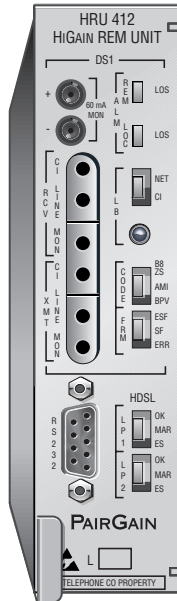


# HIGAIN REMOTE UNIT

Model	List Number	Part Number	CLEI Code
HRU-412	6	150-1103-06	T1LIEF04AA



**PAIRGAIN TECHNOLOGIES, INC.**  
**ENGINEERING SERVICES TECHNICAL PRACTICE**



**SECTION 150-412-106-06**

## Revision History of This Practice

Revision	Release Date	Revisions Made
04	November 15, 1994	Minor updates
05	September 22, 1998	Reformat
06	October 28, 1998	Update cover

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# USING THIS TECHNICAL PRACTICE

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



**Notes contain information about special circumstances.**



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

## ABBREVIATIONS

<b>AMI</b>	Alternate Mark Inversion
<b>BER</b>	Bit Error Rate
<b>BPV</b>	Bipolar Violations
<b>B8ZS</b>	Bipolar with Eight Zero Substitution
<b>CI</b>	Customer Interface
<b>CO</b>	Central Office
<b>CPE</b>	Customer Premise Equipment
<b>CRC</b>	Cyclic Redundancy Check
<b>CSA</b>	Carrier Service Area
<b>ES</b>	Errored Seconds
<b>ESF</b>	Extended Superframe
<b>HDSL</b>	High-bit-rate Digital Subscriber Line
<b>HLU</b>	HiGain Line Unit
<b>HRU</b>	HiGain Remote Unit
<b>NI</b>	Network Interface

<b>RLEV</b>	Receive Level
<b>SF</b>	Super Frame
<b>SNR</b>	Signal-to-Noise Ratio
<b>SPLB</b>	Special Loopback
<b>ZBTSI</b>	Zero Byte Time Slot Interchange

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# OVERVIEW

The PairGain<sup>®</sup> HiGain<sup>®</sup> Remote Unit Model HRU-412 List 6 is the remote end of a repeaterless T1 transmission system. An HRU-412 List 6 connects to a HiGain Line Unit (HLU), creating a HiGain system which provides 1.544 Mbps transmission on two unconditioned copper pairs over the full Carrier Service Area (CSA) range. The CSA encompasses approximately 12,000 feet of AWG 24 wire or 9,000 feet of AWG 26 wire, including bridge taps and gauge changes. A HiGain system utilizes 2B1Q High-bit-rate Digital Subscriber Line (HDSL) transmission technology.

The HRU-412 List 6 complies with ANSI T1E1.4, T1.403-1989, and T1E1.4/92-002R2 technical standards and recommendations. The HRU-412 List 6 mounts in a single slot of an industry standard 400 Mechanics type shelf. The system also complies with GR-63 Core of Network Equipment Building System (NEBS) Generic Equipment requirements, and Transport System Generic Requirements (TSGR) common requirements TR-TSY-000499.

The HRU-412 List 6 features:

- Customer Interface (CI)
- Front panel DS1 and HDSL LEDs
- Generic and addressable repeater loopback activation codes
- Metallic Smart-Jack loopback (conforms to TR-TSY-000312)
- Provisioning switches for customer premise equipment current, receive level, and transmit loss of signal-initiated loopback or alarm
- HDSL line powered—no local power required
- Front panel jacks for test access
- Craft port
- CPE current monitor test points
- Front panel HDSL margin threshold indicator for each loop
- Lightning and power cross protection on HDSL and DS1 interfaces
- 784kbps full-duplex 2B1Q HDSL transmission on two pairs
- DS0 blocking support

# APPLICATIONS

A HiGain system, consisting of a HiGain line unit and a HiGain remote unit, provides a quick and cost-effective way of delivering T1 High Capacity Digital Service (HCDS) to customers over copper wire pairs. The HiGain system can be deployed on two unconditioned, non-loaded copper wire pairs without repeaters, and without the need for bridged tap removal or binder group separation.

The general guidelines for HiGain system usage are that each loop must have less than 35 dB of loss at 196 kHz, with 135 ohm driving and terminating impedances.

**Table 1** provides a guide for the loss over various cable gauges at 196 kHz and 135 ohms. The table applies to the HDSL wire pairs between the HiGain line unit and the HiGain remote unit. When specific loop insertion loss data is unavailable, add 3 dB for each bridged tap and 1 dB for each cable gauge change.

The dc cable resistance determines the simplex powering resistance path of the loops. The maximum allowable resistance for a HiGain system is 800 ohms over two HDSL simplex loops. This means, for example, where 12 kft of AWG 24 wire equals 34.08 dB (insertion loss), resistance is at 622 ohms which is well below the limit of 800 ohms.

**Table 1.** *HDSL Loss Over Cables*

<b>Cable Gauge</b>	<b>Loss at 196 kHz (db/kft)</b>	<b>Ohms per kft</b>
26/0.4mm	3.88	83
24/0.51mm	2.84	52
22/0.61mm	2.18	32
19/0.91mm	1.54	16

A HiGain system operates with a variety of other T1, POTS, Digital Data Service (DDS) equipment, or other HiGain systems sharing the same cable binder group. HiGain systems provide temporary or permanent DS1 service and can provide a means of deploying service in advance of fiber-optic transmission systems.

# FUNCTIONAL DESCRIPTION

This section describes the functions of the HRU-412 List 6.

## OPERATIONAL CAPABILITIES

HiGain utilizes PairGain's 2B1Q HDSL transceiver system to establish two full-duplex 784 kbps data channels between the HLU and a remotely mounted HRU-412 List 6. This provides a total transmission capacity of 1.568 Mbps between the two units.

The HRU-412 power supply converts the power feed voltage received on the simplex wire pairs to voltages and currents required by the HRU-412 circuitry. The power supply generates +5, -5 and 30 Vdc outputs. The 30 Vdc output converts to a 60 mA current feed to power a Network Interface Device (NID). The HRU-412 List 6 cannot power a NID and another product simultaneously.

The HRU-412 dissipates 5.5 Watts of power and may consume up to 7 Watts when feeding 60 mA of simplex current to the CI.

# FRONT PANEL FEATURES

Figure 1 shows the front view of the HRU-412 List 6. Table 2 describes the HRU-412 List 6 front panel components.

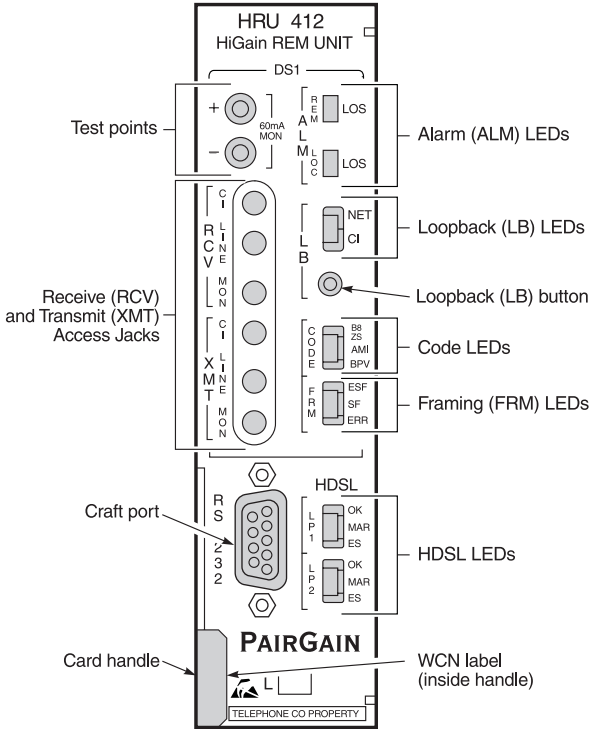


Figure 1. HRU-412 List 6 Front Panel

**Table 2. HRU-412 List 6 Front Panel Components**

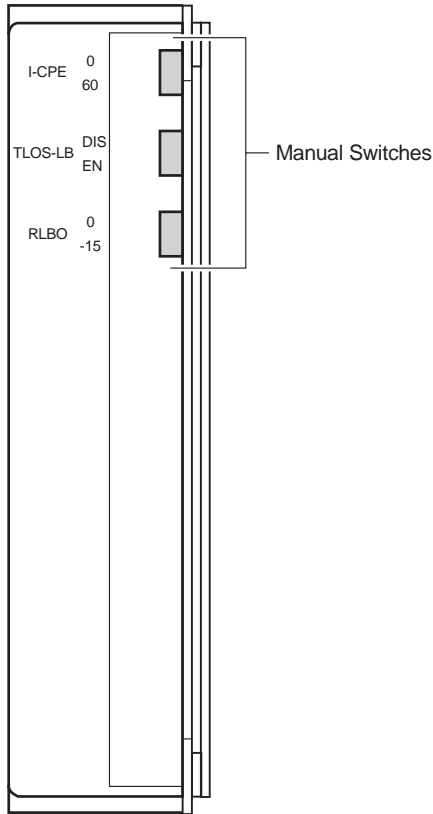
<b>Name</b>	<b>Function</b>
Test points	Allow measurement of the 60 mA CPE current. The current is related to the voltage measurement across the + and - test points by the following relationship: CPE CURRENT = 1 MA/1 MV. Typical readings range from 55 to 65 mV, which equate to a 55 to 65 mA current range.
Receive (RCV) and transmit (XMT) jacks	Provide splitting and monitor access to the CPE DS1 interface. The jacks are transformer isolated from the CPE DS1 metallic interface.
Alarm LEDs	REM LOS LED lights red to indicate a loss of signal (LOS) at the T1 input to the HLU. This LOS condition causes the HRU-412 List 6 to transmit the alarm indicating signal (AIS) pattern toward the CPE. LOC LOS LED lights red to indicate a loss of signal (LOS) at the T1 input to the HRU-412 List 6. This LOS condition transmits the AIS pattern toward the DSX-1 (TLOS Disabled) or to execute a logic loopback in the HRU-412 List 6 (TLOS Enabled).
Loopback (LB) LEDs	NET LED lights green to indicate the HRU-412 List 6 is in a loopback state in which the signal from the network is looping back to the network. CI LED lights yellow to indicate the HRU-412 List 6 is in a loopback state in which the signal from the customer interface (CI) is looping back to the CI.
Code LEDs	B8ZS LED lights green to indicate that the user DS1 code option is set to B8ZS. AMI LED lights yellow to indicate that the user DS1 code option is set to AMI. BPV LED lights red to indicate that the user DS1 code option is set to BPV. If the user DS1 code option is set to AUTO, the lit LED indicates what DS1 signal is being received. Note that these settings are made on the HLU.
Framing LEDs	ESF LED lights green to indicate that the framing pattern of the received signal is Extended Super Frame (ESF). SF LED lights yellow to indicate that the framing pattern of the received signal is Super Frame (SF). ERR LED lights red to indicate that a DS1 frame error has occurred. No frame LED lights when the HRU-412 List 6 input pattern is unframed or when the framing option is set to UNFR (unframed). Note that the framing option is set on the HLU.

**Table 2. HRU-412 List 6 Front Panel Components (Cont.)**

Name	Function
HDSL LEDs	<p>LP1 OK LED flashes green while HDSL Loop 1 is synchronizing with the HLU. The LED lights green to indicate that loop 1 is properly synchronized with the HLU.</p> <p>LP1 MAR LED lights yellow when the HRU-412 List 6 margin on HDSL loop 1 has dropped below the user-defined margin threshold value. This indicator flashes yellow at a slow rate to indicate that a loss of sync word (LOSW) exists in span 1, loop 1 of the HDSL pair between the HLU and the doubler or HRU-412 List 6. If using doublers, this indicator flashes yellow at a rapid rate to indicate that a LOSW problem exists in span 2, loop 1 of the HDSL pairs.</p> <p>LP1 ES LED flashes red every second that a CRC error is detected on loop 1 from the upstream doubler or line unit.</p> <p>LP2 OK LED flashes green while HDSL Loop 1 is synchronizing with the HLU. The LED lights green to indicate that loop 2 is properly synchronized with the HLU.</p> <p>LP2 MAR LED lights yellow when the HRU-412 List 6 margin on HDSL loop 2 has dropped below the user-defined margin threshold value. This indicator flashes yellow at a slow rate to indicate that a loss of sync word (LOSW) exists in span 1, loop 2 of the HDSL pair between the HLU and the doubler. This indicator flashes yellow at a rapid rate to indicate that a LOSW problem exists in span 2, loop 2 of the HDSL pairs between the first and second doublers.</p> <p>LP2 ES LED flashes red every second that a CRC error is detected on loop 2 from the upstream doubler or line unit.</p>
Craft port	Provides an RS-232 connection for a dumb terminal. The ASCII terminal allows access to the maintenance, provisioning, and performance monitoring menus and screens.
Loopback button	Places the HRU-412 List 6 in loopback mode.
Card handle	Pull on the card handle to remove the HRU-412 List 6 from the shelf slot.
WCN label	Provides the warranty control number for the HRU-412 List 6.

# REAR PANEL FEATURES

The HRU-412 List 6 rear panel features are shown in [Figure 2](#). [Table 3](#) describes the features.



**Figure 2.** HRU-412 List 6 Rear Panel

**Table 3. Rear Panel Components**

Switch	Setting	Function
I-CPE	0*	Sets the CPE current to 0 mA.
	60	Sets the CPE current to 60 mA to power an external NID.
TLOS-LB	DIS*	A loss of the T1 XMT signal from the CPE causes the HLU to transmit the AIS signal toward the DSX-1 and does not cause the HRU to enter its logic loopback state.
	EN	A loss of the T1 XMT signal from the CPE forces the HRU to enter its logic loopback state (TLOS in <a href="#">Figure 14</a> ). While in this state, the HRU transmits the AIS signal toward the CPE and returns the Network signal back to the network. The HLU displays TLOS in the front panel display. This condition remains in effect until a valid T1 signal is received from the CPE or until a loopdown command is issued. Once the TLOS-initiated loopback has occurred, it cannot occur again until the CPE T1 signal has been reapplied and then removed. This feature prevents the HRU from oscillating into and out of TLOS loopback when a loopdown command is issued in the absence of a T1 signal from the CPE.
RLBO	0*	Configures the T1 RCV LBO to 0 dB. This sets the T1 output signal level from the HUR toward the NI to 0 dB. This setting is recommended when the HRU is connected to an external NID. It allows the external NID to set the appropriate NI level.
	15	Configures the T1 RCV LBO to -15 dB. This sets the T1 output signal level from the HRU toward the NI level to -15 dB. This setting is recommended when the HRU functions as a NID.

\* Default setting



# INSTALLATION

This section describes how to install the HRU-412 List 6.

## UNPACK AND INSPECT THE SHIPMENT

Upon receipt of the equipment:

- 1 Unpack the container and visually inspect the product for signs of damage. If the equipment has been damaged in transit, immediately report the extent of the damage to the transportation company and to your sales representative.
- 2 Verify the contents using the packing list to ensure complete and accurate shipment.

If you must store the equipment for a prolonged period, store it in the original container.

## INSTALL THE HRU-412 LIST 6

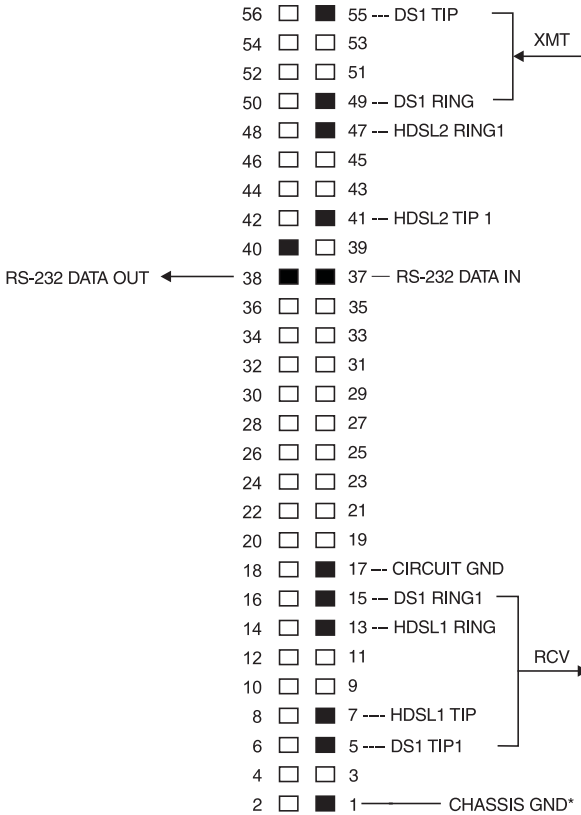
For indoor installation, the HRU-412 List 6 mounts in the following shelves:

- PairGain's HRE-421 (double-width, single-mount)
- HRE-422 (single-wide, two-slot)
- HRE-424 (double-wide, four-slot wall mount)
- HRE-420 (single-wide, single-slot)
- HRE-427 (seven-slot wall or rack mount)
- HRE-425 (12 slot wall or rack mount)

For outdoor applications, the HRU-412 List 6 mounts in the following shelves:

- HRE-454 (four-slot)
- HRE-450 (single-slot)
- 400 Mechanics-type shelves

The HRU-412 List 6 pin-outs are shown in Figure 3. The active pins are shown in black.



\* Chassis GND may be tied to Earth GND per local practice

**Figure 3. HRU-412 List 6 Pinouts**

To install the HRU-412 List 6:

- 1 Ensure that the shelf is correctly mounted and wired (refer to the shelf’s technical practice for additional information).
- 2 Slide the HRU-412 List 6 into the card guides for the desired slot, then push the unit back until it touches the backplane card-edge connectors.

- 3 Place your thumbs on the HRU-412 List 6 front panel and push the HRU-412 List 6 into the card-edge connector until it is secured in the card guides.

## INSTALLATION TEST

Perform the following procedure to test the HRU-412 List 6.

- 1 Press the loopback button (see [Figure 1](#) for the location of this button) for at least five seconds.

Verify that the LB NET LED lights green, indicating that the HRU-412 List 6 is in a digital network remote (NREM) loopback state. If possible, verify that the HLU front panel displays NREM.

- 2 Have the CO transmit a T1 test signal to the HLU.

Measure the return (loop) signal to verify it is error free. If the signal is not error free, remove the HRU-412 List 6 from loopback by pressing the loopback button for five seconds. The LB NET LED turns off.

- 3 Have the CO send the HLU 4-in-7 in-band loop-up (NLOC) for five seconds.

If possible, verify that the HLU front panel displays NLOC.

- 4 Repeat step 2.

If the test passes, a problem exists in the cable pair or in the HRU-412 List 6. If the test fails, the problem is at the CO.

- 5 Check that the proper ports are in use for the HDSL and DS1 pair by using an ohm-meter to verify that the HDSL ports have a 180k transmit to receive resistive signature and that the DS1 ports have a 15 ohm transmit to receive resistive signature.

Measure the return (loop) signal to verify it is error free.

- 6 If using an external NID, set the I-CPE switch (located on the back panel of the HRU-412 List 6; see [Figure 2](#)) to 60 mA and verify the NID has power. Check that the voltage across the front panel test points (60 mA MON) measures between 55 mV and 65 mV.
- 7 Enable the sealing current option (JP2 connected). Use a milli-amp meter to verify transmit or receive current in either HDSL pair.

# CONFIGURE, PROVISION, AND MONITOR PERFORMANCE

The following sections describe how to perform configuration, provisioning and performance monitoring functions using the HRU-412 List 6 menus and screens.

## CONNECT A DUMB TERMINAL

Connect a dumb terminal:

- 1 Connect a standard 9-pin serial terminal cable to the Craft port, a DB-9 female connector, on the HRU-412 List 6. See [Figure 4](#) for the Craft port wiring diagram.

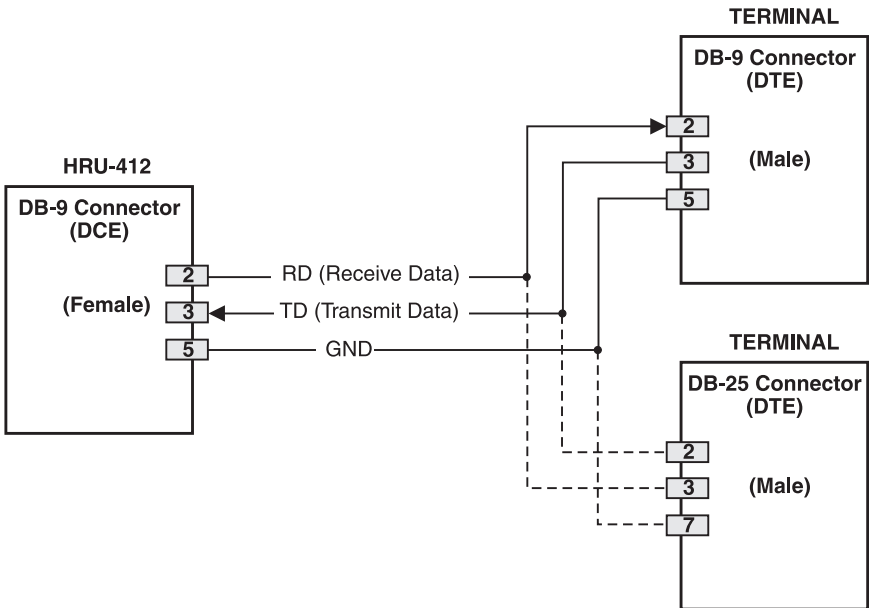


Figure 4. HRU-412 List 6 Craft Port Wiring

- 2 Connect the other end of the terminal cable to the console port on the dumb terminal.
- 3 Configure the dumb terminal to the following communication settings:
  - 1200 to 9600 baud
  - no parity
  - 8 data bits
  - 1 stop bit
  - hardware flow control to OFF

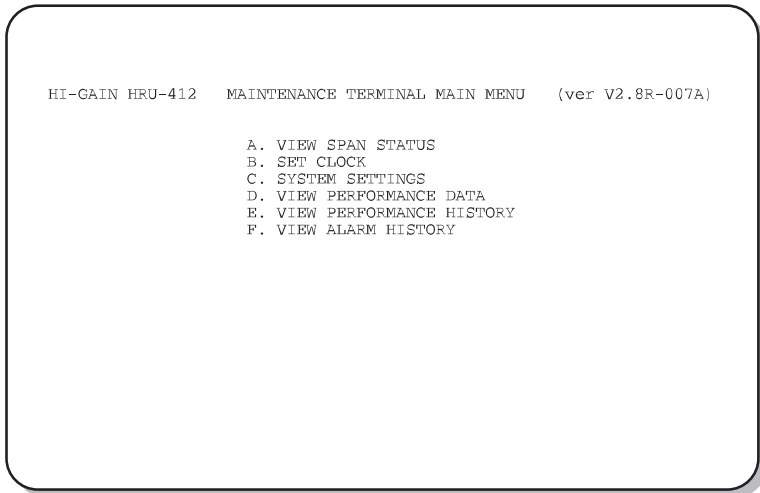
## LOGGING ON AND USING THE MENUS

The HRU-412 List 6 supports local and remote log on. Local log is when a terminal connects to the HRU-412 List 6 internal database at the Craft port. Remote log on connects the HRU-412 List 6 to the HLU using the HDSL Embedded Operation Channel (EOC) as the data link between the two units. Remote log on displays menus and screens at the HRU-412 List 6 that are identical to those at the HLU. See the appropriate line unit technical practice for more information about the menus and screens.

Initial log on to the HRU-412 List 6 is local for non-doubler applications. When the HRU-412 List 6 is not connected to an HLU, the displayed menus and screens are those from the HRU-412 List 6 internal database.

When the HRU-412 List 6 is connected to an HLU and doublers are in use, the port interface resets to remote when the two units synchronize. The remote log off option on the Main Menu (shown when in remote mode only) allows the termination of a remote session. Terminating a remote log on allows other units (such as a doubler) to log on through the Craft port. Terminating each remote session before beginning another is necessary because a HiGain circuit can support the log on of only one unit at a time. An active session for any unit prevents simultaneous sessions for any other circuit.





**Figure 6.** Main Menu, Local Log On

- 2 Access Main Menu options by typing the letter of the desired option.

## View Span Status

From the Main Menu, type **A**. The Span Status screen displays.

When no doublers are in use, the following Span Status screen displays:

```

                                SPAN STATUS
                                (HLU/ver0.0-0000:HRU/ver2.8-007A)

TIME: 08:29:25
DATE: 06/25/97

ALARMS: NONE
LOOPBACK: OFF

                                HLU                                HRU
                                HD5L-1 HD5L-2 HD5L-1 HD5L-2
                                cur/min/max cur/min/max cur/min/max cur/min/max
MARGIN:                        N/A      N/A      N/A      N/A  dB
PULSE ATTN:                    N/A      N/A      N/A      N/A  dB
PPM OFFSET:                    N/A      N/A      N/A      N/A  ppm
24 HOUR ES:                    00001   00002   00001   00001 seconds
24 HOUR UAS:                   00000   00000   01073   01070 seconds

                                DS1 STATUS
                                HLU                                HRU
24 HOUR BPV Seconds:          00001   00000
24 HOUR UAS Count:          00000   00000
Frame type:                  N/A      Unframed
Code type:                   N/A      B8ZS

                                (E)xit (U)pdate

```

**Figure 7.** Span Status Screen, No Doublers in Use

- 1 Type **U** to update the screen.
- 2 Type **E** to exit to the Main Menu.

When doublers are in use, the following Span Status screen displays:



```

                                SPAN 1 STATUS
                                ( HLU/ver2.2-002D:HDJ1/ver2.7-0004)
TIME: 08:41:01
DATE: 06/25/97                                CIRCUIT ID#: PairGain2

ALARMS: NONE
LOOPBACK: OFF

                                HLU                                HDJ1
                                HDSL-1                                HDSL-2
                                cur/min/max cur/min/max cur/min/max cur/min/max
MARGIN:                                20/17/21                                21/18/21                                21/00/22                                21/00/22 dB
PULSE ATTN:                                00                                00                                00                                00
PPM OFFSET:                                00                                00                                06                                06 ppm
24 HOUR ES:                                00001                                00002                                00001                                00002
seconds
24 HOUR UAS:                                00792                                00791                                00013                                00012
seconds

                                DS1 STATUS
                                HLU                                HRU
24 HOUR EPV Seconds:                                00058                                00241
24 HOUR UAS Count:                                00013                                00009
Frame type:                                Unframed                                Unframed
Code type:                                AMI                                AMI

                                (E)xit (U)pdate (S)pan

```

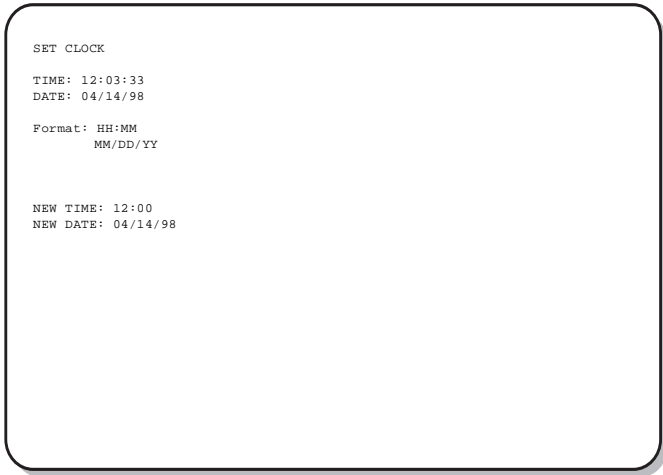
**Figure 8.** Span Status Screen, Doublers in Use

Do any of the following:

- Type **S** to view the next span.
- Type **U** to update the screen.
- Type **E** to exit.

## Set Clock

- 1 From the Main Menu, type **B** to display the Set Clock menu.
- 2 Enter the time (in 24 hour format, hours and minutes only) at the New Time prompt.
- 3 Press **ENTER**.
- 4 Enter the date (mm/dd/yy) at the New Date prompt.
- 5 Press **ENTER**.



**Figure 9.** Set Clock Screen

## System Settings

From the Main Menu, type **C** to display the System Settings menu.

```
                                SYSTEM SETTINGS

TIME: 08:57:36
DATE: 06/25/97                                CIRCUIT ID#: PairGain2

EQUALIZATION:          399
SMART-JACK LB:        ENABLE
SPECIAL LPBK:         GNLB
POWER:                 ENABLE
ZBTST:                OFF
ES ALARM THRES:       NONE
LOOPBACK TIMEOUT:    20
ALARM:                DISABLE
DSL LINE CODE:        AUTO
FRAMING:              AUTO
AIS ON HDSL LOSW:     2 LOOPS
AIS ON SMJK/NREM:     ENABLE
MARGIN ALM THRES:    15
DSO 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

                                (E)xit
```

**Figure 10.** System Settings Menu

View HRU-412 List 8B system settings on this screen. Change system settings at the HLU connected to the HRU-412 List 6.

# View Performance Data

- 1 From the Main Menu, type **D** to display the Performance Data screens.

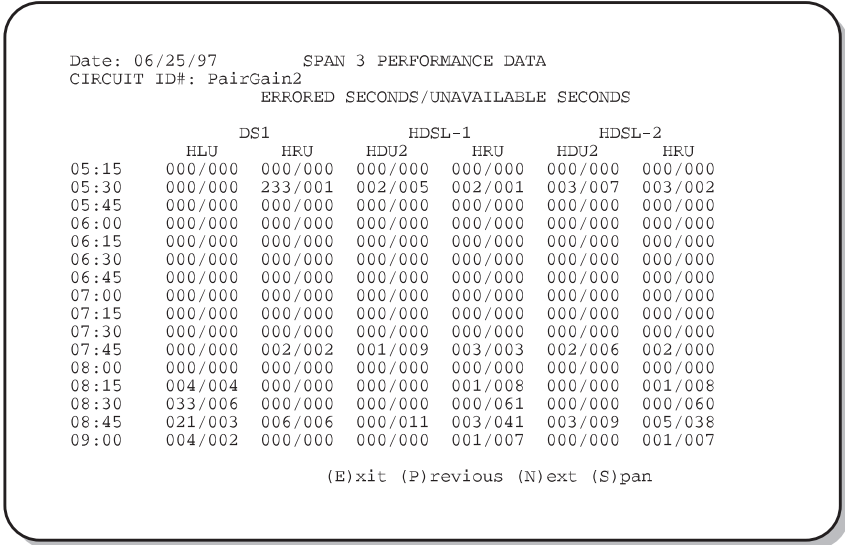


Figure 11. Performance Data Screen

- 2 Do any of the following:
  - type **S** to view a span
  - type **P** to view the previous page of information
  - type **N** to view the next page of information
- 3 Type **E** to exit the Performance Data screens.

## View Performance History

- 1 From the Main Menu, type **E** to display the Performance History screen.

```

Time: 09:14:01                7 DAY HISTORY
CIRCUIT ID#: PairGain2

                                SPAN 3
                                ERRORED SECONDS/UNAVAILABLE SECONDS

                                DSL                HDSL-1                HDSL-2
                                HLU                HRU                HDU2                HRU
06/18  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
06/19  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
06/20  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
06/21  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
06/22  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
06/23  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
06/24  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
current 00062/00015  00241/00009  00003/00025  00010/00121  00008/00022  00012/00115

                                (E)xit (S)pan

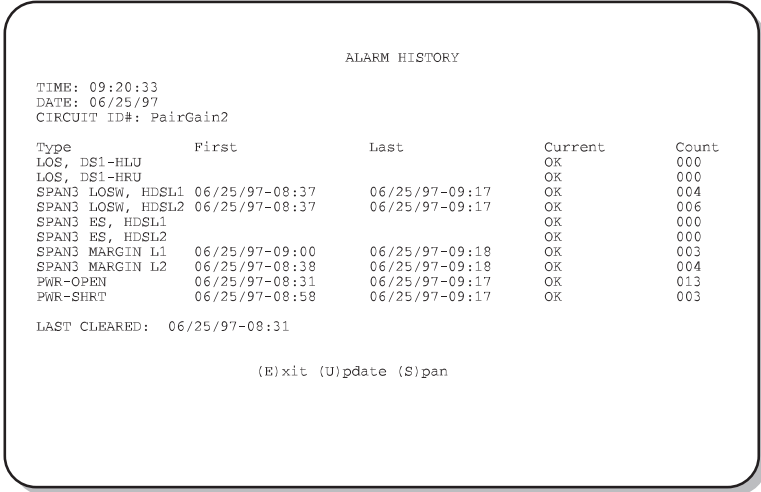
```

**Figure 12.** Performance History Screen

- 2 Type **S** to view the next span.
- 3 Type **E** to exit the Performance History screen.

# View Alarm History

- 1 From the Main Menu, type **F** to display the Alarm History screen.



**Figure 13.** Alarm History Screen

- 2 Type **U** to update the Alarm History screen to the most current data.
- 3 Type **S** to view the next span.
- 4 Type **C** to clear the Alarm History screen.
- 5 Type **E** to exit the Alarm History screen.

Table 4 lists the HRU-412 List 6 alarm types and descriptions.

**Table 4.** HRU-412 List 6 Alarm History Screen Definitions

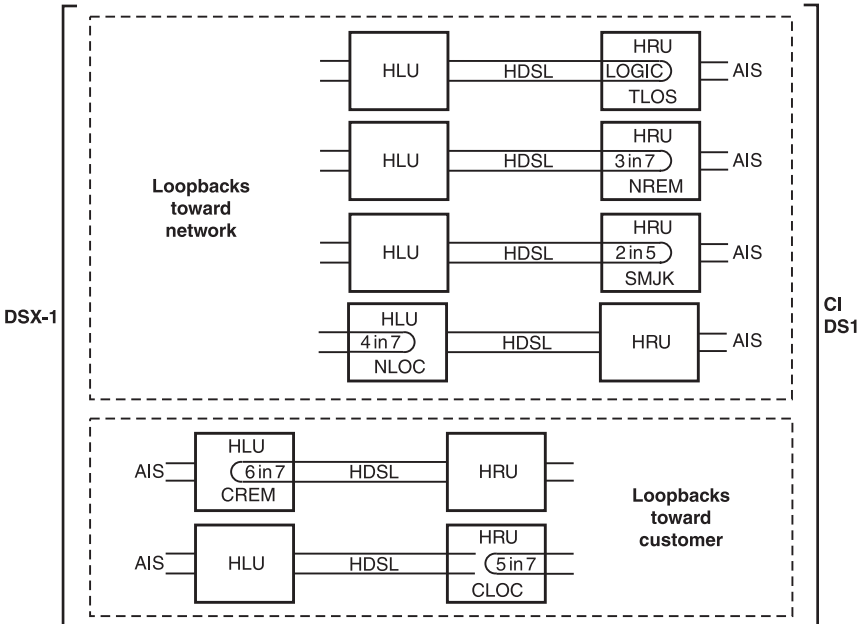
<b>Message</b>	<b>Full Name</b>	<b>Description</b>
NONE	No Alarms	No active alarms, or alarms previously detected are no longer active or have been reset.
LLOS	Local Loss of Signal	No signal from local T1 interface.
RLOS	Remote Loss of Signal	No signal from remote T1 interface.
LOSW	Loss of Sync Word	One of the HDSL loops has lost sync.
H1ES	HDSL Loop 1 Errored Second	Loop 1 CRC exceeds the ES threshold (set at the HLU).
H2ES	HDSL Loop 2 Errored Second	Loop 2 CRC exceeds the ES threshold (set at the HLU).
DS1	Digital Service 1	BPVs exceed the ES threshold set at the HLU.
ACO	Alarm Cut Off	An Alarm Cut Off is in effect.
MNR	Minor Alarm	A minor alarm condition is in effect.
AIS	Alarm Indicating Signal	An AIS (all 1s) pattern is transmitting from the local T1 output port.
MAL1	Margin Alarm 1	The margin on HDSL Loop 1 dropped below the threshold set on the System Settings menu.
MAL2	Margin Alarm 2	The margin on HDSL Loop 2 dropped below the threshold set on the System Settings menu.
LAIS	Local Alarm Indicating Signal	Indicates an AIS pattern (all 1s) is transmitting from the local T1 output port.
CHREV	Channel Reversed	The channel 1 and 2 HDSL pairs are reversed at the HRU-412 List 6 line input ports.
RAIS	Remote Alarm Indicating Signal	Indicates an AIS pattern (all 1s) is transmitting from the remote T1 output port.

# LOOPBACKS

The HRU-412 List 6 supports 6 types of loopbacks (see [Figure 14](#)).

- TLOS (transmit loss of signal)
- CREM (customer remote loopback)
- NREM (network remote loopback)
- NLOC (network local loopback)
- CLOC (customer local loopback)
- SMJK (Smart-Jack)
- ARM (intelligent repeater loopback 2-in-5 arming code)

Loopback tests initiate at the CO, using in-band commands.



**Figure 14.** HRU-412 List 6 Loopbacks



A Smart-Jack loopback causes the T1 interface chip to transmit the AIS pattern to the NI and back to the HRU-412 List 6 T1 receiver circuit. The T1 input to the HRU-412 List 6 at the XMT port is disconnected and terminated in 100 ohms. The AIS pattern is examined by the HRU-412 List 6 for its overall integrity. The Smart-Jack loopback lasts about 100 milliseconds and terminates in one of the following conditions:

- 1 Pre-loop failed: if the transmit and receive patterns (all 1s) do not match, there is a problem in the HRU-412 List 6. The HLU declares an HRU pre-loopback fail condition. This terminates the loopback test and returns the HRU-412 List 6 to its unlooped normal state, indicating a defective HRU-412 List 6 at the HLU.
- 2 Pre-loop passed: if the transmit and receive patterns do match, an HRU pre-loopback pass condition is declared. All active circuits are working. The metallic loopback relay remains closed and a logic loopback within the HRU-412 List 6 is enabled.

Logic loopback is required in order to present the all 1s pattern to the CI and at the same time to loop the signal received from the network back toward the network. The HiGain system is in the AIS/ENA Smart-Jack loopback state. It remains in this state until a loopdown command is detected or the default time out period (if enabled at the HLU) expires.

When the HRU-412 List 6 is in the AIS/ENA Smart-Jack metallic loopback state, the T1 input LOS, Code, and Frame monitoring circuits are connected to the unframed AIS pattern, which is being looped back to these circuits through the loopback relay. The CPE input signal is no longer monitored, since the input circuit is open and terminates in 100 ohms. This forces the FRM LED off and the LOC LOS LED off. The CODE LED indicates AMI if the HLU CODE option is set to AUTO or AMI. It indicates B8ZS if the CODE option is set to B8ZS. The AIS/ENA metallic loopback scenario tests all of the HiGain system's active circuits and fully conforms to TR-TSY-000312.

When the HRU-412 List 6 is in an AIS/DIS Smart-Jack metallic loopback state, the T1 input LOS, Code, and Frame monitoring circuits are connected to the network signal, which is being looped back to these circuits through the loopback relay. The CPE input signal is no longer being monitored, since the input circuit was opened and terminated in 100 ohms. The FRM and LOC LOS LEDs indicate the status of this signal from the network. The CODE LED indicates the code (AMI or B8ZS) if the CODE option is set to AUTO. It indicates AMI or B8ZS if the CODE option is set to AMI or B8ZS, respectively.

All HRU-412 List 6 loopbacks toward the network (NREM and SMJK) are metallic/logic (AIS/ENA) or metallic only (AIS/DIS). The TLOS loopback is a logic loopback.

The SMJK and NREM loopbacks perform the same functions but their initiation differs. The SMJK identifying label indicates that the loopback was initiated by the 2-in-5 in-band command. NREM initiates by any in-band command except the 2-in-5 command. These other in-band commands include 3-in-7 command, 16-bit addressable repeater commands, or activation using the front panel MODE and SEL buttons.



**When T1 loopback tests are made on the HiGain system with external metallic loopback connections at either end, the DS1 code at the metallic loopback interface may be different from the DS1 code at the opposite end when the DS1 user option is set to AUTO. For example, if the HRU-412 List 6 has a metallic loopback and the HLU receive pattern code is changed from AMI to B8ZS, an all 0s pattern is sent to the HLU. The HRU-412 List 6 remains in AMI mode and loops all 0s causing the HRU-412 List 6 to indicate an LOS condition. The result is that the HLU outputs an AIS pattern.**

# SPECIFICATIONS

## HDSL

Line Code	784 kbps 2B1Q full duplex
Output	+13 dBm ± 0.5 dB at 135 ohms
Line Impedance	135 ohms
Startup Time	15 seconds (typical), 60 seconds (maximum)

## Maximum Provisioning Loss

35 dB at 196 kHz, 135 ohms

## Line Clock Type

Internal Stratum 4 clock

## Power Consumption

6 Watts (typical), 8 Watts (maximum)

## Electrical Protection

Secondary surge and power cross protection on all DS1 and HDSL ports

## Environmental

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

## Mounting

Single-wide 400 Mechanics-type shelf

## DS1

One-way Delay	< 220 microseconds per span
Line Impedance	100 ohms
Pulse Output	0 dB (RLEV = 0), -15 dB (RLEV = 15)
Input Level	> -22.5 dB
Line Rate	1.544 Mbps + 200 bps
Output Wander (MTIE and TVAR)	Compliant with Section 7.2.1 of the T1X1.3/90-026R7 SONET committee report
Line Format	AMI, B8ZS, or ZBTISI
Frame Format	ESF, SF, or unframed

## Dimensions

Height:	5.6 in. (14.22 cm)
Width:	1.4 in. (3.55 cm)
Depth:	5.6 in. (14.22 cm)
Weight	1 lb. 2 oz. (510.75 g)

# PRODUCT SUPPORT

This section contains product support and warranty information.

## TECHNICAL SUPPORT

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

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

**Fax:** (714) 832-9924

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

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

## WARRANTY

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

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

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

PairGain Technologies, Inc.  
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.

## FCC COMPLIANCE

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

Refer to the installation section of the appropriate instruction manual for the unit you are installing to get information on:

- Cabling
- Correct connections
- Grounding
- Line vs. local power

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

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

## **MODIFICATIONS**

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

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



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**Corporate Office**

14402 Franklin Avenue  
Tustin, CA 92780

Tel: (714) 832-9922

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**For Technical Assistance:**

(800) 638-0031

