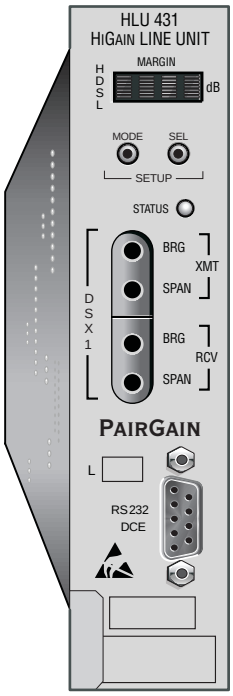
# HiGain Line Unit

| Model | List Number | Part Number |
|---|---|---|
| HLU-431 | 1F | 150-1504-16 |




**PairGain Technologies, Inc.**
**Engineering Services Technical Practice**

**Section 150-431-116-01**

PairGain

# REVISION HISTORY OF THIS PRACTICE

| Revision | Release Date | Revisions Made |
|---|---|---|
| 01 | May 14, 1999 | Initial release |

# USING THIS TECHNICAL PRACTICE

The following conventions are used in this manual:

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

**Notes contain information about special circumstances.**

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

**Shock warnings Indicate the possibility of equipment damage or personal injury due to electricity.**

For a list of abbreviations used in this document, refer to “Appendix E - Glossary” on page 52.

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

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

# INSPECTING SHIPMENT

Upon receipt of the equipment:

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

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# OVERVIEW

The PairGain® HiGain® Line Unit HLU-431 List 1F is the Central Office (CO) side of a repeaterless T1 transmission system. When used in conjunction with a HiGain Remote Unit (HRU), the system provides 1.544 Mbps transmission on two unconditioned copper pairs over the full Carrier Service Area (CSA) range. The CSA includes loops up to 12,000 feet of 24 AWG or 9,000 feet of 26 AWG wire, including bridged taps. This line unit can be used with HiGain Doubler Units (HDUs) to extend reach.

## FEATURES

- Front panel features:
  - Four-character status display
  - DS1 splitting and bridge access
  - Status LED
  - RS-232 craft port for connection to a maintenance terminal
- Selectable DS1 pre-equalizer
- Low HDSL voltage (-140 V) for all applications including doublers
- Compatible with any 400 mechanics shelf
- Selectable loopback activation codes
- Network Management and Administration (NMA) interface
- Non-volatile storage of user-selectable system options
- Lightning and power cross protection on HDSL interfaces
- 784 kbps full duplex 2B1Q HDSL transmission on two pairs
- DS1 Loss of Signal (LOS) detector
- Margin threshold alarm
- HDSL AIS and SmartJack AIS options
- Easy reset to factory default user settings
- Circuit ID option
- Can be used with Positron High Voltage Protection (HVP) equipment (see “Higain Doubler Circuit Deployment” on page 48).

## COMPATIBILITY

The HLU-431 List 1F is designed to mount in 400 mechanics shelves. For a list of compatible shelves, see “Appendix C - Compatibility” on page 48.

All generations of HiGain HLU and HRU modules are compatible with each other. To take advantage of the enhanced features of newer HiGain doublers, refer to “Higain Doubler Circuit Deployment” on page 48.

# APPLICATIONS

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

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

In general, HiGain systems:

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

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

## Applications without Doublers

For applications without doublers, the HLU-431 is directly connected to the HRU by the two HDSL cable pairs. The HLU-431 List 1F is compatible with all HiGain HRUs.

## Applications with HiGain Doublers

For doubler applications, one or two doublers may be used in the HDSL loops between the HLU and HRU for a total of up to three spans.

## Positron High Voltage Protection

Since the HLU-431 List 1F restricts its output voltage to 140 V for all applications including doublers, it can be used with Positron High Voltage Protection (HVP) equipment. This equipment consists of High Voltage HDSL isolation transformers and dc-to-dc converters located in external High Voltage Interface (HVI) cabinets. The two HLU HDSL pairs are routed into the HVI cabinet where each terminates into a two-wire HDSL transformer card. The HDSL-simplexed line voltage is accessed at the center taps of these two transformers and then applied to a dc-to-dc converter circuit. The converter creates an identical, but isolated, output voltage that is reinserted onto the outgoing HDSL pairs through a holding coil and then sent on to power the doubler. This equipment is used to provide high voltage metallic isolation between the HLU and the cable network. Such isolation is required when the HLU can be exposed to Ground Potential Rise (GPR) faults that can occur. For example, if the HLU is located in a power utility substation or on a high voltage tower. The maximum input voltage that the dc-to-dc converter can tolerate is 150 V which makes it compatible with the HLU-431 List 1F, whose maximum output voltage is 140 V. For more information on the HDSL-compatible HVP equipment, contact Positron at 303-688-5800.

# FRONT PANEL

The HLU-431 List 1F front panel is shown is Figure 1. The front panel components are described in Table 1 on page 4.

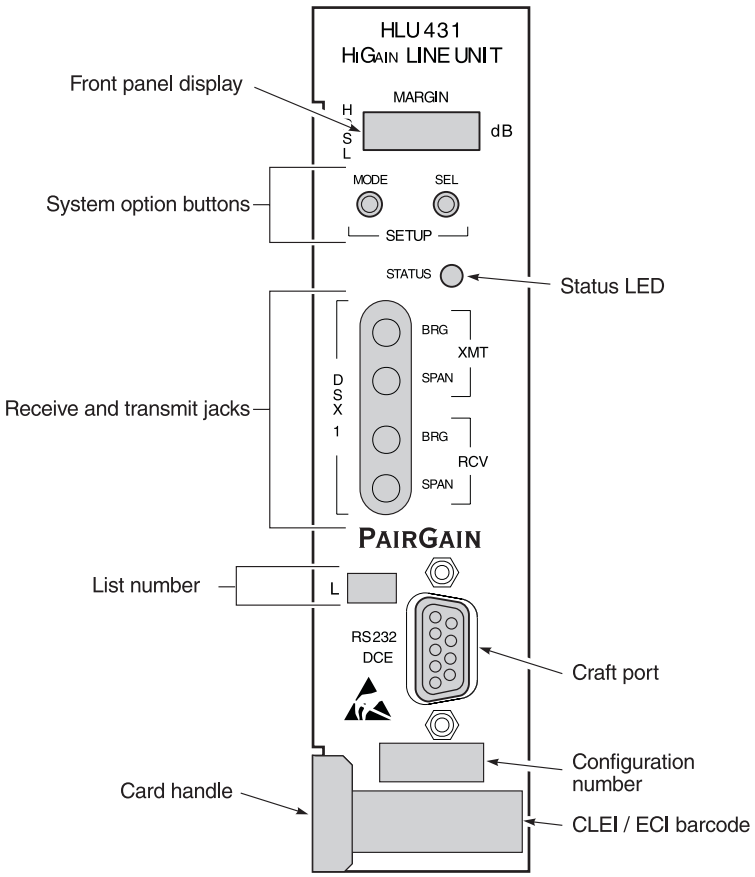



***Figure 1.*** *HLU-431 List 1F Front Panel*

***Table 1.*** *Front Panel Description*

| Front Panel | Feature Function |
|---|---|
| Front panel display | Displays four-character status, provisioning, and alarm system messages. The front panel display illuminates when power is initially applied. To conserve power the display only remains on for 4 minutes. Using the MODE or SEL buttons reactivates the display and restarts the 4-minute timer. Refer to Table 2 on page 5 for a listing of the four-character messages. |
| System option buttons (MODE and SEL) | Permits the user options to be monitored and modified without the need of a maintenance terminal. Used to initiate all HiGain loopbacks and to display DSX-1 line parameters and line unit identity. |
| Status LED | The status LED can report the following conditions: |
| Green | Normal operation |
| Flashing green | HDSL acquisition |
| Red | Fuse Alarm |
| Flashing red | System alarm |
| Yellow | Self Test is in process or an HLU-431 Customer Remote Loopback (CREM) or a Network Local Loopback (NLOC) is in effect. |
| DSX-1 access jacks | |
| SPAN | Provides splitting jack access to (XMT) and from (RCV), the HDSL span at the DSX-1 interface.Breaks the XMT and RCV paths to permit test signal insertion and retrieval. |
| 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. |
| List number | Identifies the version of the HLU-431 List 1F. |
| CLEI/ECI bar code label | Provides the human-readable Common Language Equipment Identifier (CLEI) code number and the Equipment Catalog Item (ECI) bar code number. |
| Configuration Number | Contains either a five-digit or six-digit warranty configuration number or a standalone two or three-digit configuration number as follows:<br>Digit 1 = Last digit of shipment year<br>Digits: 2 and 3 = Shipment month<br>Digits: 4 and 5 = Configuration number<br>The configuration number can also be found on a small bar label that also contains the Julian date code and part number. This gummed label may be attached to the PC board or to the front panel. |

***Table 2.*** *Front Panel Display Messages*

| Message | Full Name | Description |
|---|---|---|
| **ALARM MESSAGES** | | |
| ACO | Alarm CutOff | A system alarm has occurred, and has been retired to an ACO condition by pressing the SEL button on the HLU front panel. |
| ALRM | Alarm Condition Exists | A system alarm condition is in effect. |
| LLOS | Local Loss of Signal | Indicates that no signal is detected at the T1 input to the HLU. Causes a system alarm. |
| LOSW | Loss of Sync Word | Indicates that one of the HDSL loops has lost sync. Causes a system alarm. |
| MAL1(2) | Margin Alarm Loop 1 or 2 | The margin on HDSL Loop 1 (2) has dropped below the threshold (1 to 15 dB) as set by the operator. |
| RLOS | Remote Loss of Signal | Indicates that no signal is detected at the T1 input to the HRU. Causes a system alarm. |
| **LOOPBACK MESSAGES** | | |
| ARM | HiGain System ARMED | Armed to respond to Intelligent Repeater Loop Codes. |
| CD*n*? | Customer Doubler n Loopback | Query to initiate loopback at doubler *n* to CI, where *n* is the number of the doubler. |
| CLOC | Customer Local Loopback | Signal from Customer is looped back to the customer at the HRU. |
| CREM | Customer Remote Loopback | Signal from customer is looped back to the customer at HLU-431. |
| ND*n*? | Network Doubler n Loopback | Query to initiate loopback at doubler *n* to network, where *n* is the number of the doubler. |
| NLOC | Network Local Loopback | DSX-1 signal is looped back to DSX-1 at HLU. |
| NREM | Network Remote Loopback | DSX-1 signal is looped back to DSX-1 at the HRU. |
| SMJK | Remote SmartJack Loopback | Signal from DS1 is looped back at the HRU by the HRU SmartJack module. |
| TLOS | Transmit Loss Of Signal | HRU is in a logic loopback state caused by a loss of its T1 input from the CI, if enabled at the HRU by its TLOS switch option. |
| **DIAGNOSTIC MESSAGES** | | |
| 1=xx or 2=yy | HDSL Loop Margin 1 or 2 | Indicates the power of the received HDSL signal on each loop relative to noise. Any value of '06' or greater is adequate for reliable system operation. |
| ACQ 1 or 2 | Acquisition 1 or 2 | The multiplexers of the HLU and HRU or first doubler are trying to establish synchronization over Loops 1 or 2 of Span 1. |
| A*n*L1 or 2 | Acquisition *n* Loop 1or 2 | The multiplexers of the first doubler and either the HRU or second doubler are trying to establish synchronization with each other on Loops 1 or 2 of Span *n*, where *n* is the number of the span. |
| BAD RT? | No response from HRU | The HLU does not receive any response from the HRU. Thus, the integrity of the HRU or the two HDSL loops (they may be open) is questionable. |

***Table 2.*** *Front Panel Display Messages (Cont.)*

| Message | Full Name | Description |
|---|---|---|
| CODE | Line Code: AMI, B8ZS, AUTO | The line code that HLU-431 is receiving at its DSX-1 interface, if the DS1 option is set to Auto. Otherwise, it mimics either of the other two DS1 line code settings, Alternate Mark Inversion (AMI) or Bipolar with 8-zero Substitution (B8ZS). Displayed during System Settings review mode. |
| DS0 | DS0 Blocked Channels | Indicates status of DS0 blocked channels. NONE indicates no channels are blocked. BLK indicates some channels are blocked. |
| DS1 | DS1 BPV Errors | Indicates the number of BPVs at the HLU or HRU T1 inputs have exceeded the 24-hour ES threshold. Causes a system alarm. |
| FERR | Framing Bit Error Occurred | Framing bit error occurred at HLU T1 input. |
| FRM | Frame: SF, ESF, UNFR, NONE | Defines the type of frame pattern being received from the DSX-1. Displayed during System Settings review mode. |
| H1(2)ES | HDSL CRC Error Channel 1 or 2 | HLU HDSL Loop 1 or Loop 2 CRC error. |
| xHDU | Number of Doublers | This message indicates the number of doublers in the circuit. |
| INSL, then xxDB | Maximum Insertion Loss | The Maximum Insertion Loss message (INSL) appears followed by xxDB, where xx is the maximum insertion in dB of all spans and loops. |
| LBPV | Local Bipolar Violation | A bipolar violation has been received at the T1 input to the HLU-431. |
| LIST xxxx | HLU-431 list number | The software list number appears during the System Settings review mode. Press the MODE button for 3 seconds to display the list number. |
| MNGD | Managed | The HLU is under control of the HMU-319 Network management unit. In this state, the front panel craft port and pushbuttons are disabled. |
| PWR FEED GND | Power Feed Ground | One of the HDSL loops has been grounded. |
| PWR FEED OFF | Power Feed Off | HDSL span power has been turned off by setting the PWFD option to DIS, or HDSL span power has been turned off by use of the A1LB/A2LB/A5LB Intelligent Office Repeater (IOR) Power Down code. |
| PWR FEED OPEN | Power Feed Open | Indicates an open circuit in the transmit or receive of either pair. |
| PWR FEED SHRT | Power Feed Short | Indicates a short between the two HDSL pairs. This same message can occur with an HRU that is drawing the correct amount of power over good cable pairs but cannot communicate with the HLU. |
| SELF TEST | Self Test | The HLU is in a self-test mode. This occurs every power On/Off cycle. |
| SIG 1 or 2 | Signal 1 or Signal 2 | The transceivers of the HLU, HRU or first doubler are trying to establish contact with each other on Loop 1 or Loop 2 of Span 1. |
| S*n*L1 or 2 | Signal *n* Loop 1 or Loop 2 | The transceivers of the first doubler and either the HRU or second doubler are trying to establish contact with each other on Loop 1 or Loop 2 of Span *n*. |
| VER xxxx | HLU-431 software version number | The software version number appears during the System Settings review mode. Press the MODE button for 3 seconds to display the software version. |

# INSTALLATION

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

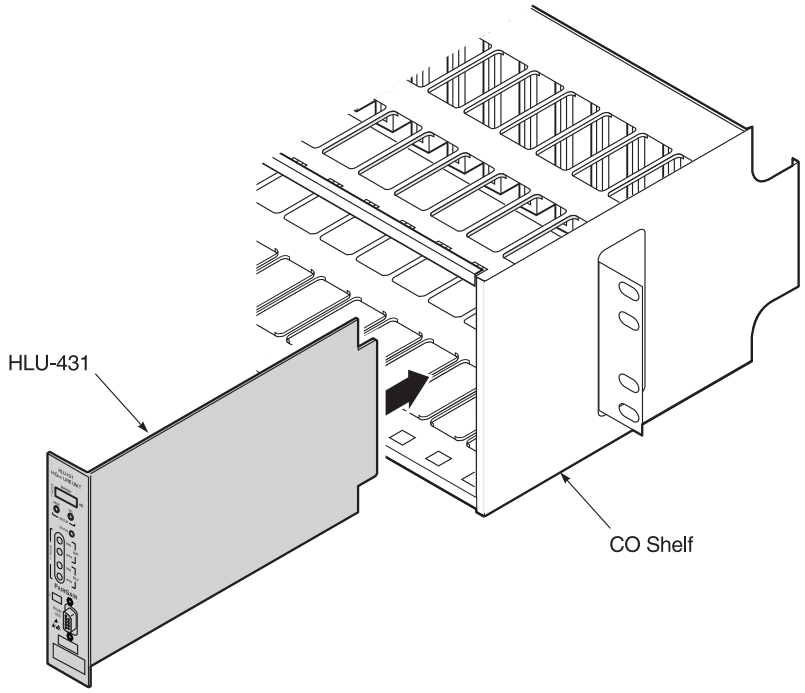



***Figure 2.*** *Installing the HLU-431 into a Shelf*

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

To install the HLU-431:

**1** Slide the HLU-431 into the card guides for the desired slot, then push the unit back until it touches the backplane card-edge connector (Figure 2).

**2** Place your thumbs on the HLU-431 front panel and push the HLU-431 into the card-edge connector until it is entirely within the card guides and properly seated.

# VERIFICATION

Once the HLU-431 is installed, verify that it is operating properly. To do this, you need to monitor the following:

- Status LED
- Status messages reported by the front panel display (see Table 2 on page 5)

## Verification without a Downstream Device

If there is no downstream device installed:

**1** Verify that the HLU powers up. (The front panel display illuminates and reports four-character status messages. See Table 2 on page 5 for a list of messages.)

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

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

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

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

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

## Verification with a Downstream Device

If a downstream device has been installed:

**1** Verify the HLU powers up. (The front panel display illuminates and reports status messages.)

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

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

**a** enters self-test mode

**b** completes self-test mode

**c** attempts communication again

**d** reports four-character status messages.

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

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

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

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

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

# PROVISIONING REQUIREMENTS

Refer to "Provisioning" on page 10 for information about using the MODE and SEL buttons or the Maintenance Terminal screens to configure the HLU. While the MODE and SEL buttons can be used to manually accomplish some provisioning tasks, such as setting system options, the Maintenance Terminal screens (available when you connect a PC to the craft port) can handle all provisioning tasks. Tasks that you need to complete are:

**1** Set the time and date (see "Set Clock Screen" on page 18.)

**2** Set the circuit IDs (see "Enter Circuit ID Screen" on page 32.)

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

**1** Clear the Alarm History screens (See "View Alarm History Screen" on page 30.)

**2** Clear Performance Data screens (See "View Performance Data Screen" on page 26.)

**3** Clear Performance History screens (See "View Performance History Screen" on page 28.)

# PROVISIONING

This is a reference section for HLU provisioning. There are two methods for provisioning the HLU-431:

- Use the MODE and SEL buttons on the front panel of the HLU to:
  - set system options
  - reset the HLU to its factory default settings for system options
  - display system option settings (scroll mode)
  - select system loopbacks
- Use a maintenance terminal (ASCII terminal or a PC running terminal emulation software) connected to the HLU craft port to access the Maintenance Terminal Main Menu (Figure 3 on page 13). This gives you full access to all HLU status, history, inventory, and provisioning screens.

**No dip switches or jumpers are required to provision the HLU-231 as it contains a non-volatile RAM (NVRAM) which stores the system option settings. System option settings are retained if shelf power is lost or if the HLU-231 is unplugged.**

## USING THE SEL AND MODE BUTTONS

### Setting Options through SEL and MODE

To provision the HLU-431 through the MODE and SEL buttons on the front panel:

**1** Press and the MODE button for two seconds and release. The front panel display alternately shows the first system parameter and its current setting.

**2** Press the SEL button to step the display through all possible settings (one at a time) of the selected parameter.

**3** After the desired setting has been selected, press the MODE button. This updates the current displayed parameter to the selected setting, and then advances to the next configurable parameter. After the last parameter has been selected, a `CONF NO` message appears on the front panel display.

**4** Do one of the following:

- To cancel the session without saving the requested parameter changes, press the MODE button or, do nothing. (After 30 seconds, the display returns to its normal mode without saving the new changes.)
- To accept the requested parameter changes, press the SEL button. (A `CONF YES` message displays, and the display returns to its normal mode after saving the new changes.)

## Resetting to Factory Default Values

All user options (Table 8 on page 20) can be set to the factory default values using the MODE and SEL buttons. To set the user options to their default values:

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

`DFLT NO`

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

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

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

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

## Displaying System Parameter Settings

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

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

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

## Disabling an Alarm

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

## Loopback Modes

See "Loopback Operation" on page 34 for instructions on using the MODE and SEL buttons to activate loopbacks.

# USING A MAINTENANCE TERMINAL

## Connecting to a Maintenance Terminal

The craft port on the front panel allows you to connect the HLU-431 to a maintenance terminal (ASCII terminal or PC running a terminal emulation program). Once connected to a maintenance terminal, you can access the maintenance, provisioning, and performance screens.

To connect to a maintenance terminal:

1. Connect a standard 9-pin terminal cable to the RS-232 craft port (Figure 1 on page 3) on the HLU-431 front panel.
2. Connect the other end of the cable to the serial port on the maintenance terminal.
3. Start a terminal emulation program such as ProComm (emulating a VT-100 terminal).
4. Configure the maintenance terminal to the following communication settings:
   - 1200 to 9600 baud (9600 baud is recommended)
   - no parity
   - 8 data bits
   - 1 stop bit
   - hardware flow control to OFF
5. Press the SPACEBAR several times to initiate the autobaud connection and to initialize the Maintenance Terminal screens.

## Accessing the Maintenance Terminal Screens

The following sections describe how to use the Maintenance Terminal screens to view, provision and diagnose an HLU-431 List 1F system.

### Navigation Keys

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

***Table 3.*** *Navigational Keys on the Maintenance Terminal*

| Key | Function |
|---|---|
| U | Updates screen data |
| C | Clears screen data |
| S | Selects the next Span Status screen |
| N | Selects the next page of screen data |
| E | Exits the current screen |

## Maintenance Terminal Main Menu

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

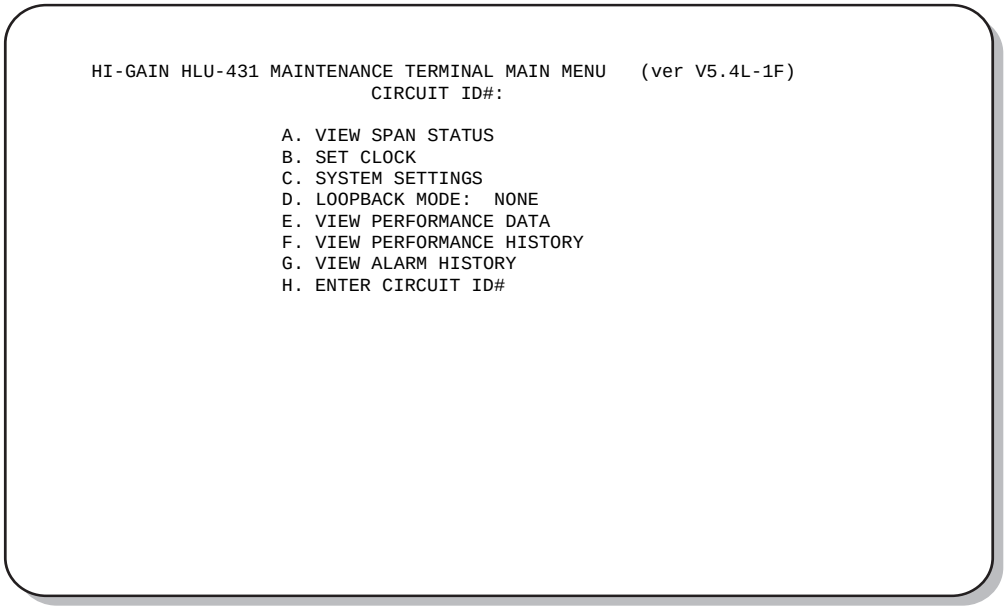



***Figure 3.*** *Maintenance Terminal Main Menu*

***Table 4.*** *Maintenance Terminal Screens*

| Press Key | To View Screen | Screen Description | See page: |
|---|---|---|---|
| A | View Span Status | Provides access to subscreens that allow you to monitor the HDSL and T1 line status between the HLU and the HRU. | 14 |
| B | Set Clock | Allows you to set both the time and the date parameters at the HLU, and to update the same settings at the HRU. | 18 |
| C | System Settings | Allows you to set all user options. | 19 |
| D | Loopback Mode | Provides access to a subscreen that allows you to enable and disable loopbacks at both the network and customer side at all module locations. | 23 |
| E | View Performance Data | Provides access to subscreens that allow you to view the Errored Seconds (ES) and Unavailable Seconds (UAS) between the HLU and the HRU in 15-minute intervals over a 4-hour time period per screen for a total of 24 hours (6 screens). | 26 |
| F | View Performance History | Provides access to subscreens that allow you to view the ES and UAS between the HLU and the HRU in 24-hour intervals over a 7-day period. | 28 |
| G | View Alarm History | Provides access to subscreens that allow you to view alarm conditions between the HLU and the HRU. | 30 |
| H | Enter Circuit ID | Allows you to enter a unique circuit ID (up to 24 alpha-numeric characters). | 32 |

### Selecting a Maintenance Terminal Function

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

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

### System Spans

As shown in Figure 4, the HLU-431 List 1F can support up to two doublers with three HDSL spans. The Span Status, Performance Data, and Performance History may display as many as three screens to depict an HLU-431 List 1F system.

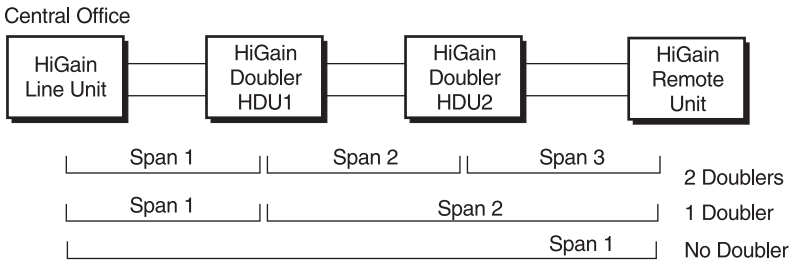



***Figure 4.*** *System Spans*

# USING THE MAINTENANCE TERMINAL SCREENS

## View Span Status Screen

The View Span Status option allows you to view three 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.

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

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 (doubler applications).
- Press **E** to return to the previous screen.

## Span Status Screen without Doublers

```
                          SPAN STATUS
TIME: 00:14:11
DATE: 05/03/99            Circuit ID#:
ALARMS:   NONE
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:           21/17/21     20/17/21     21/18/21     20/18/21 dB
PULSE ATTN:         19           19           19           19    dB
INS LOSS:           23           23           23           23    dB
PPM OFFSET:         00           00           06           05    ppm
24 HOUR ES:       00002        00004        00005        00007  seconds
24 HOUR UAS:      00016        00013        00002        00001  seconds

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

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

***Figure 5.*** *Span Status Screen: No Doubler*

## Span Status Screen for Doubler Applications

If doublers have been added, status is also reported for these. Span Status can have up to three screens, depending on the number of HDUs.

```
                          SPAN 3 STATUS
TIME: 12:06:04
DATE: 05/03/99            Circuit ID#:
ALARMS:   NONE
LOOPBACK: OFF

                       HDU2                      HRU
                  HDSL-1       HDSL-2       HDSL-1       HDSL-2
                cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:           21/21/21     21/21/21     21/21/21     21/21/21 dB
PULSE ATTN:         19           19           20           19    dB
INS LOSS:           23           23           25           23    dB
PPM OFFSET:         00           00           17           17    ppm
24 HOUR ES:       00000        00000        00000        00000  seconds
24 HOUR UAS:      00000        00000        00000        00000  seconds

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

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

***Figure 6.*** *Span Status Screen: Two Doublers (Span 3)*

Table 5 lists the Span Status fields and descriptions.

***Table 5.*** *Span Status Fields and Descriptions*

| Field | Description |
|---|---|
| Time | Time of day when Span Status was checked. |
| Date | Date when Span Status was checked. |
| Circuit ID | Shows the user-defined circuit ID. |
| Alarms | Presence or absence of alarm conditions. See Table 12 on page 33. |
| Loopback | Indicates Off condition or identifies specific active loopback. See Table 13 on page 38. |
| Margin | Indicates the excess signal to noise ratio at all HDSL ports, relative to a $10^{-7}$ Bit Error Rate.<br>• First value is current margin.<br>• Second value is minimum margin since last cleared.<br>• Third value is maximum margin since last cleared.<br>• N/A means that the margin is not available.<br>The minimum and maximum margins are cleared and updated every time the Span Status screen is cleared and every time the system clock passes 12:00 AM midnight. |
| Pulse ATTN | Indicates the attenuation of the 2B1Q pulse from the distant end. The value is related to the 196 kHz loss of the cable pair. The pulse attenuation is a more direct indication of the loop attenuation to the 2B1Q signal than is the 196 kHz loss. The normal HiGain ATTN operation range is from 0 to 28 dB. |
| INS Loss | Indicates the approximate insertion loss of the various loops at the HDSL line rate of 196 KHz. It is generated by multiplying the PULSE ATTN by 1.25. |
| PPM Offset | Indicates the relative offset of the crystal oscillator in the HLU from the HRU or HDU crystal oscillator. Any value between -100 and +100 is adequate. |
| 24-Hour ES | The number of one second intervals that contained at least one CRC error. This value is a running total of the last 24 Hours. |
| 24-Hour UAS | The number of seconds the HDSL loop was out of sync. |
| 24-Hour BPV Seconds | The number of seconds in which at least one bipolar violation was detected on the DS1 input over a 24-hour period. |
| 24-Hour UAS Count | The number of seconds during which the DS1 input signal was absent (125 or more consecutive zeroes) over a 24-hour period. |
| Frame type | Type of DS1 framing used on the input stream (SF or ESF). |
| Code type | Type of DS1 line coding used (AMI, B8ZS, AMI: ZBTSI, or B8ZS: ZBTSI). The latter two indicate the code type that is being received when HiGain line is set to ZBTS1 mode. When set to AMI or B8ZS, the HLU displays the selected code rather than the code type that is actually being received. |

**The Span Status screens shown on the previous page display a four-character code under the Alarms entry. These codes are described in Table 6 on page 17.**

**The following codes are reported with a RCV or XMT prefix that indicates the signal is being transmitted or received: LLOS, RLOS, LAIS, or RAIS.**

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

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

***Table 6.*** *HDSL System Alarms*

| Message | Name | Description |
|---|---|---|
| LOSW | Loss of Sync Word | One of the HDSL loops has lost synchronization. |
| LLOS | Local Loss of Signal | No signal from HLU-431 local T1 input. |
| MAL1(2) | Margin Alarm 1 or 2 | The margin on the HDSL Loop 1 (or Loop 2) has dropped below the threshold (1 to 15 dB) set by the user. Setting the threshold to zero inhibits the margin alarm. |
| NONE | No Alarm | No alarm is indicated. |
| R(L)AIS | Remote (Local) Alarm Indicating Signal | Indicates an AIS pattern (all ones) is being transmitted from the remote (or local) T1 output port. |
| RLOS | Remote Loss of Signal | No signal from HRU T1 input. |

Table 7 lists loopback messages displayed on the Span Status screens. For information about loopback codes, see "GNLB Loopback Test Procedures" on page 38.

***Table 7.*** *Loopback Messages*

| Message | Full Name | Description |
|---|---|---|
| ARM | Armed | The HiGain system has detected the Intelligent Repeater (IR) loopback arming code (2-in-5). |
| CDU*n* | Customer Doubler *n* Loopback | Loopback at Doubler (*n*) to Customer Installation (CI) initiated by an Intelligent Line Repeater (ILR) code, the MODE and SEL buttons on HLU-431 front panel, or by the maintenance terminal. |
| CHREV-SPx | Channels Reversed | The Loop 1 and Loop 2 HDSL pairs are reversed at Span x. Loop 1 is specified to carry the (-) simplex DC voltage, and Loop 2 is specified to carry the (+) simplex DC voltage. SPx indicates that the first occurrence of a reversed span is on Span x, where x is the number of the span. |
| CLOC | Customer Local Loopback | Loopback at HRU (local) to CI initiated from Customer Premises Equipment (CPE) by the ILR code, the MODE and SEL buttons on the HLU-431 front panel, or by the maintenance terminal. |
| CREM | Customer Remote Loopback | Loopback at HLU-431 (remote) to customer initiated by Intelligent Office Repeater (IOR) code, the MODE and SEL buttons on the HLU-431 front panel, or by the maintenance terminal. |
| H1 (H2) ES | HDSL CRC Error Channel 1 or 2 | HLU HDSL Loop1 or Loop2 CRC error. |
| NDU*n* | Network Doubler *n* Loopback | Loopback at Doubler (*n*) to network initiated by IOR code, by the MODE and SEL buttons on the HLU-431 front panel, or by the maintenance terminal. |
| NLOC | Network Local Loopback | Loopback HLU-431 (local) to network initiated from CO by IOR code, the HLU-431 front panel MODE and SEL buttons, or by the maintenance terminal. |
| NREM | Network Remote Loopback | Loopback at HRU to network initiated from CO (network) by ILR #2 code, the MODE and SEL buttons on the HLU-431 front panel, the HRU manual loopback button, or by the maintenance terminal. |
| SMJK | SmartJack Loopback | Loopback from HRU to network initiated by (2-in-5) inband loopback code or out-of-band ESF data link code. |
| TLOS | Transmit Loss of Signal Loopback | HRU is in a logic loopback state caused by a loss of its T1 input from the CI (if enabled at the HRU through its TLOS switch option). |

## Set Clock Screen

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

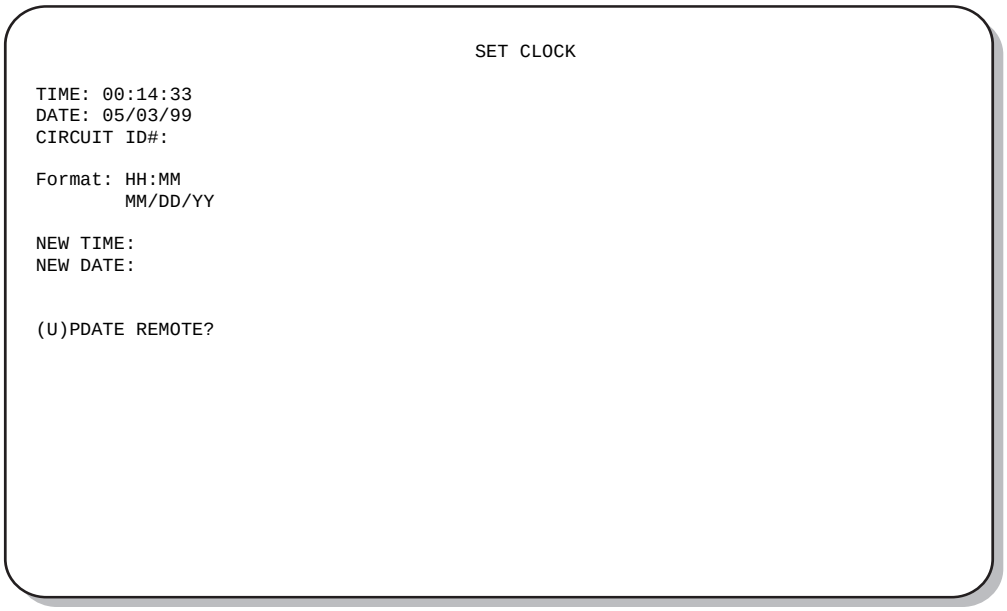



***Figure 7.*** *Set Clock Screen*

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

### Set Time

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

### Set Date

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

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

### Update the HRU Time and Date

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

- Press **U** to update the HRU to the same date and time set for the HLU-431.
- Press **ENTER**. (The remote unit is not updated.)

## System Settings Screen

The options set from the System Settings screen are the same as the options set through the HLU-431 front panel Mode and SEL buttons (except for Margin Alarm Threshold and DS0 Blocking, which can only be set at this screen). Refer to Table 8 on page 20 for a listing of system setting options.

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

```
                                  SYSTEM SETTINGS

TIME: 12:46:06
DATE: 05/03/99                     CIRCUIT ID#:

A. EQUALIZATION....: EXT                  P. MARGIN ALARM THRESH : 4
B. SMARTJACK LPBK..: ENABLED
C. SPECIAL LPBK....: GNLB
F. POWER...........: AUTO
G. ZBTSI...........: OFF
H. ES ALARM THRESH.: NONE
I. LOOPBACK TIMEOUT: 60
J. ALARM...........: DISABLED
K. DS1 LINE CODE...: AMI
L. FRAMING.........: AUTO
M. AIS ON HDSL LOSW: 2 LOOPS
N. AIS ON SMJK/NREM: ENABLED

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

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

(C)onfirm
```

***Figure 8.*** *System Settings Screen*

You have the following options at the Systems Settings screen:

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

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

***Table 8.*** *HLU-431 List 1F System Settings Screen Options*

| System Settings Screen Options | Front Panel Display Code | Selection | Description |
|---|---|---|---|
| Equalization | EQL | **0** | Sets the Equalizer to DSX-1 for 0 to 133 feet. |
| | | 133 | Sets the Equalizer to DSX-1 for 133 to 266 feet. |
| | | 266 | Sets the Equalizer to DSX-1 for 266 to 399 feet. |
| | | 399 | Sets the Equalizer to DSX-1 for 399 to 533 feet. |
| | | 533 | Sets the Equalizer to DSX-1 for 533 to 655 feet. |
| SmartJack Loopback | LBPK | DIS | Configures the HiGain system to ignore all inband SmartJack loopback commands. |
| | | **ENA** | Enables the HiGain system to recognize all inband SmartJack loopback commands. |
| Special Loopback | SPLB | **GNLB** | Configures the HiGain system to respond to the generic (3-in-7 or 4-in-7) inband loopback codes. |
| | | A1LB and A2LB | Configures the HiGain system to respond to the inband loopback codes of the Teltrend addressable repeater. |
| | | A3LB | Configures the HiGain system to respond to the inband loopback codes of the Wescom addressable repeater. |
| | | A4LB | Configures the HiGain system to respond to the inband loopback codes of the Wescom Mod 1 addressable repeater. |
| | | A5LB | Configures the HiGain system to respond to the inband loopback codes of the Teltrend Mod 1 addressable repeater. |
| Power | PWRF | DIS | Disables powering to the HDSL pair. |
| | | **ENA** | Allows the HLU to provide -140 V HDSL line voltage. |
| ZBTSI | ZBTS | ON | Tells the HiGain system that the ESF frame is operating in its Zero-Byte Timeslot Interchange (ZBTSI) mode. |
| | | **OFF** | Tells the HiGain system that the ESF frame is operating in its normal non-ZBTSI mode. |
| ES Alarm Threshold | ESAL | 17 | Activates (closes) the minor alarm relay contacts on pins 20 and 21 and flashes the red Status LED when 17 errored seconds (ES) occur within a 24-hour period. |
| | | 170 | Activates (closes) the minor alarm relay contacts on pins 20 and 21 and flashes the red Status LED when 170 errored seconds (ES) occur within a 24-hour period. |
| | | **NONE** | Prevents generation of a minor alarm due to errored seconds. |
| Loopback Timeout | LBTO | NONE | Disables automatic time-out cancellation of all loopbacks. |
| | | 20 | Sets automatic cancellation of all loopbacks to 20 minutes after initiation. |
| | | **60** | Sets automatic cancellation of all loopbacks to 60 minutes after initiation. |
| | | 120 | Sets automatic cancellation of all loopbacks to 120 minutes after initiation. |
| Alarm | ALM | **DIS** | Opens the system alarm relay contacts if closed, and disables activation of the system alarm relay when a system alarm condition occurs. |
| | | ENA | Enables activation of the system alarm relay when a system alarm condition occurs. |

***Table 8.*** *HLU-431 List 1F System Settings Screen Options (Cont.)*

| System Settings Screen Options | Front Panel Display Code | Selection | Description |
|---|---|---|---|
| DSX-1 Line Code | DS1 | AUTO | The HLU-431 and HRU monitor the incoming T1 bit streams for the B8ZS line code. If the HRU detects this code, the HLU enters B8ZS output mode. The HLU reverts back to AMI output mode if no B8ZS codes are received at the HRU input for 5 seconds. Similarly, when the HLU detects the B8ZS code, the HRU enters the B8ZS mode and returns to AMI mode if no B8ZS code is received at the HLU input for 5 seconds. |
| | | B8ZS | Places both the HLU-431 and HRU into their B8ZS modes. |
| | | **AMI** | Places both the HLU-431 and HRU into their AMI modes. |
| Framing | FRMG | **AUTO** | Configures the HiGain system to operate in an auto-framing (AUTO) mode in which it continuously searches the input T1 bit stream for a valid SF or ESF frame pattern. This feature is required for fractional T1 applications (DS0 blocking) where it insures proper channel time slot alignment. While the HiGain system can also process unframed data in this AUTO mode, it is recommended that the unframed (UNFR) mode be used for all unframed applications. Using the AUTO mode for unframed applications runs the risk of detecting "pseudo-valid" frame sequences, which can affect the data integrity. |
| | | UNFR | Configures the HiGain system to operate in an unframed mode. This mode disables the auto framing process and forces the HiGain system to function as a transparent bit pipe. |
| AIS On HDSL LOSW | HAIS | **2LP** | Causes the HiGain system to transmit the AIS signal at both the HLU-431 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-431 and HRU T1 output ports when either of the two HDSL loops is not in sync (LOSW) or if a Margin alarm occurs. |
| AIS On SMJK/NREM | SAIS | **ENA** | Causes the HRU to transmit the AIS signal towards the Customer Interface (CI) when in NREM or SmartJack loopback (see Figure 5). |
| | | DIS | Causes the HRU to either transmit the signal from the network towards the CI RCU port or to open and terminate its RCV CI port when an HRU NREM or SmartJack loopback is executed. The AIS signal is not sent (towards the CI). |
| Margin Alarm Threshold | MARG | 0 to 15 dB | The Margin Alarm Threshold can only be set through the craft port with a terminal. It determines the minimum allowable margin below which a system alarm can occur. Zero disables the alarm. |
| | | **4dB** | Default value |
| DS0 Blocking | DS0 | BLK | The DS0 blocking option can only be set through a maintenance terminal connected to the craft port. The four-character front panel display only shows the status of the blocking option. BLK indicates at least one channel is blocked. |
| | | **NONE** | Indicates no channels are blocked. |

## DS0 Blocking Option

To set the DS0 Blocking option from the Main screen:

1 Press C to select the Systems Settings screen (see Figure 8 on page 19).

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

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

If DS0 blocking is invoked in a HiGain system that has an earlier version HRU that does not support the blocking option, blocking only occurs at the DSX-1 output of the HLU-431. The HRU DS1 output will not be blocked.

Also, all blocked channels are temporarily unblocked for all HiGain system loopback tests for all DS1 blocking settings. This allows the standard full bandwidth T1 loopback tests to be performed for all DS0 blocking settings.

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

Blocking the idle code results in a mismatch between the CRC checksum delivered to the remote end (when the payload is in the ESF format) and the checksum calculated by the remote T1 CSU. This implies errors are being made on the loop when actually the blocking function created the CRC errors. Enabled DS0 channels pass error-free.

In order to avoid this condition, fractional T1 customers should fill the unused time slots with an idle code. This is a common capability on Fractional T1 CSU/DSU, D4 channel banks, and other CPE devices capable of connecting to Fractional T1 service.

## DS1 Line Code Option

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

## Margin Alarm Threshold

To set the Margin Alarm Threshold:

**1** Select **P** from the System Settings Main Menu screen.

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

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

## HAIS Selections

The HAIS option provides two selections for the T1 transmit outputs at both the HLU-431 and HRU for HDSL loss of sync conditions.

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

at turn-up, when one conductor does open, a system alarm occurs and causes the AIS/LOS condition. This alerts the maintenance personnel of the problem.

- **2LP** requires both HDSL loops to be out of sync (LOSW) before the HAIS signal is transmitted. 2LP preserves the integrity of the 12 surviving channels when just one loop is lost.

### HDSL Line Voltage Operation

The HDSL line voltage is set to 0 V on Loop 2 and to -140 V on Loop 1. This setting keeps the HDSL cable pair voltage at or below ground potential, thereby avoiding corrosion problems that may be caused by cable voltages more positive than ground.

For both doubler and non-doubler applications this setting also allows the HLU-431 List 1F to power one-doubler or two-doubler circuits (with local-powered HRU) without exceeding -140 V line voltage. This is required, for example, when the HLU-431 is used with Positron HDSL DC/DC convertor circuits to provide high voltage isolation between the cable pairs and the HLU-431. Such an application occurs when HiGain is the transport system between utility company power substations which must be isolated from the cable pair to avoid damage form Ground Potential Rise (GPR) faults.

## Loopback Mode Screen

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

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

The following options are available:

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

Table 9 lists the HLU-431 Loopback field messages and descriptions.

***Table 9.*** *Loopback Field Messages and Descriptions*

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

## Loopback Menu without Doubler

```
                                LOOPBACK MENU

TIME: 00:15:34
DATE: 05/03/99
CIRCUIT ID#:

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


                               (E)xit
```

***Figure 9.*** *Loopback Menu: No Doubler*

## Loopback Menu for Doubler Applications

```
                            LOOPBACK MENU

TIME: 00:03:33
DATE: 05/03/99
CIRCUIT ID#:


     A. DISABLE LOOPBACKS
     B. NETWORK LOOP HLU        (NLOC)
     C. NETWORK LOOP HRU        (NREM)
     D. NETWORK LOOP DOUBLER 1  (NDU1)
     F. NETWORK LOOP DOUBLER 2  (NDU2)
     G. CUSTOMER LOOP HLU       (CREM)
     H. CUSTOMER LOOP HRU       (CLOC)
     I. CUSTOMER LOOP DOUBLER 1 (CDU1)
     J. CUSTOMER LOOP DOUBLER 2 (CDU2)

                                (E)xit
```

***Figure 10.*** *Loopback Menu: Two Doublers*

## Initiating a Loopback

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

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

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

**The Loopback Menu screen is also available at the HRU connected to the HLU-431, thus allowing all HiGain System loopbacks to be initiated from either end of the circuit.**

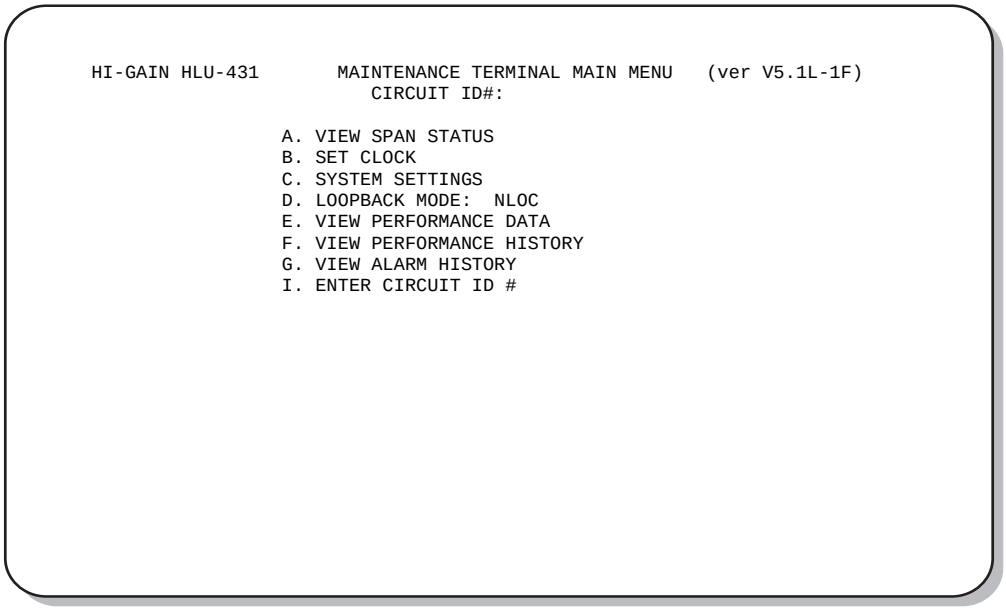



***Figure 11.*** *NLOC Loopback Mode Reported in the Maintenance Terminal Main Menu*

## Disabling a Loopback

The Disable Loopbacks option (Figure 9 on page 23) allows you to disable (cancel) any of the loopbacks listed in the screen. To disable loopbacks, press **A** in the Loopback Menu. The following prompt appears:

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

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

## View Performance Data Screen

The Performance Data screens show the Errored (ES) and Unavailable Seconds (UAS) for both HDSL loops and each T1 input at 15-minute intervals over a 4-hour time interval. The ES and UAS data is separated by a slash mark.) Earlier and later data, in 4-hour time periods on different span screens, can be accessed by pressing P (Previous) or N (Next) respectively. All Performance Data counters can be set to zero by pressing C (Clear) from the HLU-431 Span Status screen shown below.

Errored and Unavailable seconds are defined in Table 10.

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

- Press P to view the previous 4-hour data screen.
- Press N to view the next 4-hour data screen.
- Press S to view the next available span (for doubler applications).
- Press E to exit.

**All Performance Data counters can be set to zero by pressing C (Clear) from the HLU-431 Span Status screen shown in Figure 5 on page 15. The HLU-431 is considered the master module; it clears all performance data screens at both the HLU-431 and the HRU. Counters can not be cleared by accessing the HRU craft port.**

Errored and Unavailable seconds are defined in Table 10.

***Table 10.*** *Errored and Unavailable Seconds Definitions*

| ES and UAS | Definition |
|---|---|
| HDSL Errored Second. | A second in which at least one HDSL CRC has occurred. |
| HDSL Unavailable Second | A second in which an HDSL loop has sync loss 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. |

## Performance Data Screen without Doubler

Figure 12 shows a single non-doubler span. This screen shows the Errored and Unavailable Seconds for the HDSL span between the HLU-431 and the HRU.

```
Date: 05/03/99          PERFORMANCE DATA
CIRCUIT ID#:

                  ERRORED SECONDS/UNAVAILABLE SECONDS

               DS1              HDSL-1             HDSL-2
           HLU      HRU      HLU      HRU      HLU      HRU
00:00    000/000  000/000  000/000  000/000  000/000  000/000
00:15    000/000  016/012  010/016  003/005  007/013  002/001
00:30    000/000  000/000  000/000  000/000  000/000  000/000
00:45    006/010  012/005  000/000  000/000  000/000  001/000
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  001/000  001/000  000/000  001/000  000/000
03:15    000/000  006/003  006/000  002/002  004/000  002/000
03:30    000/000  000/000  000/000  000/000  000/000  000/000
03:45    000/000  000/000  000/000  000/000  000/000  000/000

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

***Figure 12.*** *Performance Data Screen: No Doubler*

## Performance Data Screen for Doubler Applications

Figure 13 is an example of a Performance Data screen that lists performance data for the third span (HDU2 to the HRU).

```
Date: 05/03/99          SPAN 3 PERFORMANCE DATA
CIRCUIT ID#:
                  ERRORED SECONDS/UNAVAILABLE SECONDS

               DS1              HDSL-1             HDSL-2
           HLU      HRU      HDU2     HRU      HDU2     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    000/000  000/000  000/000  000/000  000/000  000/000
                    (E)xit (P)revious (N)ext
```

***Figure 13.*** *Performance Data Screen: Two Doublers (Span 3)*

## View Performance History Screen

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).

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

The following options are available:

- Press **S** from the Performance History screen to advance through the history screens for the various spans (for doubler applications).
- From the 7-day Performance History screen press **N** (Next) for a continued history.
- From the 7-day Performance History screen press **P** (Previous) for the previous screen.
- Press **E** to exit from the Performance History screen.

**All Performance History counters can be set to zero by pressing C (Clear) from the HLU-431 Span Status screen shown in Figure 5 on page 15. The HLU-431 is considered the master module; it clears all performance data screens at both the HLU-431 and the HRU. Counters can not be cleared by accessing the HRU craft port.**

### Performance History Screen without Doubler

```
Time: 00:16:55                Performance History - 7 DAY
CIRCUIT ID#:

                          ERRORED SECONDS/UNAVAILABLE SECONDS

                  DS1                   HDSL-1                HDSL-2
            HLU          HRU        HLU         HRU         HLU         HRU
04/26   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/27   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/28   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/29   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/30   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/01   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/02   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 14.*** *7 Day History Screen: No Doubler*

## Performance History Screen for Doubler Applications

The 7 Day History screen displays information by span. With no doubler, there is only one span (Figure 14). With multiple doublers (up to two), there can be as many as three span screens.

```
Time: 03:09:34                Span 3 PERFORMANCE HISTORY 7 DAY
CIRCUIT ID#:                 ERRORED SECONDS/UNAVAILABLE SECONDS


                  DS1                   HDSL-1                  HDSL-2
             HLU         HRU        HDU2        HRU         HDU2        HRU
04/26   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/27   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/28   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/29   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/30   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/01   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/02   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000

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

***Figure 15.*** *7 Day History Screen: Two Doublers (Span 3)*

## View Alarm History Screen

Press **G** at the Maintenance Terminal Main Menu to open the Alarm History screen. This screen allows you to view alarms that are currently active. In the Alarm History screen (Figure 16 and Figure 17 on page 31) 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 (doubler applications).
- Press **C** to clear all data from the screen.
- Press **E** to exit from the Alarm History screen.

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

***Table 11.*** *Alarm History Fields and Descriptions*

| Field | Description |
|---|---|
| Type | Identifies the type of alarm |
| LOS, DS1-HLU | First and last instance of LOS at the HLU DSX-1 input; Current condition, number of alarms |
| LOS, DS1-HRU | First and last instance of LOS at the HRU DS1 input; Current condition, number of alarms |
| Span 1 LOSW, HDSL1 | First and last instance of LOSW on HDSL1; Current condition, number of alarms |
| Span 1 LOSW, HDSL2 | First and last instance of LOSW on HDSL2; Current condition, number of alarms |
| Span 1 ES, HDSL1 | First and last instance of ES on HDSL1; Current condition, number of alarms |
| Span 1 ES, HDSL2 | First and last instance of ES on HDSL2; Current condition, number of alarms |
| Span 1 Margin L1 | First and last instance of exceeded margin on Loop 1; Current condition, number of alarms |
| Span 1 Margin L2 | First and last instance of exceeded margin on Loop 2; Current condition, number of alarms |
| PWR-OPEN | Power open condition; Current condition, number of alarms |
| PWR-SHRT | Power short condition; Current condition, number of alarms |
| Last Cleared: | Last time Alarm History cleared |

## Alarm History Screen without Doubler

```
                                ALARM HISTORY

TIME: 00:17:18
DATE: 05/03/99
CIRCUIT ID#:

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

LAST CLEARED:  NONE

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

***Figure 16.*** *Alarm History Screen: No Doubler*

## Alarm History Screen for Doubler Applications

The Alarm History screen displays information by span. With no doubler, there is only one span (Figure 16). With multiple doublers (up to two), there can be as many as three span screens. Figure 17 is an example of an Alarm History screen that lists history for the third span (Doubler #2 to the HRU).

```
                                ALARM HISTORY

TIME: 00:17:18
DATE: 05/03/99
CIRCUIT ID#:

Type                  First              Last               Current        Count
LOS, DS1-HLU          05/03/99-00:00     05/03/99-00:00      OK             000
LOS, DS1-HRU                                                  OK             001
SPAN3 LOSW, HDSL1     05/03/99-00:01     05/03/99-00:01      OK             001
SPAN3 LOSW, HDSL2     05/03/99-00:01     05/03/99-00:01      OK             001
SPAN3 ES, HDSL1                                               OK             000
SPAN3 ES, HDSL2                                               OK             000
SPAN3 MARGIN L1                                               OK             000
SPAN3 MARGIN L2                                               OK             000
PWR-OPEN                                                      OK             000
PWR-SHRT                                                      OK             000

LAST CLEARED:  NONE

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

***Figure 17.*** *Alarm History Screen: Two Doublers (Span 3)*

## Enter Circuit ID Screen

To set a Circuit ID:

**1** Press **H** from the Maintenance Terminal Main Menu.

**2** Type a unique identifier for the circuit, up to 24 characters, then press **ENTER**. If you type more than 24 characters, a warning beep sounds, and only the first 24 characters are accepted.

**3** Choose **C** to confirm.

# TROUBLESHOOTING

## SYSTEM ALARMS

Table 12 lists possible HLU-431 alarm states. The accompanying front panel message is listed in the Alarm column. More than one alarm condition can exist at any given time, but only one message can be displayed. For multiple alarms, only the highest priority alarm displays are accepted.

***Table 12.*** *HDSl System Alarms*

| Front Panel Message | Alarm | Description | To Inhibit: |
|---|---|---|---|
| ALRM LOSW | Loss of Sync Word [(a)] | One of the HDSL loops has lost synchronization. | Cannot be inhibited. |
| ALRM LLOS Signal | Local Loss of Signal | Loss of the DSX-1 input signal. | Cannot be inhibited. |
| ALRM RLOS | Remote Loss of Signal | Loss of the HRU DS1 input signal. | Disable the RDA (Remote DS1 Alarm) option. This prevents an LOS condition at the DS1 input to a HRU from activating Pin H. The front panel Status LED still flashes red and the ALRM RLOS message displays to alert you of the LOS state. LOS is sent towards the network from the HLU. This option prevents the common occurrences of a CPE LOS condition from generating recurring alarms and AIS payloads. |
| ALRM TLOS | Transmit Loss of Signal | The DS1 input is not present at the HRU. Places the HRU in loopback towards the network. | Set the TLOS switch at the HRU to disable. |
| ALRM H1ES or ALRM H2ES | Errored Second Rate exceeded | The number of errored seconds on HDSL Loop 1 or Loop 2 has exceeded the threshold value set by the terminal ES ALARM THRES option. | Set the Errored Second Threshold option to 0 (zero). |
| ALRM DS1 | Bit Error Rate exceeded | The combined T1 and HDSL BER has exceeded you set threshold limits of $10^{-6}$ or $10^{-7}$. | Select NONE for the BER system option. |
| ALRM MAL1 or ALRM MAL 2 | Margin Alarm Loop1 or Margin Alarm Loop 2 | The margin on HDSL Loop 1 or Loop 2 has dropped below the minimum threshold value set by the terminal MARGIN ALARM THRES option. | Set the Margin Alarm Threshold option to 0 (zero). |

(a) When both HDSL loops lose sync word (LOSW), a system alarm condition exists. However, since the HLU-431 enters a self-test cycling mode, the front panel LED lights yellow instead of red and the SELF TEST message displays instead of the ALRM message.

### Retiring System Alarms

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

### Self Test

The Self Test mode that occurs when both HDSL loops are not in sync has been enhanced to include the input DS1 transceiver chip. The Self Test procedure can cause the AIS pattern that is normally transmitted from the HLU-431 during these out of sync intervals, to exhibit occasional BPVs.

## LOOPBACK OPERATION

This section discusses loopback operations that are used to test the HiGain system.

### Smartjack (SMJK) Loopback

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

### Generic Loopback Code (GNLB)

The HiGain generic loopback code is GNLB. The GNLB allows inband codes to loop-up either the HLU/NLOC (4-in-7) or HRU/NREM (3- in-7) towards the network. In addition, it allows inband codes to loop-up the HLU/CREM (6-in-7) or HRU/CLOC (5-in-7) towards the customer. Either loop-up condition is terminated (looped-down) with the 3-in-5, loop-down code. Both inband codes must be present for 5 seconds before the HiGain system responds. See “GNLB Loopback Test Procedures” on page 38 for the test procedures that apply when using the GNLB mode.

### Addressable Repeater Loopback Functions

In addition to the SMJK loopback, a HiGain system can be configured for one of five special inband loopback (SPLB) command sequences. These are selected from the SPLB user option shown in Table 8 on page 20. Loopback locations are shown in Figure 18 on page 37.

A1LB through A5LB are five special, addressable, repeater loopback functions which are supported by the HLU-431 List 1F. These loopbacks provide the HiGain system with sophisticated maintenance and trouble shooting tools. A2LB and A5LB are patterned after the Teltrend addressable T1 repeater loopbacks. A3LB and A4LB are patterned after the Wescom addressable T1 repeater loopbacks. All four SPLBs have been enhanced to handle the specific requirements of the following HiGain system customers:

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

The A1LB loopback selection, Table 14 on page 41, complies with that proposed for HDSL systems in the T1E1.4/92 recommendation with the following additions:

- Query loopback
- IOR (Intelligent Office Repeater) power-down
- Three loopback time-out choices

- Initiation from either end
- Repeating bit error signatures
- Alternate query loopback

These additions make A1LB identical to A2LB described in the next section. It is given a separate identity to allow future T1/E1 enhancements to be added without affecting A2LB.

A5LB differs from A2LB in that A5LB does not block the arming code from exiting the HLU-431 into the network. A2LB can be configured to either block this arming code after two seconds, and replace it with the AIS code, or to unblock it by executing the Far-end Activate code. Since A5LB never blocks the arming code from exiting the Line Unit, it does not need this Far-end Activate code. A3LB differs from A4LB in that A3LB supports the additional (1-in-6) SMJK loopback command.

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

## Initiating Manual Loopback Sessions

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

**Any of the HiGain loopbacks can be executed using the MODE and SEL buttons. In general, to execute a manual loopback session using the MODE and SEL buttons:**

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

To initiate a manual loopback session:

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

`MAN LPBK`

`followed by the message:`

`NLO?`

**2** Do one of the following:

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

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

  – Press the SEL button to execute the NREM loopback.

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

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

These same loopbacks can be initiated from the craft port by choosing the Loopback Mode, option D, from the Main Menu. This displays the Loopback Menu (Figure 9 on page 24) from which any of the loopbacks can be initiated or terminated.

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

## Loopback Test Procedures

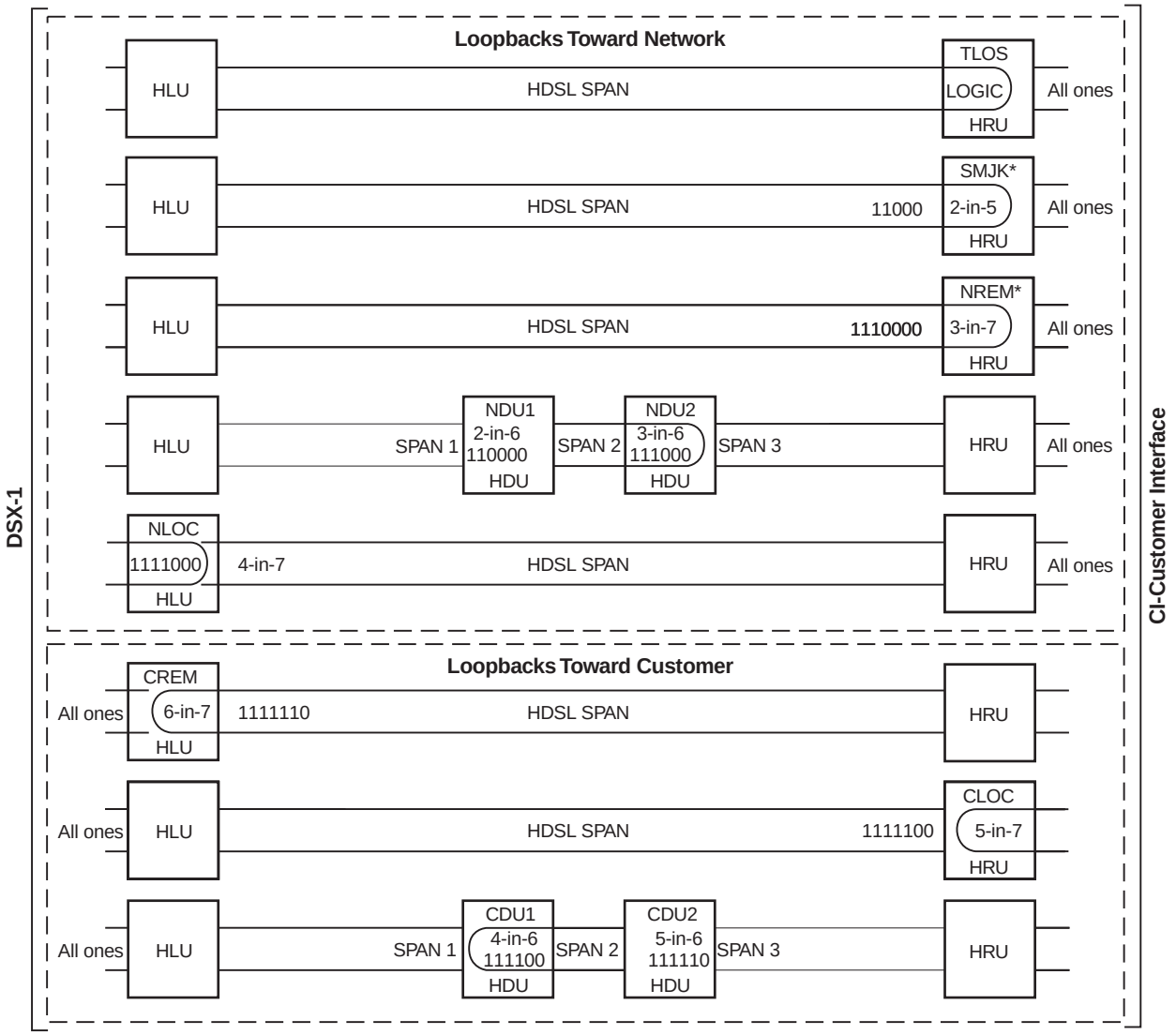
The following sections provide step-by-step test procedures for the HLU-431 as a function of the loopback option selected. These procedures allow verification of the integrity of the HDSL channels at every module location as well as the DS1 channels to the customer and the local DSX-1 interface.

If trouble is encountered on the HLU-431 DSX-1 interface, verify that the HLU is making a positive connection with its mounting assembly (shelf) connector. Also, verify that the HLU internal equalizer is set to the correct distance range. All equalizers should be set to the distance from the DSX-1 to the shelf.

The transmit and receive T1 DSX-1 ports have splitting access jacks and miniature, 210-series, bridging jacks as shown in Figure 1 on page 3. Connecting one cable between the two BRG jacks and another between the two SPAN jacks splits the XMT and RCV and creates metallic loopbacks towards both the DSX-1 and the HLU-431. If separate plugs are inserted into both SPAN jacks with the other end disconnected, the BRG jacks can be used to send and receive test patterns towards the DSX-1.

## Loopback Configurations

The complete family of loopbacks that a HiGain system equipped with the HDU-409 can execute is shown in Figure 18. Four of those loopbacks, NDU1, NDU2; CDU1, CDU2 occur in the doubler. The loopbacks can be initiated from the HLU craft port, the HLU front-panel MODE and SEL buttons, or from a family of Special Loopback (SPLP) inband loopback commands.




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

***Figure 18.*** *Doubler Loopback Configurations*

The more common generic, SPLB inband loopback commands for doubler loopbacks are listed in Table 12. The commands are very specific combinations of either 6 or 7 bits that continuously repeat. All NXXX loopbacks are towards the network. All CXXX loopbacks are towards the customer.

***Table 13.*** *SPLB Loopback Command Set*

| Loopback | Command |
|---|---|
| NDU1 | 1 1 0 0 0 0 (2-in-6) |
| NDU2 | 1 1 1 0 0 0 (3-in-6) |
| CDU1 | 1 1 1 1 0 0 (4-in-6) |
| CDU2 | 1 1 1 1 1 0 (5-in-6) |

## GNLB Loopback Test Procedures

To perform the GNLB loopback test procedure:

**1** Have the CO tester send the HRU (3-in-7) inband loopup code for 5 seconds. You should be able to see that an HRU NREM loopback is in effect by observing the NREM message on the front panel display. (Loopback states are indicated by the green LOOP LED on the front panel and also display in the Span Status screen.)

**2** Have the CO tester transmit a T1 test signal into the HLU-431 and verify that the returned (looped) signal is error-free.

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

**4** Have the CO tester send the HLU-431 (4-in-7) inband loopup for 5 seconds. You should be able to see that an NLOC HLU-431 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-431 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-431 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-431 DS1 input port.

## A1LB, A2LB, and A5LB Test Procedures

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

**1** Send into the HLU-431 the inband ARMING and NI LPBK code 11000 for at least 5 seconds.

**2** Monitor the output of the HLU-431 for the return of the pattern. Return of the pattern indicates that:

- either the HRU has looped up (if the SMJK Loopback option is Enabled),
- or that an external NI has looped up (if the SMJK Loopback option is Disabled) and that the HLU-431 and HRU units have been ARMED.

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

**4** Once armed, the HLU-431 can be looped back by sending Intelligent Office Repeater (IOR) LPBK activation code 1101 0011 1101 0011 (D3D3) for at least 5 seconds. The tester observes, the following activation response, in the order presented:

**a** 2 seconds of AIS (all ones pattern)

**b** 2 seconds of returning data pattern

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

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

**d** normal looped data

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

**Some Intelligent Repeater (IR) test sets do not count frame errors as bit errors when the test pattern is framed and the HLU-431 is set to the AUTO framing mode. To improve compatibility with those test sets, the HLU-431 generates 201 (NDU2) and 232 (NLOC) ID bit errors. As a result, the HLU-431 may indicate one more or one less bit error, depending on the test set type and the number of frame bits contained in the block of errored bits. To avoid this uncertainty, PairGain recommends sending the IR commands unframed.**

The HLU is now in Logic Loopback. You can set the Loopback Time-out option to:

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

These selections determine the duration of this loopback unless it is overridden by the Time-out Override command or a loop-down command is sent. If the Time-out Override code 1101 0101 1101 0110 (D5D6) is received, the activation sequence described in step 4, above, is repeated and the automatic timed expiration of the loopback is inhibited. If this Time-out Override is sent, then the only way to loop the HLU-431 down is to do the following:

- issue the IR (Intelligent Repeater) LPDN (loop-down) 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.

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

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

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

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

Using the codes listed in Table 14 on page 41, a network tester can activate loopbacks NLOC or NREM or SMJK (if enabled). A customer tester can activate loopbacks CLOC or CREM. All loopbacks shown in Table 14 can also be initiated from the HLU-431 front panel MODE and SEL buttons (see "Setting Options through SEL and MODE" on page 10).

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

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

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

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

## A3LB and A4LB Test Procedures

The HLU-431 can be looped back by sending the Addressable Office Repeater (AOR) LPBK activation code 1111(F) 1111(F) 0001(1) 1110(E) for at least 5 seconds. This causes the HLU-431 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-431 down is to issue one of the three loopdown commands listed in Step 2. The automatic time-out mode is restored during subsequent loopback sessions.

Table 15 summarizes the codes required to execute Addressable 3 and 4 (A3LB and A4LB) repeater loopback commands. All code sequences must be present for at least 5 seconds. The abbreviations used in Table 15 are as follows:

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

Information specific to HiGain doublers is shown in bold in Table 15.

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

| Position | Name | Code [a] |
|---|---|---|
| HLU-431 LU FROM NI 1111(F) b | NLOC | 1111(F) [b] 0001(1)1110(E) |
| HLU-431 LU from CI | CREM | 0011(3)1111(F)0001(1)1110(E) |
| **HDU DOUBLER 1 FROM NI** | **NDU1** | **1111(F)1111(F)0000(0)1000(4)** |
| **HDU DOUBLER 1 FROM CI** | **CDU1** | **0011(3)1111(F)0000(0)0100(4)** |
| **HDU DOUBLER 2 FROM NI** | **NDU2** | **1111(F)1111(F)0000(0)0110(6)** |
| **HDU DOUBLER 2 FROM CI)** | **CDU2** | **0011(3)1111(F)0000(0)0110(6** |
| HRU LU FROM NI | NREM | 1111(F)1111(F)0000(0)0010(2)10(6) |
| HRU LU FROM CI | CLOC | 0011(3)1111(F)0000(0)0010(2)10(6) |
| HRU LU FROM NI | SMJK | 11000 11000 11000 … |
| HRU LU FROM NI (ESF-DL) | SMJK | 1111(F)1111(F)0100(4)1000(8) |
| HLU and HRU LD FROM NI OR CI | Loopdown | 11100 11100 11100 … |
| HLU and HRU LD FROM NI OR CI | Loopdown | 100 100 100 … |
| HLU and HRU LD FROM NI OR CI (ESF-DL) | Loopdown | 1111(F)1111(F)0010(2)0100(4) |

(a) The left-most bit arrives first in all sequences. The detection algorithm functions reliably with a random $10^{-3}$ Bit Error Ratio (BER) on the facility. The entire arming and loopback sequence can be initiated at the remote HRU location.
(b) This is the HEX number for the 4-bit group.

# APPENDIX A - SPECIFICATIONS

| | |
|---|---|
| **HDSL Line Code** | 784 kbps 2B1Q |
| **HDSL Output** | +13.5 dBm ±0.5 dB at 135 Ω |
| **HDSL Line Impedance** | 135 Ω |
| **Maximum Provisioning Loss** | 35 dB at 196 kHz, 135 Ω |
| **Line Clock rate** | Internal “Stratum 4” clock |
| **HDSL Start-up Time** | 30 sec. (typical), 60 sec. (maximum) per span |
| **One-way DS1 Delay** | <200 µs per span without doublers. Doubler delay <80 µs |
| **DSX-1 Line Impedance** | 100 Ω |
| **DSX-1 Pulse Output** | Pre-equalized 0-655 feet of ABAM cable |
| **DSX-1 Input Level** | +1.5 to -7.5 dB DSX-1 |
| **DS1 Line Rate** | 1.544 Mbps ±200 bps |
| **DS1 Line Format** | AMI, B8ZS or ZBTSI |
| **DS1 Frame Format** | ESF, SF or UNFR |
| **Maximum Heat Dissipation** | See “Power Consumption” on page 44 |
| **Fusing** | Internal; connected to Fuse Alarm output on pin 25 |
| **HDSL Span Voltage** | -140 V |
| **Electrical Protection** | Secondary surge and power cross protection on HDSL ports. |
| **Operating Temperature** | -40 °F to +149 °F (-40 °C to +65 °C) |
| **Operating Humidity** | 5% to 95% (non-condensing) |
| **Mounting** | 400 mechanics |
| **Dimensions** | |
| Height: | 5.6 in. (14 cm) |
| Width: | 1.4 in. (3.5 cm) |
| Depth: | 5.6 in. (14 cm) |
| Weight: | 1 lb. 2 oz. (.46 kg) |
| **Wander (Looped)** | 0.3 UI maximum (1 UI = 648 ns) |
| **WB Jitter (Looped)** | 0.2 UI maximum |
| **NB Jitter (Looped)** | 0.1 UI maximum |

# HDSL INSERTION LOSS GUIDELINES

Each loop has no more than 35 dB of loss at 196 kHz, with driving and terminating impedances of 135 Ω. Table 16 provides a "loss" guide for the various cable gauges at 196 kHz and 135 Ω. The table applies to the HDSL cable pairs between the HLU, HRU, and HDU modules. In the absence of specific insertion loss measurement data, add 3 dB for each bridged tap and 1 dB for each cable gauge change.

***Table 16.*** *HDSL Loss Over Cables*

| Cable Gauge | Loop Loss at 196 kHz (dB/kft) | Loop Resistance (W 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 |

# 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-431 consumes or draws from its -48 V shelf power source. This parameter is needed when the HLU-431 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 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.

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 thermal stress on the plugs.

### Maximum Power Dissipation:

- Per Slot = 6 Watts
- Per Shelf = 84 Watts (14 slots)

### Maximum Power Consumption:

- Per Slot = 14 Watts
- Per Shelf = 196 Watts

### Maximum Current Drain:

- Per Slot = 0.38 Amps
- Per Shelf = 5.3 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 14-slot shelf, and a -42.5 V shelf battery voltage with the HLU-431 4-character display "OFF.**

# CARD-EDGE CONNECTOR

Figure 19 shows the card-edge connectors on the HLU-431. Active pins are highlighted in black.

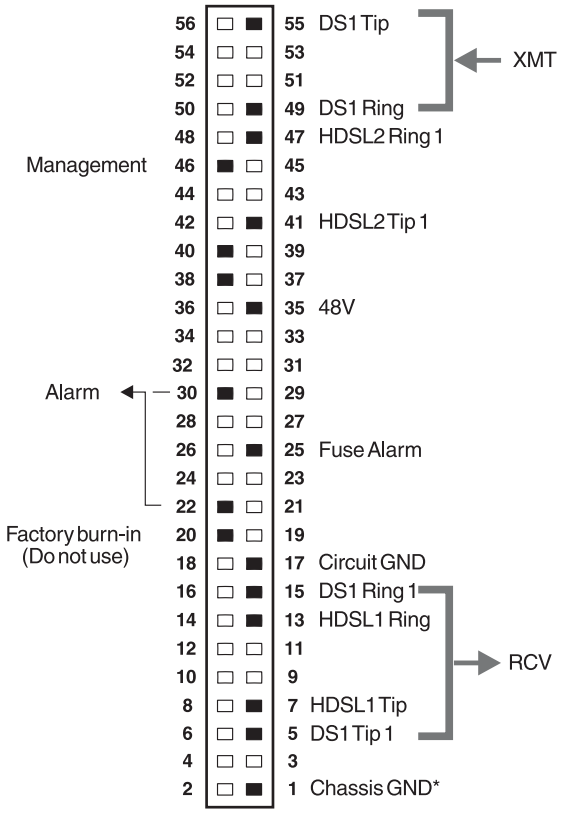



***Figure 19.*** *HLU-431 List 1F Card-Edge Connector*

## Network Management Control Bus

The HLU-431 List 1F provides a Network Management Control Bus on pin 46 of the card-edge connector. This allows the various PairGain Management System protocols to manage the HLU through the HMU-319 HiGain Management Unit. Whenever the HLU-431 is under management, the MNGD message displays periodically on the HLU-431 front panel display.

**Some HLU-431 features are affected when it is under management. Consult the management unit practice for further information.**

## Fuse Alarm

Pin 25 on the card-edge connector is a Fuse Alarm that is driven to -48 V through a 1000 W resistor whenever the onboard fuse opens.

## System Alarm Relay Output

The normally open alarm contacts available across pins 20 and 21 (Figure 19) comprise the HLU-431 system alarm output. These alarm contacts close for any system alarms condition. The alarm contacts also close if power is lost or removed from the slot, providing fail-safe relay output. See "System Alarms" on page 33 for further information about system alarms.

# CRAFT PORT

Figure 20 shows the pinout for the craft port connector and its connection to a DB-9 or DB-25 connector on a maintenance terminal.

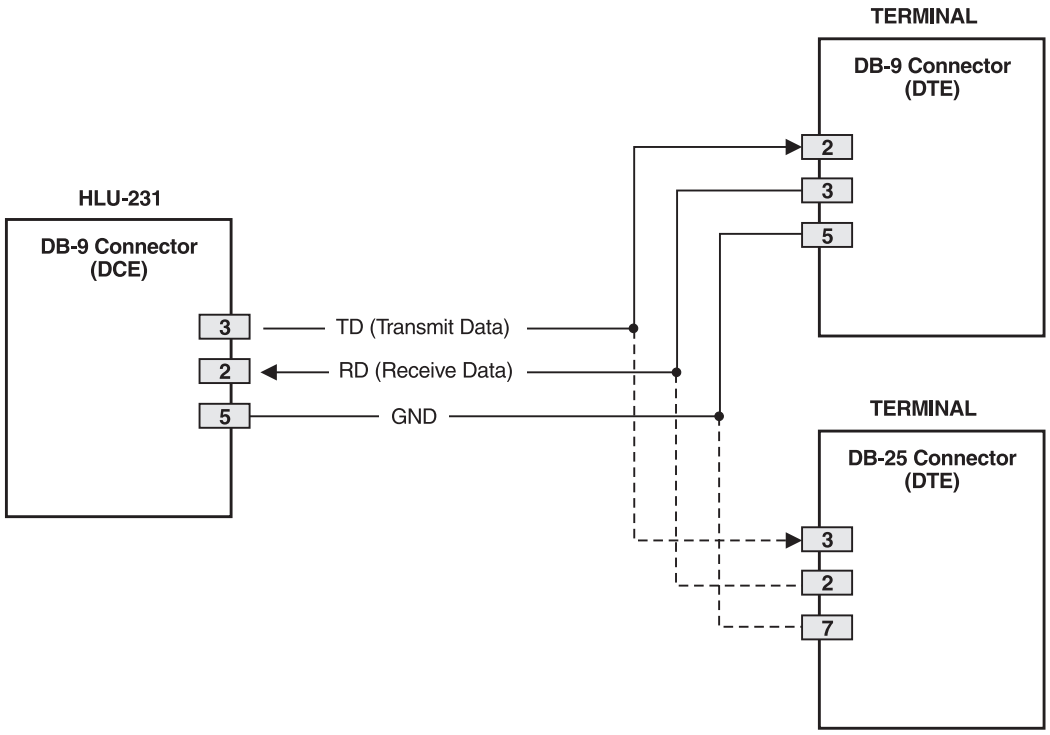



***Figure 20.*** *RS-232 Craft Port Pinouts*

# APPENDIX B - FUNCTIONAL OPERATION

PairGain HDSL technology provides full-duplex services at standard T1 rates over copper wires between an HLU and an HRU, which comprise one HiGain system. HiGain systems use PairGain 2-Binary 1, Quartenary (2B1Q) HDSL transceiver systems to establish two, full-duplex, 784 kbps data channels between the HLU-431 and a remotely located HDU or HRU. This provides a total capacity of 1.568 Mbps between the two units. A block diagram of the HLU-431 is shown in Figure 21. The HLU-431 receives a 1.544 Mbps DSX-1 data stream from the DSX-1 digital cross connect interface. The HLU-431 contains a DS1 frame synchronizer controlled by an 8-bit microprocessor that determines the type of framing on the DS1 stream and synchronizes to it. The HLU-431 recognizes Super Frame (SF), including D4, or Extended Super Frame (ESF) framing. When the data is unframed, the HLU-431 arbitrarily defines a frame bit.

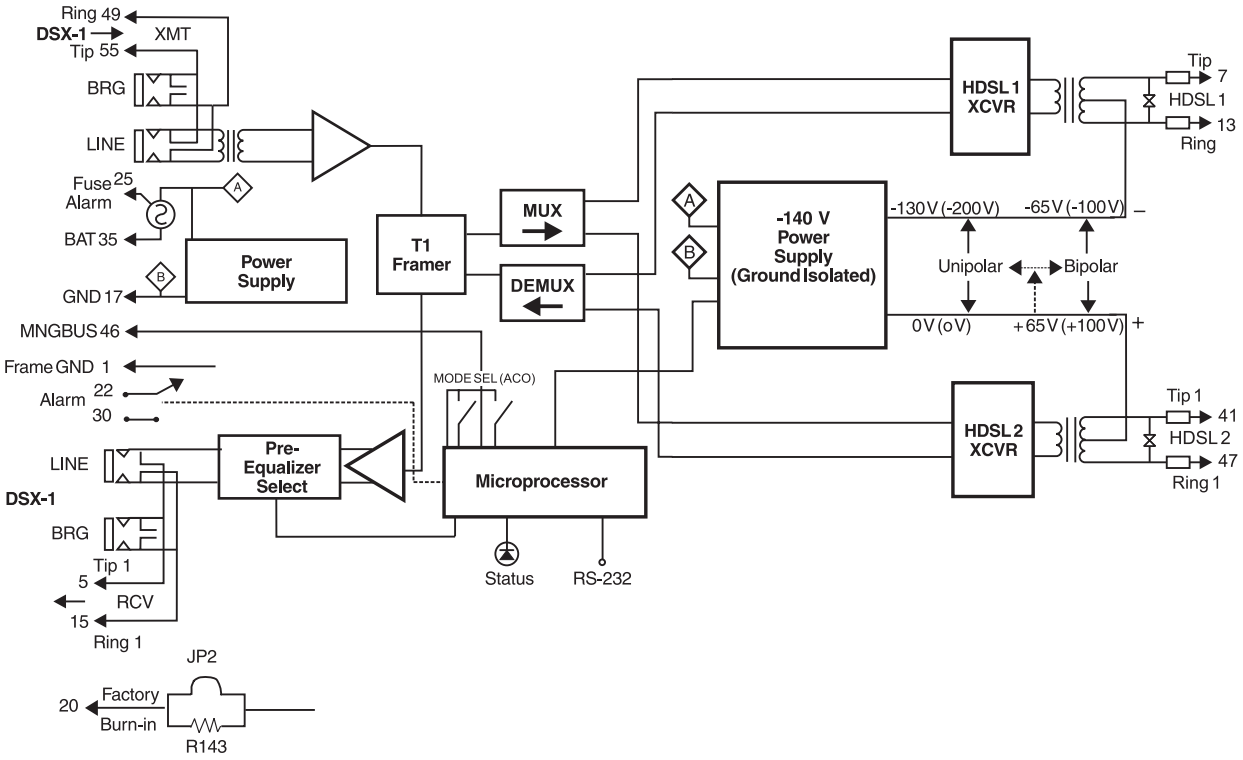



***Figure 21.*** *HLU-431 Block Diagram*

# APPENDIX C - COMPATIBILITY

## MOUNTING

The HLU-431 List 1F is compatible with any mounting that accepts 400 mechanics, including the following PairGain mountings:

- HRE-420, Single Slot
- HRE-422, Dual Slot
- HRE-427, Seven Slot
- HRE-450, Single Slot Outdoor
- HRE-454, Four Slot Outdoor

## HIGAIN DOUBLER CIRCUIT DEPLOYMENT

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

Table 17 provides a matrix of HiGain doubler deployment rules to achieve maximum circuit enhancement. It lists:

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

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

***Table 17.*** *HiGain Doubler Deployment Matrix*

| | **Maximum Number of Doublers Per Circuit** [a] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **HDU-451, List 3, 3B 4, 4B** | | | | **HDU-437, 439** | | | | **HDU-404, 407, 409** | | | |
| | *Line Powered* | | *Local Powered* | | *Line Powered* | | *Local Powered* | | *Line Powered* | | *Local Powered* | |
| **HLU Model** | CPEI ON | CPEI OFF | CPEI ON | CPEI OFF | CPEI ON | CPEI OFF | CPEI ON | CPEI OFF | CPEI ON | CPEI OFF | CPEI ON | CPEI OFF |
| HLU-231 List 6X HLU-232 List 1D | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 2 |
| HLU-319 List 2X HLU-388 List 2X | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 2 |
| HLU-231 List 7X HLU-431 List 1D and List 1E | 1 | 1 | 2 | 2 | 1 | 2 [b] | 2 | 2 | 1 | 2 | 2 | 2 |
| HLU-231, List 8X HLU-319, List 5X HLU-388 List 5X | 1 | 2 [c] | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 3 [c] | 2 | 4 [d] |
| HLU-431 List 1F | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 [c] | 1 | 2 |

(a) HRU-411 applications with CPEI are limited to single doubler circuits (HDU-404, HDU-407 or HDU-409). The HRU-412, HDU-451, HDU-437 and HDU-439 are limited to applications with one and two doublers only.

(b) 2000 Ω maximum loop resistance. Requires HRU-412 List 7A or 8A, or HRU-402 or HRU-411.

(c) Requires HRU-402 or 411.

(d) Requires HRU-402.

# APPENDIX D - PRODUCT SUPPORT

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

## TECHNICAL SUPPORT

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

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

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

## WORLD WIDE WEB

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

## RETURNS

To return equipment to PairGain:

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

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

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

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

- Company name, address, and the name of a person PairGain can contact regarding this equipment.
- The purchase order number provided to Customer Service when the RMA number was requested.
- A description of the equipment, as well as the number of units that you are returning. Be sure to include the model and part number of each unit.
- The shipping address to which PairGain should return the repaired equipment.
- The reason for the return, for example:
  - The equipment needs an ECO/ECN upgrade.
  - The equipment is defective.

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

4 Pack the equipment in a shipping carton.

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

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

Attention: **CRF RMA (Number)**

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

# APPENDIX E - GLOSSARY

| | |
|---|---|
| **2B1Q** | 2 Binary,1 Quaternary |
| **ACO** | Alarm Cut Off |
| **AIS** | Alarm Indicator Signal |
| **ALMP** | Alarm Pattern |
| **AMI** | Alternate Mark Inversion |
| **AWG** | American Wire Gauge |
| **B8ZS** | Bipolar with 8-zero Substitution |
| **BBS** | Bulletin Board System |
| **BER** | Bit Error Rate |
| **BPV** | Bipolar Violation |
| **BPVT** | Bipolar Violation Transparency |
| **BRG** | Bridge |
| **CDI** | Customer Disconnect Indicator |
| **CI** | Customer Installation |
| **CLEI** | Common Language Equipment Identifier |
| **CLOC** | Customer Local Loopback |
| **CO** | Central Office |
| **COM** | Communications |
| **CPE** | Customer Premises Equipment |
| **CRC** | Cyclic Redundancy Check |
| **CREM** | Customer Remote Loopback |
| **CSA** | Carrier Service Area |
| **CSU** | Channel Service Unit |
| **DCE** | Data Circuit-Terminating Equipment |
| **DDS** | Digital Data Service |
| **DIS** | Disabled |
| **DLC** | Digital Loop Carrier |
| **DS0** | Digital Signal, level 0 |
| **DS1** | Digital Signal, level 1 |
| **DSX-1** | DS1 Cross-connect Frame |
| **ECI** | Equipment Catalog Item |
| **ENA** | Enabled |
| **ENFT** | Enable Fractional T1 |
| **ES** | Errored Seconds |
| **ESF** | Extended SuperFrame |
| **ESF DL** | Extended SuperFrame Data Link |
| **HCDS** | High Capacity Digital Service |
| **HCS** | HiGain Central Office Shelf |
| **HDSL** | High-bit-rate Digital Subscriber Line |
| **HDU** | HiGain Doubler Unit |
| **HLU** | HiGain Line Unit |
| **HMS** | HiGain Management Shelf |
| **HMU** | HiGain Management Unit |
| **HRE** | HiGain Remote Enclosure |
| **HRU** | HiGain Remote Unit |
| **I-CPE** | Current (amperes) requirements for Customer Premises Equipment |
| **ILR** | Intelligent Line Repeater |
| **IOR** | Intelligent Office Repeater |
| **IR** | Intelligent Repeater |
| **LED** | Light Emitting Diode |
| **LOS** | Loss of Signal |
| **LOSW** | Loss of Sync Word |
| **NEBS** | Network Equipment Building System |
| **NEC** | National Electric Code |
| **NI** | Network Interface |
| **NID** | Network Interface Device |
| **NIU** | Network Interface Unit |
| **NLOC** | Network Local Loopback |

| | |
|---|---|
| **NMA** | Network Management and Administration |
| **NREM** | Network Remote Loopback |
| **NVRAM** | Non-Volatile Random Access Memory |
| **ORB** | Office Repeater Bay |
| **PCS** | Personal Communication Services |
| **PL** | Payload |
| **POTS** | Plain Old Telephone Service |
| **PPM** | Pulse Position Modulation |
| **PWRF** | Power Feed |
| **RCV** | Receive |
| **RDA** | Remote DS1 Alarm |
| **RLOS** | Remote Loss of Signal |
| **RMA** | Return Material Authorization |
| **SAIS** | SmartJack AIS |
| **SF** | Super Frame |
| **SMJK** | SmartJack |
| **SNR** | Signal-to-Noise Ratio |
| **SPLB** | Special Loopback |
| **STS** | Span Terminating Shelf |
| **TEC** | Total Error Count |
| **TLOS-LB** | Transmit Loss of Signal-Loopback |
| **TSEC** | Total System Error Count |
| **TSGR** | Transport System Generic Requirements |
| **UAS** | Unavailable Seconds |
| **XMT** | Transmit |

# CERTIFICATION AND WARRANTY

## FCC COMPLIANCE

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

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

- Cabling
- Correct connections
- Grounding

## LIMITED WARRANTY

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

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

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

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

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

## MODIFICATIONS

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

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

## STANDARDS COMPLIANCE

The HLU-431 List 1F  has been tested and verified to comply with the applicable sections of the following standards.

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

**Corporate Office**

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**For Technical Assistance:**

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DNV Certification, Inc.
Certificated Firm