIRCUIT ID#:
                                       SPAN 1
                           ERRORED SECONDS/UNAVAILABLE SECONDS

                  DS1                    HDSL-1                  HDSL-2
            HLU          HRU         HLU           HDU1      HLU          HDU1
04/09   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/10   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/11   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/12   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/13   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/14   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/15   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00001/00000 01094/00798 00000/01101 00369/00004 00000/01101 00141/00006

                                       (E)xit   (S)pan
```

Figure 18. *7 Day History Screen Span 1: With Doubler*

VIEW ALARM HISTORY

The View Alarm History screen allows you to view alarms that are currently active. In the Alarm History screen 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.
- 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.
- Press C to clear all data from the screen.
- Press E to exit from the Alarm History screen.

Table 9 lists the Alarm History fields and descriptions. These descriptions apply to the Alarm History for doubler applications as well. The LOS and PWR system alarms are common to all spans. Only the LOSW, ES and Margin are span-specific alarms.

Table 9. HLU-319 *Alarm History Messages*

Message	Full Name	Description
	ALARMS	
NONE	No Alarms	No alarms.
LLOS	Local Loss of Signal	No signal from HLU-319 local DSX-1 interface.
RLOS	Remote Loss of Signal	No signal from HRU-412 remote DS1 interface.
LOSW1	Loss of Sync Word 1	HDSL loop 1 has lost sync.
LOSW2	Loss of Sync Word 2	HDSL loop 2 has lost sync.
H1ES	HDSL Loop 1 Errored Second	Loop 1 CRCs have exceeded the user-selected ES threshold.
H2ES	HDSL Loop 2 Errored Second	Loop 2 CRC have exceeded the user-selected ES threshold.
DS1	Digital Service 1	T1 input BPVs, at either the HLU-319 or HRU, have exceeded the user-selected ES threshold.
RAIS	Remote Alarm Indicating Signal	Indicates an AIS (all ones) pattern is being transmitted from the remote T1 output port.
LAIS	Local Alarm Indicating Signal	Indicates an AIS (all ones) pattern is being transmitted from the local T1 output port.
MAL1	Margin Alarm 1	The margin on HDSL loop 1 has dropped below the threshold (0 to 15 dB) set by the user. Setting the threshold to 0 inhibits the margin alarm.
MAL2	Margin Alarm 2	The margin on HDSL loop 2 has dropped below the threshold (0 to 15 dB) set by the user. Setting the threshold to 0 inhibits the margin alarm.
CHREV	Channels Reversed	The loop 1 and loop 2 HDSL pairs are reversed at the HDU or HRU line input ports. Loop 1 is specified to carry the (-) simplex dc voltage, and loop 2 is specified to carry (+) simplex dc voltage.
ACO	Alarm CutOff	A minor alarm occurred and was retired to an ACO condition after pressing the SEL button on the HLU-319 front panel.

Table 9. HLU-319 *Alarm History Messages (Cont.)*

Message	Full Name	Description
	LOOPBACKS	
SMJK	Smart-Jack Loopback	The loopback at HRU-412 (remote) toward network (see Figure 15) initiated by either the (2 in 5) in-band loopback code or the out-of-band ESF data link loopback code.
NREM	Network Remote Loopback	The loopback at HRU (remote) toward network initiated from CO (network) by either the Intelligent Line Repeater (ILR) number 2 code, the HLU-319 front panel Manual Loopback push buttons, the HRU-412 front panel push button, or the maintenance terminal.
NLOC	Network Local Loopback	The loopback at HLU-319 (local) toward network initiated from CO (network) by either the Intelligent Office Repeater (IOR) code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
NDU1	Network Doubler 1 Loopback	The loopback at doubler 1 toward network initiated by either the IOR code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
NDU2	Network Doubler 2 Loopback	The loopback at doubler 2 toward network initiated by either the IOR code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
CLOC	Customer Local Loopback	The loopback at HRU (local) toward CI initiated from CPE (customer) by either the ILR number 2 code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
CREM	Customer Remote Loopback	The loopback at HLU-319 (remote) toward customer initiated by either the IOR code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
CDU1	Customer Doubler 1 Loopback	The loopback at doubler 1 toward CI initiated by either the ILR number 1 code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
CDU2	Customer Doubler 2 Loopback	The loopback at doubler 2 toward CI initiated by either the ILR number 20 code, the HLU-319 front panel Manual Loopback push buttons, or the maintenance terminal.
ARM	Armed	The HiGain system has detected the IR loopback (2 in 5) arming code.
TLOS	Transmit Loss of Signal Loopback	HRU-412 is in a logic loopback state, caused by a loss of its DS1 input from the CI when ENAbled at the HRU-412, List 6 and List 7, via its TLOS switch option.

Alarm History Screen: No Doubler

Press **G** from the Maintenance Terminal Main Menu to view the Alarm History screen for an application without a doubler (Figure 19).

```
                                ALARM HISTORY

TIME: 00:17:18
DATE: 02/02/98
CIRCUIT ID#:

Type              First               Last                Current        Count
LOS, DS1-HLU      05/18/95-00:00      05/18/95-00:00      OK             001
LOS, DS1-HRU      05/18/95-00:00      05/18/95-00:02      OK             002
LOSW, HDSL1       05/18/95-00:00      05/18/95-00:14      OK             003
LOSW, HDSL2       05/18/95-00:00      05/18/95-00:14      OK             003
ES, HDSL1                                                 OK             000
ES, HDSL2                                                 OK             000
MARGIN L1         05/18/95-00:00      05/18/95-00:15      OK             004
MARGIN L2         05/18/95-00:00      05/18/95-00:01      OK             002
PWR-OPEN          05/18/95-00:01      05/18/95-00:15      OK             004
PWR-SHRT          05/18/95-00:00      05/18/95-00:00      OK             001

LAST CLEARED:    NONE

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

Figure 19. *Alarm History Screen for Span 1: No Doublers*

Alarm History Screen: With Doubler

The Alarm History screen displays information by span. With no doubler, there is only one span (Figure 19). With multiple doublers (up to two), there can be as many as three span screens.

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

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

Figure 20 is an example of an Alarm History screen that lists history for span 1 of a system that contains a doubler.

```
                                ALARM HISTORY


TIME: 00:17:18

DATE: 02/02/98

CIRCUIT ID#:


Type              First               Last                Current        Count
LOS, DS1-HLU      05/18/95-00:00      05/18/95-00:00      OK             001
LOS, DS1-HRU      05/18/95-00:00      05/18/95-00:02      OK             002
SPAN1 LOSW, HDSL1 05/18/95-00:00      05/18/95-00:30      OK             004
SPAN1 LOSW, HDSL2 05/18/95-00:00      05/18/95-00:30      OK             004
SPAN1 ES, HDSL1                                           OK             000
SPAN1 ES, HDSL2                                           OK             000
SPAN1 MARGIN L1   05/18/95-00:00      05/18/95-00:31      OK             006
SPAN1 MARGIN L2   05/18/95-00:00      05/18/95-00:31      OK             003
PWR-OPEN          05/18/95-00:01      05/18/95-00:30      OK             005
PWR-SHRT          05/18/95-00:00      05/18/95-00:00      OK             001

LAST CLEARED:    NONE


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

Figure 20. *Alarm History Screen for Span 1: With Doublers*

SYSTEM ALARMS

Minor system alarms are listed in Table 10. More than one alarm condition can exist at any given time, but only one message can display. For multiple alarms, the highest priority alarm displays. The alarms are listed in priority order.

Table 10. *System Alarms*

Front-Panel Message	Alarm	Description	Inhibit
ALRM LOSW	Loss of Sync Word	Either HDSL loop lost sync.	Cannot be inhibited.
ALRM LLOS	Local Loss of Signal	Loss of HLU DSX-1 input signal.	Cannot be inhibited.
ALRM RLOS	Remote Loss of Signal	Loss of HRU DSX-1 input signal.	Cannot be inhibited.
ALRM TLOS	Transmit Loss of Signal	A user option that causes the loss of the HRU DS1 input from the CI to initiate a logic loopback in the HRU.	Set the TLOS option to OFF at HRU.
ALRM H1ES	HDSL Loop 1 Errored Seconds	HDSL loop 1 has exceeded the 24-hour user-selected Errored Seconds CRC threshold. If both H1ES and H2ES occur, only H1ES is displayed on the front panel.	Set the ES Alarm Threshold on the System Settings menu to NONE.
ALRM H2ES	HDSL Loop 2 Errored Seconds	HDSL loop 2 has exceeded the 24-hour user-selected Errored Seconds CRC threshold. If both H1ES and H2ES occur, only H1ES is displayed on the front panel.	Set the ES Alarm Threshold on the System Settings menu to NONE.
ALRM DS1	DS1 Bipolar Violations Alarm	The total number of bipolar violations (BPV), at either the HLU-319 or the HRU DS1 inputs, have exceeded the 24-hour user-selected threshold.	Set the ES Alarm Threshold on the System Settings menu to NONE.
ALRM MAL1	HDSL Loop 1 Margin Alarm	The margin on HDSL loop 1 has dropped below the minimum threshold value set by the RS-232 terminal Margin Alarm Threshold	Set the Margin Alarm Threshold option to 0.
ALRM MAL2	HDSL Loop 2 Margin Alarm	The margin on HDSL loop 2 has dropped below the minimum threshold value set by the RS-232 terminal Margin Alarm Threshold.	Set the Margin Alarm Threshold option to 0.

Retiring System Alarms

To retire a minor system alarm, press the **SEL** button on the front panel 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.

LOOPBACK OPERATION

In addition to the Smart-Jack loopback, the HiGain system can be configured for one of five special in-band loopback (SPLB) command sequences. These are selected from the SPLB user options, which are shown in Table 7 on page 22. Non-doubler loopback configurations are shown in Figure 21 on page 42. Doubler loopback configurations are shown in Figure 22 on page 43.

SMARTJACK (SMJK) LOOPBACK

One of the most important loopback options is the SmartJack (SMJK) loopback, which enables an HRU response to the standard (2/3 in 5) SMJK in-band loopback codes in emulation of standard Network Interface Device (NID) functions. This option can be enabled or disabled from either the front panel MODE and SEL buttons or through the System Settings Menu.

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 the HRU/NREM (3 in 7) toward the network. In addition, it allows in-band codes to loop-up the HLU/CREM (6 in 7) or the HRU/CLOC (5 in 7) toward 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 five seconds before the HiGain system responds.

A1LB LOOPBACK CODE

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

- Query loopback
- Intelligent Office Repeater (IOR) 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. It is given a separate identity to allow future T1/E1 enhancements to A1LB without affecting A2LB.

ADDRESSABLE REPEATER LOOPBACK FUNCTIONS

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

- 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 (3 in 5) 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 unblock it by executing the Far-End Activate code. Since A5LB never blocks the arming code from exiting the HLU-319, it does not need this Far-End Activate code. A3LB differs from A4LB in that A3LB supports the additional (1 in 6) Smart-Jack loopback command.

When T1 loopback tests are performed on the HiGain system with metallic loopback connections at either end, the T1 code, which exists at the metallic loopback interface, may be different from the T1 code being received at the opposite end when the DS1 user code is set to Auto. This is caused by the fact that, in the Auto DS1 code mode, the HLU-319 and HRU-412 set their own codes independently of each other. Each end sets its transmit code to match its receive code. Thus, if one end is receiving AMI, and the other B8ZS, their codes are different. For example, if the HRU-412 has a metallic loopback, and the HLU-319 receive pattern code is changed from AMI to B8ZS, and next, the all “0” pattern is sent into the HLU-319, then the HLU-319 changes to its B8ZS mode while the HRU-412 remains in its AMI mode, and thus loops all “0.” This causes the HRU-412 to indicate an LOS condition, which causes the HLU-319 to output the AIS pattern.

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 sent 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

To initiate a manual loopback session:

1 Press both the MODE and SEL buttons on the front panel for at least three 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:

  a Press the MODE button. The message changes from `NLO` to `NRE`.

  b 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 Craft port by choosing the Loopback Mode (option D) from the Main Menu. This displays the Loopback Menu from which any of the loopbacks can be initiated or terminated.

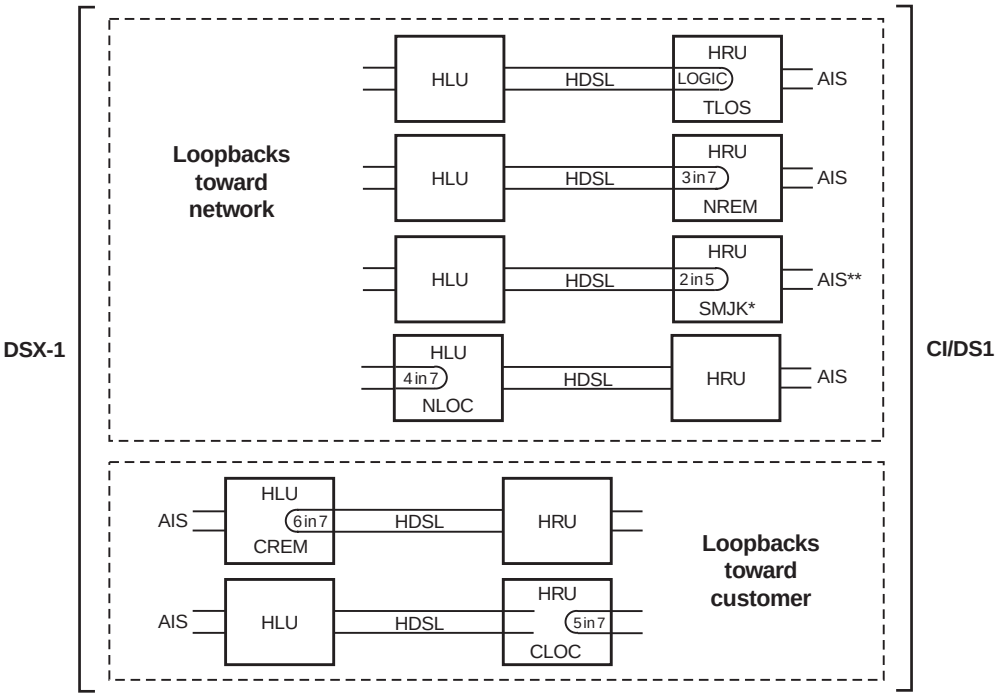
LOOPBACK TEST PROCEDURES

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-319 is making a positive connection with its mounting assembly (shelf) connector. Also, verify that the HLU-319 equalizer is set to the correct distance range per Table 1. All equalizers should be set to the largest distance range value that does not exceed the distance from the DSX-1 to the shelf.

The transmit and receive DSX-1 ports have splitting access and bridging, miniature 210-series jacks (See Figure 23 on page 50). Connecting one cable between the two Bridging jacks, and another between the two Line jacks, splits the XMT and RCV and creates metallic loopbacks toward both the DSX-1 and the HLU-319. If plugs are inserted into both Line jacks, the BRG jacks can be used to send and receive test patterns toward the DSX-1.

The complete family of loopbacks that a HiGain system without doublers can execute is shown in Figure 21. The loopbacks can be initiated from the HLU-319 Craft port, the HLU-319 front-panel MODE and SEL buttons, or from a family of Special Loopback (SPLP) in-band loopback commands.

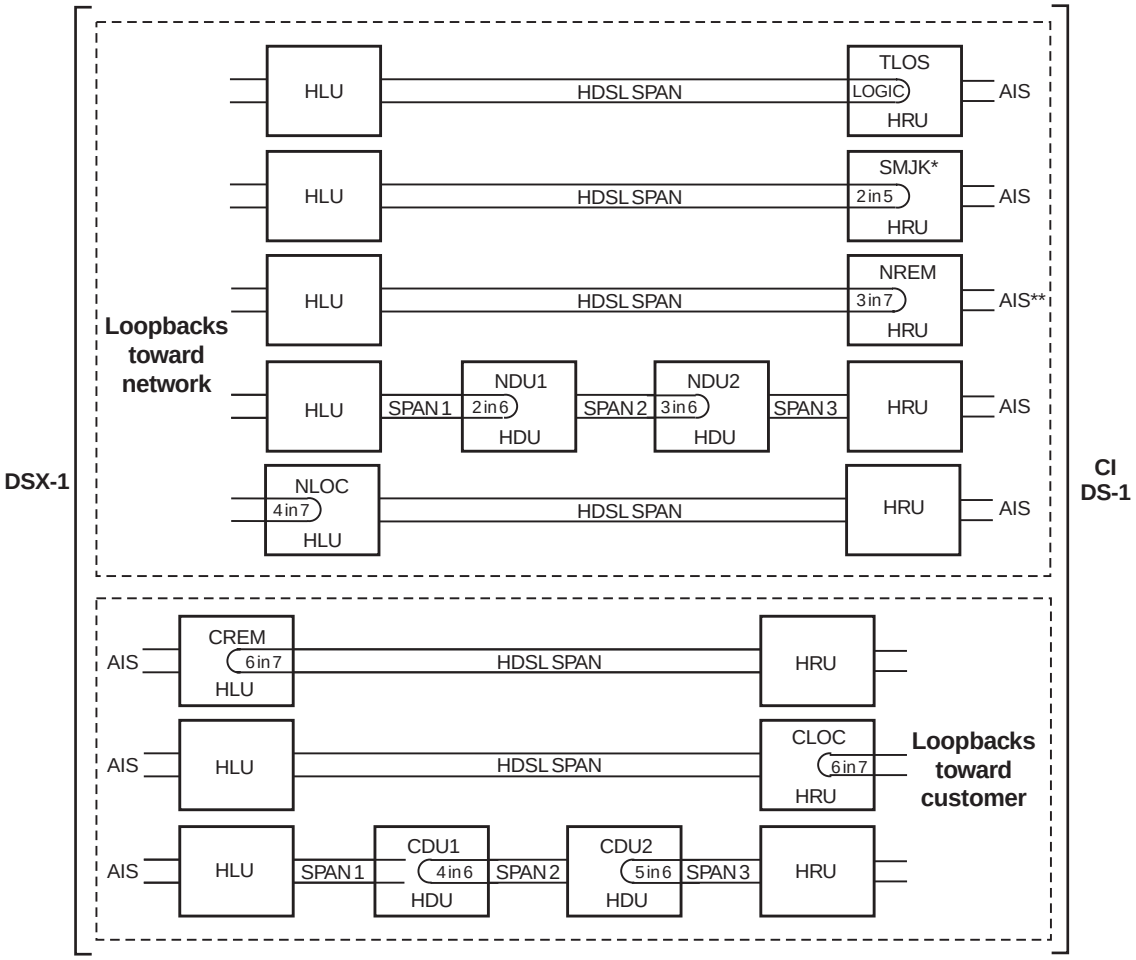


* The Smart-Jack loopback is a metallic loopback in the HRU Lists 6 and 7. It is a logic loopback in HRU Lists 1 through 5.

** Set the SAIS option to ENA to send the AIS pattern to the CI during Smart-Jack Loopback.

Figure 21. *HLU-319 Non-Doubler Loopback Configurations*

The complete family of loopbacks that a HiGain system with doublers can execute is shown in Figure 22. The loopbacks can be initiated from the HLU-319 Craft port, the HLU-319 front-panel MODE and SEL buttons, or from a family of Special Loopback (SPLP) in-band loopback commands.



Use the 3 in 5 code to loop down any of these loopbacks.

* The Smart-Jack loopback is a metallic loopback in the HRU's Lists 6 and 7. It is a logic loopback in all lower HRU list numbers.

** The SAIS option must be set to ENA to cause the AIS pattern to be sent to the CI during Smart-Jack Loopback.

Figure 22. *HLU-319 Doubler Loopback Configurations*

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 five seconds. Verify that the NREM message displays on the front panel, indicating that an HRU NREM loopback is in effect. (Loopback states are indicated by the green LOOP LED on the front panel and also display in the maintenance terminal 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, then verify that the display returns to normal.

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

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

Notes on Non-doubler GNLB Loopback Test Procedures:

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

Notes on Doubler GNLB Loopback Test Procedures:

- Doubler #1 can engage loopback from the remote location (CDU1) by issuing the (4-in-6) loopback command at the HRU DS1 input port.
- Doubler #1 can engage loopback from the local location (NDU1) by issuing the (2-in-6) loopback command at the HLU-319 DS1 input port.
- Doubler #2 can engage loopback from the remote location (CDU2) by issuing the (5-in-6) loopback command at the HRU DS1 input port.
- Doubler #2 can engage loopback from the local location (NDU2) by issuing the (3-in-6) loopback command at the HLU-319 DS1 input port.

HLU-319 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 five seconds or at least four repetitions of the 16-bit ESF data link Arming code 1111 1111 0100 1000 (FF48). (Left bit arrives first.)

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

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

3 Verify that the HLU-319 display intermittently indicates ARM and, if the HRU is in loopback, that it intermittently displays SMJK.

4 Verify, if possible, that the HRU Loopback LED is flashing (indicating that the HRU is armed), or lights steadily (indicating that the HRU is both armed and in loopback).

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

- two seconds of AIS (all ones)
- five seconds of returning data pattern
- 231 Logic errors (including the frame bit) occur in the returned pattern:
  - 10 errors if ILR-1 (Doubler 1) was sent
  - 200 errors if ILR-20 (Doubler 2) was sent
  - 20 errors, if ILR-2 (HRU) was sent
  - Normal looped data.

This error pattern will repeat every 20 seconds, as long as the IOR loopback pattern is being sent. This also applies to the Time-out Override and Query commands. It also applies (with the appropriate number of bit errors) to the other ILR commands.

The HLU-319 is now in Logic Loopback. The display on the HLU-319 periodically displays NLOC and ARM in addition to the margin displays. 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 this step 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 do one of the following:

- Issue the Intelligent Repeater Loop-down (IR LPDN) code 1001 0011 1001 0011 (9393).
- Issue the NI LPDN and Disarm code 11100.

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

6 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.

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

Table 11. *Addressable 1 (A1LB) Repeater Loopback Commands*

Loopback Command	Description	Code
ARMING or NI LPBK (in-band)	Arming code	11000 11000 ...
ARMING or NI LPBK (ESF data link)	Arming code	1111 1111 0100 1000 (FF48)
IR LPDN or DISARM (in-band)	Disarming code	11100 11100 ...
DISARM (ESF data link)	Disarming code	1111 1111 0010 0100 (FF24)
IOR LPBK (NLOC and CREM 231 errors)	HLU Loop-up	1101 0011 1101 0011 (D3D3)
ILR-1 LPBK (NDU1 and CDU1 10-bit errors)	Doubler 1 Loop-up	1100 0111 0100 0001 (C741)
ILR-20 LPBK (NDU2 and CDU2 200-bit errors)	Doubler 2 Loop-up	1100 0111 0101 0100 (C754)
ILR-2 LPBK (NREM and CLOC 20-bit errors)	HRU Loop-up	1100 0111 0100 0010 (C742)
IR LPDN	Loop-down (HLU or HRU)	1001 0011 1001 0011 (9393)
IR QUERY LPBK	Query Loopback	1101 0101 1101 0101 (D5D5)
IR ALTERNATE QUERY LPBK	Alternate Query Loopback	1101 0101 1110 1010 (D5EA)
TIME-OUT OVERRIDE	Loopback Time- out Override	1101 0101 1101 0110 (D5D6)
FAR END NI ACTIVATE	Unblock AIS and pass 2 in 5	1100 0101 0101 0100 (C554)
IOR POWER-DOWN (HLU)	Removes HDSL line power	0110 0111 0110 0111 (6767)

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.

All loopbacks shown in Table 11 can also be initiated from the HLU-319 front panel MODE and SEL buttons (see "Setting Options Through SEL and MODE", on Page 11).

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 five 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 12. The automatic time-out mode is restored during subsequent loopback sessions.

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

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

Table 12. *Addressable 3 (A3LB) Repeater Loopback Commands*

Position	Name	Code
HLU-319 LU from NI	NLOC	1111 1111 0001 1110 (FF1E)
HLU-319 LU from CI	CREM	0011 1111 0001 1110 (3F1E)
HDU-451 Doubler 1 from NI	NDU1	1111 1111 0000 0100 (FF04)
HDU-451 Doubler from CI	CDU1	0011 1111 0000 0100 (3F04)
HDU-451 Doubler 2 from NI	NDU2	1111 1111 0000 0110 (FF06)
HDU-451 Doubler 2 from CI	CDU2	0011 1111 0000 0110 (3F06)
HRU-412 LU from NI	NREM	1111 1111 0000 0010 (FF02)
HRU-412 LU from CI	CLOC	0011 1111 0000 0010 (3F02)
HRU-412 LU from NI	SMJK	11000 11000 11000 ...
HRU-412 LU from NI	SMJK	100000 100000 100000 ...
HRU-412 LU from NI (ESF-DL)	SMJK	1111 1111 0100 1000 (FF48)
HLU and HRU LD from NI or CI	Loop Down	11100 11100 11100 ...
HLU and HRU LD from NI or CI	Loop Down	100 100 100 ...
HLU and HRU LD from NI or CI (ESF-DL)	Loop Down	1111 1111 0010 0100 (FF24)

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.

All loopbacks shown in Table 12 can also be initiated from the HLU-319 front panel MODE and SEL buttons (see "Setting Options Through SEL and MODE", on Page 11).

SPECIFICATIONS

HDSL Line Code

784 kbps 2B1Q

HDSL Output

+13.5 dBm ± 0.5 dB at 135 ohms

HDSL Line Impedance

135 ohms

Maximum Provisioning Loss

35 dB at 196 kHz, 135 ohms

Line Clock Rate

Internal Stratum 4 clock

HDSL Start-up Time

30 seconds (typical), 60 seconds (maximum) per span

One-way DS1 Delay

<220 microseconds per span

DSX-1 Line Impedance

100 ohms

DSX-1 Pulse Output

Pre-equalized for 0 to 655 feet of ABAM-specification cable

ABAM cables must be grounded at both ends for GR-1089 CORE, section 4.5.9 compliance

DSX-1 Input Level

+1.5 to -7.5 dBDSX

DSX-1 Line Rate

1.544 Mbps ± 200 bps

DSX-1 Line Format

AMI, B8ZS or ZBTSI

DSX-1 Frame Format

ESF, SF or UNFR

Maximum Power Consumption

14 Watts (without doubler); 25 Watts (with doubler)

Maximum Heat Dissipation

6 Watts (without doubler); 9 Watts (with doubler)

Fusing

Internal; connected to Fuse Alarm output on pin 10

HDSL Span Voltage (Differential)

130 or 200 Vdc

Margin Indicator

Displays HDSL loop SNR margin for each HDSL loop relative to 10^{-7} BER operation

Electrical Protection

Secondary surge protection on DS1 and HDSL ports; Power cross protection on HDSL ports

Operating Temperature and Humidity

-40° to +65° Celsius, 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:	1 lb. 11 oz.

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-Bit 1-Quartenary (2B1Q) HDSL transceiver systems to establish two full-duplex 784 kbps data channels between the HLU-319 and a remotely mounted 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 HiGain HLU-319 receives a 1.544 Mbps DS1 data stream from the DSX-1 digital cross connect interface. The HLU-319 contains a DSX-1 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 Super Frame (SF) (including D4) or Extended Super Frame (ESF) framing. When the data is unframed, the HLU-319 arbitrarily defines a frame bit.

The HLU-319 contains a multiplexer that generates two parallel 784 kbps data streams. The data streams contain HDSL frames that are nominally 4704 bits (6 milliseconds) in length. The HDSL frames contain a 14-bit Frame Sync Word (FSW), 6-bit Cyclic Redundancy Check (CRC), 21-bit operations channel and DSX-1 payload. The DSX-1 stream is separated into two parallel streams that comprise the payloads of the HDSL channels. The HLU-319 allocates the DS0 time slots according to the version of HRU to which it is connected. Older version HRUs require the odd DS0 time slots allocated to loop 1 and the even DS0 time slots to loop 2. Newer versions allocated DS0 time slots 1 through 12 to loop 1, and time slots 13 through 24 to loop 2. The 8 kbps frame bits of the DSX-1 stream are included on both HDSL channels. The two formatted HDSL channels are passed to the HDSL transceivers which convert them to the 2B1Q format on the HDSL lines. The 2B1Q line code is designed to operate in a full-duplex mode on unconditioned pairs. The transceiver echo canceler and adaptive equalizer receive the signal from the remote end in the presence of impairments and noise on the copper pairs.

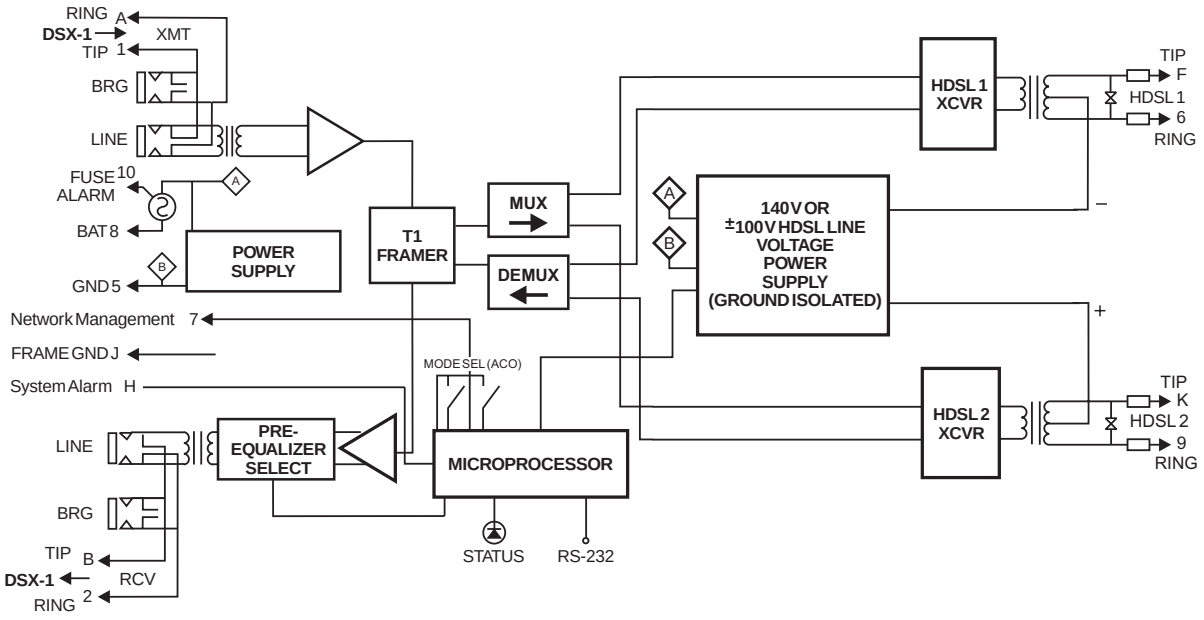


Figure 23. *HLU-319 Block Diagram*

The received HDSL channels are processed by the transceiver and then passed on to the HLU-319 demultiplexer module. The demultiplexer provides frame synchronization for each of the two HDSL loops. The demultiplexer and HDSL transceivers work under control of the HLU-319 microprocessor and compensate for data inversions caused by Tip-Ring reversals and loop swaps caused by pair reversals. The HiGain system allows for Tip-Ring or pair reversals, but does not tolerate split pairs. By synchronizing to the Frame Sync Word (FSW) of each loop, the demultiplexer can reconstruct the original 1.544 Mbps DS1 stream from the payloads of the two HDSL loops. The CRC fields on the HDSL streams allow the HLU-319 to determine if errors are present on the channel due to excessive impairments on the HDSL pairs or excessive impulse or crosstalk noise.

The demultiplexer removes data link messages from the HDSL loops and passes them to the microprocessor. This mechanism allows operations messages and status to be exchanged between the HLU-319 and the HRU.

The reconstructed HDSL data is buffered in a first-in-first-out (FIFO) buffer within the demultiplexer. A frequency synthesizer, in conjunction with the FIFO, regulates the output bit rate and reconstructs the DSX-1 clock at the exact rate received from the remote end. The HiGain system operates at T1 rates of 1.544 Mbps with up to ± 200 bps of offset.

A DSX-1 interface driver converts the input data to an Alternate Mark Inversion (AMI) or Binary Eight Zero Substitution (B8ZS) format. The DSX-1 equalizer is programmable to five different lengths, as determined by the distance between the HLU-319 and the DSX-1 interface. This provides CB-119 specification compliant pulses at the DSX-1 interface over a range of 0 to 655 feet of ABAM-specification cable.

The HLU-319 contains two separate power converters. The main power supply converts -48 Vdc local battery to logic power for the HLU-319 circuits. The line power supply converts the -48 Vdc battery to either 140 Vdc (for non-doubler applications) or 200 Vdc (for doubler applications), then provides simplex power feed on the two HDSL line interfaces. The line power supply can be turned on or off by the microprocessor and is automatically shut down in the presence of line short circuits or microprocessor failure. The HLU-319 ground fault-detecting circuit immediately detects ground faults occurring at any point along any span on any conductor, and shuts down the circuit. This power cycling and ground fault protection continues as long as the fault condition exists.

A female 9-pin (DB-9) RS-232 connector is provided on the front panel (see Figure 1). This connector provides asynchronous access to the HiGain system maintenance provisioning and performance monitoring firmware. The port is configured as DCE with 8 data bits, 1 stop bit and no parity. Operator interaction with the firmware is via an ASCII terminal or a PC running a terminal emulation program.

HDSL Line Voltage

A unique feature of the HLU-319 List 2E is that its 200 V output voltage for doubler applications is always bipolar. This bipolar voltage is required to support the Ground Fault Detection (GFD) circuit, which is also unique to the HLU-319 List 2E. The 140 V output voltage used in non-doubler unit applications is always negative. This keeps the HDSL cable pair voltage at or below ground potential, thereby avoiding corrosion problems caused by cable voltages more positive than ground.

The specific bipolar voltage levels existing between ground and the two loops for a system containing doublers depends on the following factors:

- loop length
- number of doublers
- type of doublers (which List)
- whether the HRU is locally powered or line powered

The line voltage power supply is ground referenced, but also ground isolated by 200 kohms. This ground isolation reduces problems due to induced noise currents and large surge voltages, which are ground referenced. It also reduces ground fault currents, which improves product safety. Therefore, the product safety depends solely on the differential voltage across loop 1 and loop 2.

Ground Fault Detect

The HLU-319 List 2E has a GFD circuit that is compliant with paragraph R7-1, Section 7.2.1 of GR-1089-CORE, Issue 1, Revision 1, December, 1996.

The GFD circuit immediately detects ground faults that occur at any point along any span on any conductor, and shuts down the HiGain circuit. The HLU-319 then applies power periodically to the first span to detect the ground fault condition. This power cycling and ground fault protection continues as long as the fault condition exists.

POWER CONSUMPTION

The three most important power parameters of an HLU are its maximum power consumption, its maximum power dissipation, and its maximum current drain.

The Maximum Power Consumption is the total power that the HLU-319 consumes or draws from its -48 V shelf power source. This parameter is needed when the HLU-319 is remotely located to its serving CO. It determines the battery capacity required to maintain an eight-hour standby battery reserve for emergency situations; thus limiting the maximum number of plugs per line unit's remote enclosure.

The Maximum Power Dissipation measures the power that is converted into heat buildup 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/ sq. ft. In COs, the maximum power dissipation for open-faced, natural convection cooled mountings is limited to 134.7 Watts/sq. ft. per Section 4.2.3 of the NEBS GR-63-CORE. The footprint of a standard 28-slot 23-inch HLU-319 shelf is 7.024 sq. ft. Thus, the maximum bay dissipation is limited to 946 Watts. At 7 Watts per slot, this limits the number of occupied slots to 135 per bay. The thermal loading limitations, imposed when using the HLU-319 in a Controlled Environmental Vault (CEV) or other enclosures, are determined by applying the HLU-319 power parameters to the manufacturer's requirements for each specific housing.

The Maximum Current Drain is the maximum current drawn from the shelf power supply when it is at its minimum voltage (-42.5 V). It determines the shelf fusing requirements. All HLU-319 shelves are partitioned into two equal halves, each fused at 10 amps for a total of 20 amps per shelf. A fully loaded shelf draws 10.5 amps (no doublers) or 17 amps (with doublers) worst case. This is within the 20 amp fuse limit.

Heat baffles should be placed between every other shelf, in racks containing more than two shelves. This technique deflects the rack's heat outward and reduces thermo stress on the plugs.

Power Consumption: Without Doublers

Maximum Power Dissipation:

- Per Slot = 7 Watts
- Per Shelf = 196 Watts

Maximum Power Consumption:

- Per Slot = 16 Watts
- Per Shelf = 448 Watts

Maximum Current Drain:

- Per Slot = 0.38 Amps
- Per Shelf = 10.5 Amps

The worst case conditions, under which these parameters were measured, include a 9,000 ft., AWG 26 loop, 60 mA of Customer Provided Equipment (CPE) current, a fully loaded 28-slot shelf, and a -42.5 V shelf battery voltage with the HLU-319 4-character display "OFF." For the purpose of comparison, the HLU-319, List 1 unit dissipates 8.5 Watts and consumes 18 Watts per slot under similar worst case conditions.

Power Consumption: With Doublers

See Table 13 for CO current and other related power parameters for various doubler applications.

Table 13. *HLU-319 Power Parameters With HDU-451*

60 mA CPE Current	CO Voltage Volts	CO Current Amps	Power Consumption Watts	HLU Power Dissipation Watts	HDU Doubler Models
OFF	42.50	0.50	21.00	8	HDU-451, List 1-4, 4B HDU-439/437 List 1, 1B
OFF	48.00	0.44	21.00	8	HDU-451, List 1-4, 4B HDU-439/437 List 1, 1B
OFF	56.00	0.38	21.00	8	HDU-451, List 1-4, 4B HDU-439/437 List 1, 1B
ON	42.50	0.6	25.5	9	HDU-451, List 3, 4, 4B HDU-439/437 List 1, 1B
ON	48.00	0.53	25.5	9	HDU-451, List 3, 4, 4B HDU-439/437 List 1, 1B
ON	56.00	0.45	25.5	9	HDU-451, List 3, 4, 4B HDU-439/437 List 1, 1B

The worst case conditions, under which these parameters were measured, include a loop with one HDU-451 List 1 doubler, four 9000-foot #26AWG spans, and an HRU-412 that is providing 60 mA of Customer Provided Equipment (CPE) current.

COMPATIBILITY

This section describes the HLU-319 compatibility with T1 repeater shelves and equipment, and compatibility with different HDUs for doubler deployment.

T1 REPEATER SHELVES AND RELATED EQUIPMENT

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

- 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)
- PairGain HMS-318 (22-slot, 19-inch shelf)
- PairGain HHS-319 (3-slot, 19-inch horizontal shelf)
- PairGain HMS-317 (28-slot, 23-inch shelf)
- PairGain HMS-308 (8-slot remote enclosure)

The Charles Ind. #343-00 and #340-00 shelves do not support the HLU-319's Minor 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.

DOUBLER DEPLOYMENT

For doubler applications, one or two doublers maybe used in the HDSL loops between the HLU-319 and the HRU. When using two doublers in an HDSL loop, the HRU must be locally powered. The HLU-319 can be used with low-power HDU-451, List 3 doubler units over the entire CSA range in all three spans.

Use of the HLU-319 with the higher-powered HDU-451, List 1 or List 2 doubler is restricted per the following deployment rules:

- If Span 1's loop resistance is known, then the maximum loop resistance of Span 2 is the smaller of either 800 ohms or the following calculated value:

  Maximum Span 2 Loop Resistance = [2600 - 4 (Span 1 Loop Resistance)] ohms

  For example, if Span 1 Loop Resistance = 550 ohms, then Span 2 Loop Resistance must be no more than 400 ohms. If Span 1 Loop Resistance = 400 ohms, then Span 2 Loop Resistance must be no more than 800 ohms.

- If Span 2's loop resistance is known, then the maximum loop resistance of Span 1 is calculated as follows:

  Maximum Span 1 Loop Resistance = [650 - (Span 2 Loop Resistance/4)] ohms

  For example, if Span 2 Loop Resistance = 700 ohms, then Span 1 Loop Resistance must be no more than 475 ohms.

The Span Resistance formulas in Rules 1 and 2 above illustrate that Span 1's resistance has four times the effect on the total circuit's range than does Span 2's resistance. In other words, if Span 1 can be reduced by 50 ohms, Span 2 can be increased by 200 ohms. So, always minimize the length of Span 1

- Use only HRU-412 units with list numbers 6 or higher. Do not use Lists 1, 2, 3, 3A, 4, and 5.
- The HRU-412 CPE current option must be set to 0 mA. Its 60 mA CPE current switch must be set to 0 mA, or, its card edge pins must be strapped for 0 mA in the enclosure that provides these strapping options.
- In two-doubler applications, the first doubler (the one nearest the HLU) can be a List 1 or List 2. The second doubler, however, must be a List 3 unit.
- In general, to optimize doubler performance, minimize the length of Span 1 and maximize the length of Span 3.

PRODUCT SUPPORT

This section contains product support and warranty information.

TECHNICAL SUPPORT

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

Telephone:	(800) 638-0031 or (714) 832-9922
Fax:	(714) 832-9924

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

In addition, PairGain maintains a computer bulletin board system for obtaining current information on PairGain products, product troubleshooting tips and aids, accessing helpful utilities, and for posting requests or questions. This system is available 24-hours a day by calling (714) 730-3299. Transmission speeds up to 28.8 kbps are supported with a character format of 8-N-1.

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 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.
14402 Franklin Avenue
Tustin, CA 92780
ATTN: Repair and Return Dept.
(800) 638-0031

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

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 the appropriate instruction manual for the unit you are installing to get information on:

Cabling

Correct connections

Grounding

MODIFICATIONS

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by PairGain Technologies, Inc. may void the user's authority to operate the equipment.

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

STANDARDS COMPLIANCE

The HLU-319 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

To comply with the intrabuilding wiring requirements of GR-1089 CORE, section 4.5.9, the shields of the ABAM-type cables that connect the HLU-319 DSX-1 output ports to the cross-connect panel must be grounded at both ends.

Corporate Office

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For Technical Assistance:

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