HIGAIN REMOTE UNIT

Model	List Number	Part Number	CLEI Code
HRU-512	1	150-1253-01	T1LIEPNRAA
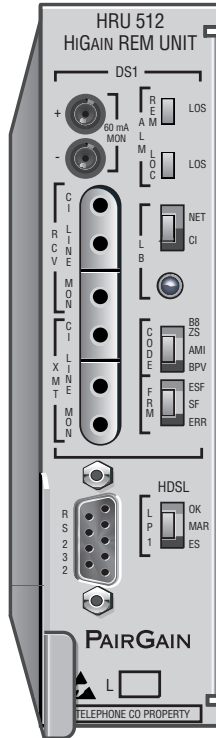
PAIRGAIN TECHNOLOGIES, INC.
ENGINEERING SERVICES TECHNICAL PRACTICE

PAIRGAIN

Revision History of This Practice

Revision	Release Date	Revisions Made
01	August 16, 1994	Initial Release
02	September 5, 1995	Modified and updated
03	September 25, 1998	Modified and updated

USING THIS PRACTICE

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

Notes contain information about special circumstances.

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

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OVERVIEW

The PairGain® HiGain® Remote Unit Model HRU-512 List 1 is the remote end of a single pair repeaterless fractional T1 (FT1) transmission system. or in equivalent enclosure manufactured by PairGain Technologies. When used in conjunction with the HiGain Line Unit (HLU) the system provides 784 kbps transmission on one unconditioned copper pair over the full Carrier Service Area (CSA) range. The CSA encompasses approximately 12000 feet of AWG 24 or 9000 feet of AWG 26 wire, including bridged taps and gauge changes. This HiGain system utilizes 2B1Q High-bit-rate Digital Subscriber Line (HDSL) transmission technology as recommended by Bellcore TA-TSY-001210.

The HRU-512 List 1 complies with ANSI T1.403-1989 and T1E1.4/92-002R2 technical standards and recommendations. The HRU-512 List 1 mounts in a single slot of any industry standard 400 mechanics shelf. The system also complies with TR-TSY-000063 Network Equipment Building System (NEBS) Generic Equipment requirements, and Transport System Generic Requirements (TSGR) common requirements TR-TSY-000499.

The HRU-512 List 1 features:

- ANSI T1.403 DS1 Customer Interface

- HDSL Line or Local Power Options

- Front Panel DS1 and HDSL Status Display Indicators

- Extensive Loopback Capabilities

- Metallic NREM Loopback. Conforms to TR-TSY-000312

- Provisioning Switches for CPE current, RCV LBO and XMT LOS Initiated Loopback or AIS

- Front Panel Jacks for Test Access

- RS-232 Craft port

- CPE Current Monitor Test Points

- Front Panel HDSL Margin Threshold Indicator

- Lightning and Power Cross Protection on HDSL and DS1 Interfaces

- 784 kbps Full-Duplex 2B1Q HDSL Transmission on 1 Pair

- Payload Bandwidth Selectable from 128 kbps (2 channels) to 768 kbps (12 channels) in increments of 128k

- Provisional Robbed Bit (RBS) or Clear (CLR) Signaling for Each DS0 Channel.

APPLICATIONS

The primary application of the HiGain Fractional System is to provide a quick and cost-effective way of delivering FT1 High Capacity Digital Service (HCDS) to customers over a metallic cable pair. The HiGain system can be deployed on one unconditioned, non-loaded wire pair without repeaters, and without the need for either bridged tap removal or binder group separation of other pairs providing FT1 services.

The general guidelines, on which the CSA deployments rules are based, require that the HDSL HiGain loop have less than 35 dB of loss at the 2B1Q line rate of 196 kHz, at 135 Ω source and load impedances.

The HiGain system operates with any number of other T1, POTS, Digital Data Service (DDS) or other HiGain Systems sharing the same cable binder group.

FUNCTIONAL DESCRIPTION

This section describes the functions of the HRU-512 List 1.

OPERATIONAL CAPABILITIES

HiGain utilizes PairGain's 2B1Q HDSL transceiver system to establish a full-duplex 784 kbps data channels between the HLU and a remotely mounted HRU-512 List 1. See Figure 1 for the HRU-512 List 1 block diagram.

When the HRU-512 List 1 is line powered, it converts the metallic 130 Vdc line voltage to the 5 V and -5 V power required by the HRU-512 List 1 circuitry. When the HRU-512 List 1 is locally powered from -48 V, an additional 30 V power supply is created. This provides a 60 mA simplex current source to power an external NID (Network Interface Device) if the 60 mA I-CPE current option is enabled.

The HRU-512 List 1 dissipates 5 Watts of power and may consume up to 6.5 Watts when feeding 60 mA of simplex current to the CI.

Use caution when the HRU-512 List 1 is used to power external CSUs. Some CSUs require more output voltage than the 30 Volts provided by the HRU. Also, the HRU can not power both a NID and a CSU at the same time.

The 60 mA option should never be turned on if the HRU-512 List 1 is line powered. This could overload the system's power capabilities and adversely affect its performance.

Figure 1 shows a block diagram of the HRU-512 List 1.
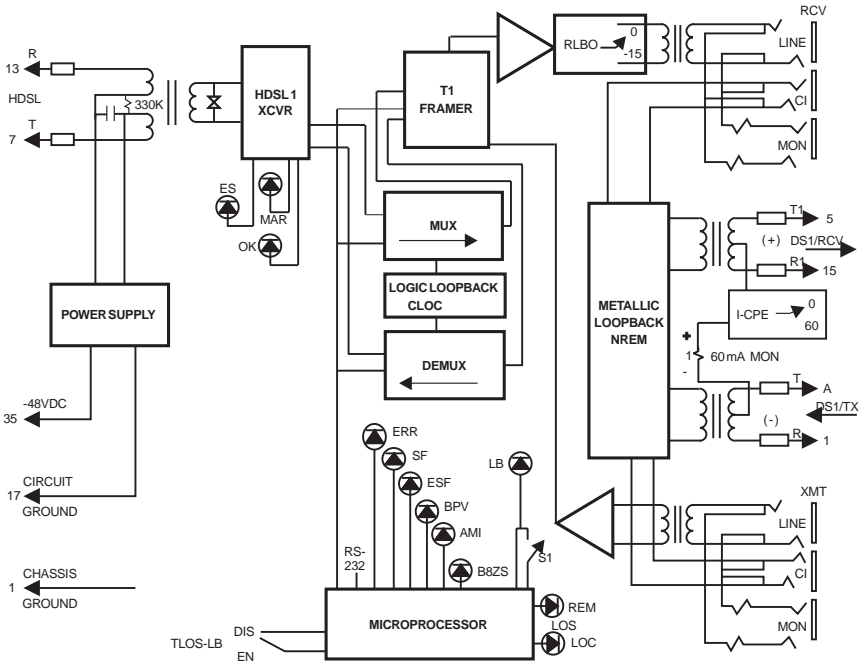
Figure 1.   HRU-512 List 1 Block Diagram

> ⚠️ **If the RS-232 port of an HRE-421 remote enclosure is used to access the HRU-512 List 1, a null modem cable adapter must be used since the HRE-421 port is configured as DTE.**

The HRU-512 List 1 is provisioned at the HLU by the BANDwidth option to process from 2 to 12 DS0 channels (active channels). The unused channels are replaced by either 7F or FF according to the setting of the IDLE option. The active channels can also be provisioned to be contiguous or alternate. The signaling mode of each of the active channels can be optioned for either Robbed Bit (RBS), as is required for voice channels, or Clear (CLR), which is normally used for data applications.

FRONT PANEL

Figure 2 shows the front view of the HRU-512 List 1. Table 1 describes the HRU-512 List 1 front panel components.

Figure 2.   *HRU-512 List 1 Front Panel*

Table 1.   *HRU-512 List 1 Front Panel Components*

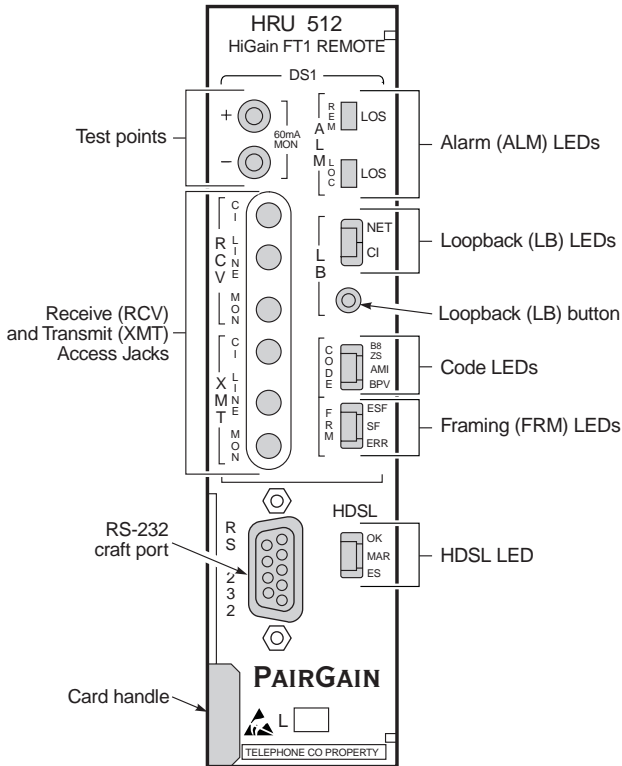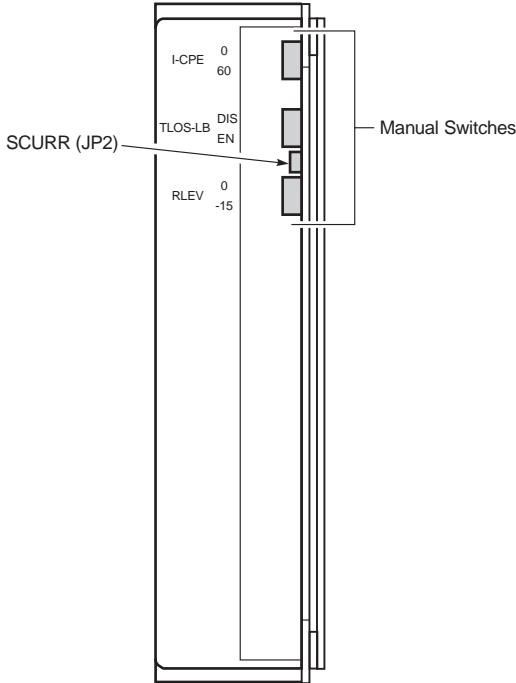| Name	Function
Test points	Allow the 60 mA I-CPE current option to be measured. The current flowing is related to the voltage measured across the + and - test points by the following relationship: CPE CURRENT = 1 mA/1 mV. Typical readings range from 55 to 65 mV which equate to a 55 to 65 mA current range.
Receive (RCV) and Transmit (XMT) Access Jacks	Provides splitting and monitoring access to the CPE DS1 interface. See Figure 2 for circuit details. 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.
	LOC LOS LED lights red to indicates a loss of signal (LOS) at the T1 input to the HRU-512 List 1. This LOS condition transmits the AIS pattern toward the D4 channel bank on the provisioned time slot only (according to the user selected bandwidth). Non-provisioned time slots are not affected.
Loopback (LB) LEDs	NET LED lights green to indicate the HRU-512 List 1 is in a loopback state where the signal from the network is looping back to the network.
	CI LED lights yellow to indicate that the HRU-512 List 1 is in a loopback state in which the signal from the Customer Interface (CI) is being looped back to the CI (CLOC).
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 LED is on to indicates what DS1 signal is being received. 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 8 input pattern is unframed or when the framing option is set to UNFR (unframed). Note that this settings is made on the HLU.

Table 1. *HRU-512 List 1 Front Panel Components (Cont.)*

Name	Function
HDSL	OK LED lights green to indicate that the HDSL loop is synchronizing with the HLU. A solid green state indicates that the loop is properly synchronized with the HLU.
	MAR LED lights yellow to indicate that the HRUs S/N MARgin on the HDSL loop has dropped below the user defined margin threshold value. This option is set at the HLU RS-232 front panel maintenance port in the System Settings menu.
	ES LED flashes red to indicate that one HDSL CRC error is detected.
RS-232 (Craft) port	Provides a connection port for a maintenance terminal. The maintenance terminal allows access to the maintenance, provisioning, and performance monitoring menus and screens.
Card handle	Pull on the card handle to remove the HRU-512 List 1 from the shelf slot.

REAR PANEL FEATURES

The HRU-512 List 1 has two user switch options and a jumper located at the rear of the unit as shown in Figure 3. Each switch has two settings as described in Table 3.

Figure 3.   *HRU-512 List 1 Rear Panel*

Table 2.   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	Does not allow the HRU-512 List 1 to enter its logic loopback state when a loss of the T1 XMT signal from the CPE causes the HLU to transmit the AIS signal toward the DSX-1.
	EN	Allows the HRU-512 List 1 to enter its logic loopback state when a loss of the T1 XMT signal from the CPE causes the HLU to transmit the AIS signal toward the DSX-1. While in this loopback state, the HRU-512 List 1 transmits the AIS signal toward the CPE and returns the network signal back to the network. The HLU displays TLOS in its front panel display. This condition remains until a valid T1 signal is received from the CPE or until the 3-in-5 in-band loopdown command is issued. Once the TLOS initiated loopback occurs, it will not reoccur until the CPE T1 signal has been reapplied and then removed. This feature prevents the HRU-512 List 1 from oscillating into and out of TLOS loopback when a loopdown command is issued in the absence of a T1 signal from the CPE. This TLOS option must never be enabled when the HRU-512 List 1 is used with old line units that do not support this feature. These older line units (List 6 and under) cannot loopdown an HRU-512 List 1 that is in a TLOS loop-up state when they receive the 3-in-5 in-band loopdown command.
RLEV	0	Configures the T1 RCV level to 0 dB. This sets the T1 output signal level from the HRU-512 List 1 toward the NI to 0 dB. Use this setting when the HRU-512 List 1 is not functioning as a NID but is connected to an external NID. It allows the external NID to set the appropriate NI level.
	15	Configures the T1 RCV level to -15 dB. This sets the T1 output signal level from the HRU-512 List 1 toward the NI level to -15 dB. This setting is recommended when the HRU-512 List 1 functions as a NID.
JP2		Allows the enabling or disabling of the sealing current. To enable, connect JP2 across both terminals. To disable (default), remove the jumper from the inner terminal and leave it attached to the outer terminal only.

The 60 mA option can only be used if the HRU-512 List 1 is locally powered.

LOCAL AND LINE POWER

The HRU-512 List 1 can be powered from either the line (over the HDSL cable pair) or from a local -48 Vdc power supply. It always chooses the local -48 Vdc power supply if present. It defaults to line power in the absence of local power. The HLU determines the power state of the HRU before applying line power. If the HRU is powered up, the HLU does not turn on the line power. If the HRU is not powered up, the HLU turns on the line power.

When locally powered, the HRU-512 List 1 provides 14 mA (long loop) to 16 mA (short loop) of metallic sealing current towards the HLU, when the HRU-512 List 1 is locally powered. Jumper JP2, located on the HRU-512 List 1 (shown in Figure 3), and switch SW5 located on the HLU, may be configured by the user to either enable or disable the metallic sealing current capability.

To enable the sealing current capability when the HRU-512 is locally powered, the following two steps must be performed:

1 At the HLU, set switch SW5 to the LOCAL position.

2 At the HRU-512 List 1, connect JP2 across both terminals.

Sealing current from the HRU-512 will only be provided if JP2 is jumpered across both terminals when the HRU-512 List 1 is locally powered.

To configure the system for the HLU line powering:

1 At the HLU, set switch SW5 to the LINE position.

2 At the HRU-512 List 1, connect JP2 across just one of the two terminals. These are the factory defaults for both units.

INSTALLATION

This section describes how to install the HRU-512 List 1.

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 in transit, immediately report the extent of damage to the transportation company and to PairGain.

2 Verify the contents using the packing list.

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

INSTALL THE HRU-512 LIST 1

The HRU-512 List 1 mounts in the following Remote Indoor Enclosures shelves

• PairGain's HRE-421 (double width, single slot)

• HRE-422 (single width, two slots)

• HRE-420 (single width, single slot)

• HRE-427 (single width, seven slots, wall or rack mount)

For outdoor applications, the HRU-512 List 1 mounts in the following:

• HRE-423 (double width, under or above ground, three slots)

• HRE-450 (single width, above ground, single unit)

• The HRU is also compatible with industry standard 400-type mechanics shelves

• HRE-456 (single width, under or above ground, four slots).

To install the HRU-512 List 1:

1 Ensure that the shelf is correctly mounted and wired (refer to the shelf's technical practice for additional information).

2 Slide the HRU-512 List 1 into the card guides for the desired slot, then push the unit back until it touches the backplane cared-edge connectors.

3 Place your thumbs on the HRU-512 List 1 front panel and push the HRU-512 List 1 into the card-edge connector until it is secured in the card guides.

The HRUs edge connector pinouts are shown in Figure 4. The active pins are shown in black.
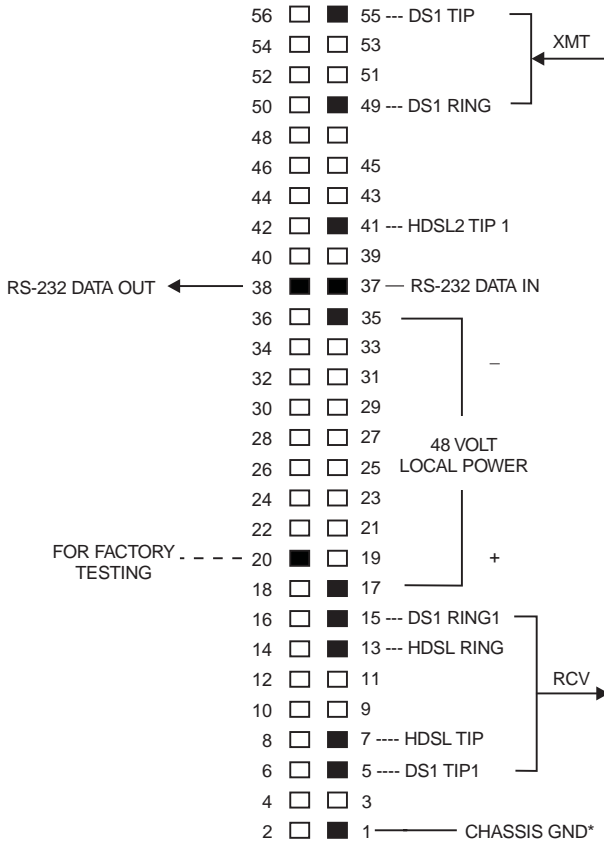
* Chassis GND may be tied to Earth GND per local practice

Figure 4.   *HRU-512 List 1 Edge Connector Pinouts*

INSTALLATION TEST

Perform the following procedure to test the HRU-512 List 1.

1   Press the loopback button (see Figure 2 for the location of this button for at least five seconds.

Verify that the LB NET LED lights green, indicating that the HRU-512 List 1 is in a digital (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-512 List 1 from loopback by pressing the loopback button for five seconds. The LB NET LED should be off.

3   Have the CO send the HLU 4-in 8 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, the problem is in the cable pair or in the HRU-512 List 1. 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 port has a 390 k Ω transmit to receive resistive signature and that the DS1 ports which have a 15 Ω 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-512 List 1; see Figure 3 on page 8) to 60 mA and verify the NDI is under power. Check that the voltage across the front panel test points (60 mA MON) measure between 55 mV and 65 mV.

7   Enable the sealing current option (JP2 connected) if required. Use a milli-amp meter to verify transmit or receive current in either HDSL pair.

PROVISIONING

The following sections describe how to perform configuration, provisioning and performance monitoring functions using the HRU-512 List 1 menus and screens.

CONNECT A MAINTENANCE TERMINAL

To connect a maintenance terminal:

1 Connect a standard 9-pin serial terminal cable to the Craft port, a DB-9 female connector to the HRU-512 List 1. See Figure 4 for the Craft port wiring diagram.
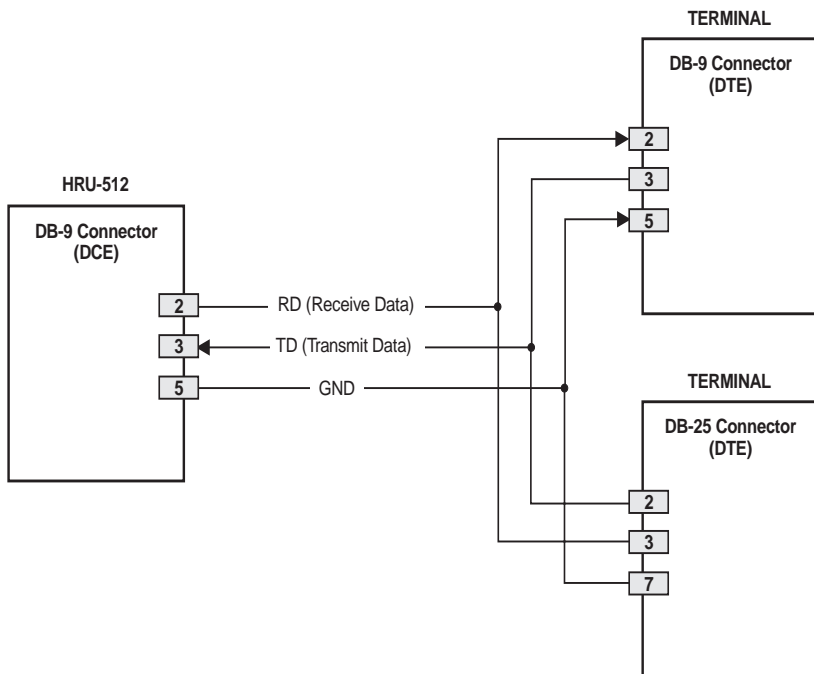
Figure 5. *DB-9 Connector Pinouts*

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

3   Configure the maintenance terminal to the following communication settings:

- 1200 to 9600 baud

- no parity

- 8 data bits

- 1 stop bit

- hardware flow control to OFF

LOG ON AND USE THE MENUS

This section shows you how to log on and access the menus and screens using the maintenance terminal.

1   Press the `SPACEBAR` several times to activate the autobaud feature and to display the logon screen. When using doublers, the remote logon screen displays when the HRU-512 List 1 and the HLU synchronize. See Figure 7.

```
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+                                                       +
+   RRRRR   EEEEEE  M     M    OO    TTTTTTT EEEEEE  +
+   R    R  E       MM   MM   OO OO     T    E       +
+   RRRRR   EEEEEE  M  M  M  O     O    T    EEEEEE  +
+   R   R   E       M     M  OO OO      T    E       +
+   R    R  EEEEEE  M     M    OO       T    EEEEEE  +
+                                                       +
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++
             HIT <ENTER> TO LOG IN
```
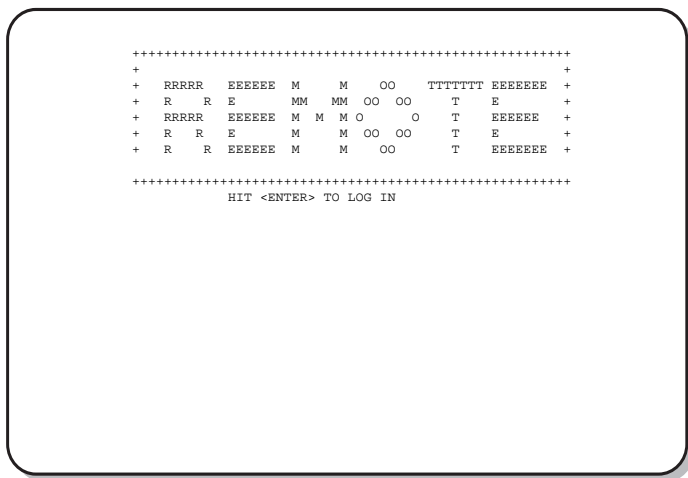
Figure 6.   *Remote Log on Screen*

2   Press `ENTER` . The Main Menu displays.

```
 Hi-GAIN FT1 LU      REMOTE TERMINAL MAIN MENU    (ver V1.3L-0001)
                     CIRCUIT ID#: PairGain Technologies

                     A. VIEW SPAN STATUS
                     C. SYSTEM SETTINGS
                     D. VIEW PERFORMANCE DATA
                     F. VIEW 7 DAY HISTORY
                     G. VIEW ALARM HISTORY
                     H. REMOTE LOGOFF
```
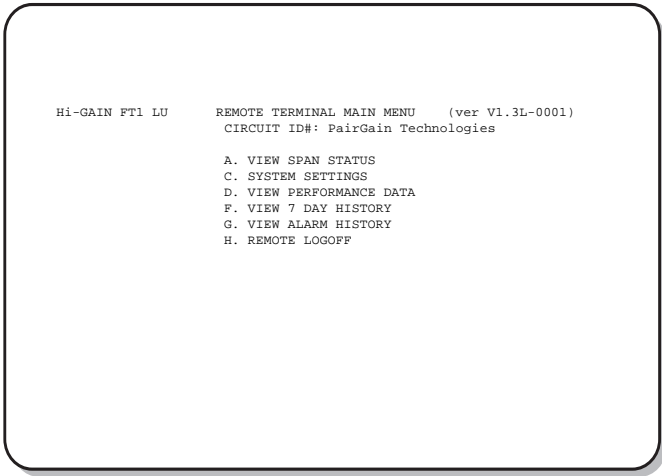
Figure 7. *Main Menu Local Log On*

To access options available on the Main Menu, type the desired letter and then press ENTER .

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/ver 1.3-0001:  HRU/ver 1.3-0001)
TIME: 11:06:15
DATE: 07/06/95
CIRCUIT ID#: PairGain Technologies

ALARMS:   NONE
LOOPBACK: OFF
                 HLU  HDSL                  HRU   HDSL-2
                 cur/min/max                cur/min/max
MARGIN:          21/18/22                  22/20/23  dB
PULSE ATTN:      00                          00     dB
PPM OFFSET:      00                          -15    ppm
24 HOUR ES:      00002                      00003   seconds
24 HOUR UAS:     00017                      00000   seconds
                             DS1 STATUS
                      HLU                  HRU
24 HOUR BPU Seconds:  ----                 00004
24 HOUR UAS Count:    00000                00002
Frame type:           SF                   SF
Code type:            AMI                  AMI

                      (E)xit (U)pdate
```

Figure 8.   Span Status Display

1   Type U to update the screen.

2   Type E to exit to the Main Menu.

System Settings

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

```
                    SYSTEM SETTINGS
TIME: 11:07:38
DATE: 07/06/95
CIRCUIT ID#:PairGain Technologies

IDLE CODE:              FF
NETWORK LOOPBACK:       DISABLE
POWER:                  ENABLE
ES ALARM THRES:         NONE
LOOPBACK TIMEOUT:       60
HRU DS1 CODE:           AMI
DS0 CHAN SLOTS:         CONT
AIS ON HDSL ALRM:       DISABLE
AIS ON NREM:            ENABLE
MARGIN ALM THRES:       4
DS0 BANDWIDTH:          128K
SIGNALING:rb-Robbed Bits:     01 02




                    (E) xit
```

Figure 9. *System Settings Menu*

2 View the HRU-512 List 1 system settings. Change system settings at the HLU connected to the HRU-512 List 1.

3 Type `E` to exit the System Settings Menu.

View Performance Data

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

```
Date: 07/06/95 PERFORMANCE DATA
CIRCUIT ID#: PairGain Technologies
                    ERRORED SECONDS/UNAVAILABLE SECONDS
                    DS1            HDSL-1
          HLU       HRU      HLU       HRU
07:15     ---/000   000/000  000/000   000/000
07:30     ---/000   000/000  000/000   000/000
07:45     ---/000   000/000  000/000   000/000
08:00     ---/000   000/000  000/000   000/000
08:15     ---/000   000/000  000/000   000/000
08:30     ---/000   000/000  000/000   000/000
08:45     ---/000   000/000  000/000   000/000
09:00     ---/000   000/000  000/000   000/000
09:15     ---/000   000/000  000/000   000/000
09:30     ---/000   000/000  000/000   000/000
09:45     ---/000   000/000  000/000   000/000
10:00     ---/000   000/000  000/000   000/000
10:15     ---/000   000/000  000/000   000/000
10:30     ---/000   002/002  001/017   002/000
10:45     ---/000   000/000  000/000   000/000
11:00     ---/000   000/000  000/000   000/000

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

Figure 10.   Performance Data

2   Type **E** to exit the Performance Data screen.

View 7 Day History

1   From the Main Menu, type **F** to display the 7 Day History screen.

```
Time: 11:12:19                  7 DAY HISTORY
CIRCUIT ID#: PairGain Technologies


                    ERRORED SECONDS/UNAVAILABLE SECONDS

                DS1                      HDSL
          HLU         HRU         HLU         HRU
06/29   -----/00000 00000/00000 00000/00000 00000/00000
06/30   -----/00000 00000/00000 00000/00000 00000/00000
07/01   -----/00000 00000/00000 00000/00000 00000/00000
07/02   -----/00000 00000/00000 00000/00000 00000/00000
07/03   -----/00000 00000/00000 00000/00000 00000/00000
07/04   -----/00000 00000/00000 00000/00000 00000/00000
07/05   -----/00000 00000/00000 00000/00000 00000/00000
current -----/00000 00002/00002 00001/00017 00002/00000



                           (E)xit
```

Figure 11.   7 Day History Screen

2   Type **E** to exit the 7 Day History screen.

View Alarm History

1   From the Main Menu type **G** to display the Alarm History screen.

```
                              ALARM HISTORY
    TIME: 11:13:39
    DATE: 07/06/95
    CIRCUIT ID#:PairGain Technologies
    Type                First    Last       Current              Count
    LOS, DS1-HRU                            OK                   000
    LOSW, HDSL                              OK                   000
    ES,  HDSL                              OK                   000
    MARGIN LP                               OK                   000
    PWR-OPEN                                OK                   000
    PWR-SHRT                                OK                   000
    LAST CLEARED:  06/30/95-00:01

                              (E)xit (U)pdate
```

Figure 12. *Alarm History Screen*

2   Type **U** to update the Alarm History screen to the most current data.

3   Type **E** to exit the Alarm History screen.

Table 3.   *HRU-512 List 1 Alarm History Screen Definitions*

Message	Full Name	Description
NONE	No Alarms	There are currently no alarms in effect.
RLOS	Remote Loss of Signal	No signal at the remote HRU-512 List 1 DS1 input port.
ALRM	Minor Alarm	A Minor Alarm condition is in effect.
LOSW	Loss of Sync Word	The HDSL loop has lost sync.
HES	HDSL Loop Errored Second	The HDSL CRC errors have exceeded the ES threshold
MOOS	Multiplexer (Mux) Out of Sync	The D4 Channel Bank is generating a "MOOS" condition.
DS1	DS1 BPV Errored Seconds	Indicates that the number of BPV seconds, in which at least one BPV has occurred at the HRU DS1 input, has exceeded the 24-hour ES threshold.
MAL	Margin Alarm	The margin on the HDSL loop has dropped below the threshold (1 to 15 dB) set by the user.
RAIS	Remote Alarm Indication Signal	Indicates an AIS (all ones pattern is being transmitted from the HRU-512 List 1 to the CPE.
LAIS	Local Alarm Indication Signal	Indicated an AIS (all ones pattern is being transmitted from the HLU onto the D4 Channel Bank data bus (towards the network) for the DS0 time slots (bandwidth) as provisioned by the user.

LOOPBACKS

The HRU-512 List 1 supports 4 types of loopbacks (see Figure 6).

• NREM (network remote loopback)

• NLOC (network local loopback)

• CLOC (customer local loopback)

• CREM (customer remote loopback

Figure 13 on page 27 shows the two remote unit loopbacks NREM and CLOC. NREM and CLOC can be initiated from the HLU front panel pushbuttons or from a maintenance terminal attached to the HLU front panel DB-9 Craft port. In addition, NREM can be initiated through the LB button on the front panel of the HRU-512 List 1 and from an HLU DDS NEI in-band DS0 latching loopback command. CLOC can also be initiated by a Full T1 5-in-7 in-band code at the HRU-512 List 1 DS1 input port. CLOC is a logic loopback that occurs in the digital multiplexer function of the HRU-512 List 1 as shown in the block diagram. (See Figure 1 on page 4).

The NREM loopback (shown in Figure 13) is the standard NID metallic loopback. NREM has two modes of operation depending on the setting (ENA or DIS) of the NAIS user option at the HLU. The ENA option causes the HRU-512 List 1 to transmit the AIS signal towards the CPE for all 24 time slots (full T1 bandwidth). The DIS option turns off the AIS signal and causes the HRU-512 List 1 to transmit LOS towards the CPE for all 24 time slots.

NAIS-ENA

Upon detection of the NREM loopback command (see Figure 13 for its location) the AIS signal is transmitted towards the CPE. In addition, a logic loopback within the HRU is enabled and loops the NI signal back towards the network. The HiGain system is now in the NAIS-ENA *logic loopback* state and remains in this state until a loopdown command is detected from the network or the user selected default time out period (if enabled) expires.

NAIS-DIS

When the HRU is in the NAIS-ENA (enabled) loopback state, the HRUs DS1 input LOS, Code, and Frame monitoring circuits are connected to the signal being received from the CPE. Thus the HRUs front panel CODE and FRM LEDs indicate the status of the customer's DS1 input signal.

When the NAIS option is set to DIS, the AIS signal is not transmitted to the CPE. Instead, the HRUs DS1 output signal is disconnected (opened) from the CPE and terminated into a 100 ohm termination. This causes an LOS signal condition to be transmitted from the HRUs DS1 output port towards the CPE which in turn alerts customer maintenance personnel of the circuit's off-line condition. In addition, the HRUs DS1 input port is also disconnected and terminated into 100 Ω. At the same time a metallic relay is activated which loops the NI signal back towards the network. The Hi Gain system is now in the NAIS-DIS *metallic loopback* state and remains in this state until a loopdown command is detected from the network or the user selected default time out period (if enabled) expires.

When the HRU-512 List 1 is in the NAIS-DIS metallic loopback state, the HRUs DS1 input LOS, Code, and Frame monitoring circuits are connected to the network's signal which is being looped back to these circuits through the metallic loopback relay. The CPE input signal is no longer being monitored since its input circuit has been opened and terminated into 100 Ω. The FRM LED indicates the framing pattern of the network signal. The LOC LOS LED will always be OFF. The CODE LED will indicate AMI or B8ZS if the CODE option is set to either AMI or B8ZS respectively. However, the CODE LED state is indeterminate if the CODE option is set to AUTO.

The HRU-512 List 1 front panel pushbuttons can also be used to terminate any NREM loopback irrespective of how it was initiated.

The HLU can be looped up (CREM) from the HRU-512 List 1 DS1 interface with a Full T1 6-in-7 in-band command. The HRU-512 List 1 itself can be looped up (CLOC) from the HRU-512 List 1 DS1 interface with a Full T1 5-in-7 in-band command. Both command patterns must be full 24-channel T1 signals that must last for at least 5 seconds, and may be either framed or unframed. The loop down command for both is the standard Full T1 3-in-5 (5 second) pattern.

The complete family of FT1 loopbacks (CLOC, CREM, NLOC and NREM) are detailed in the HLU FT1 HiGain Line Unit Technical Practice, that can be referenced to obtain a thorough understanding of the loopbacks available in this FT1 system and how the loopbacks differ in operation from a normal full T1 system.
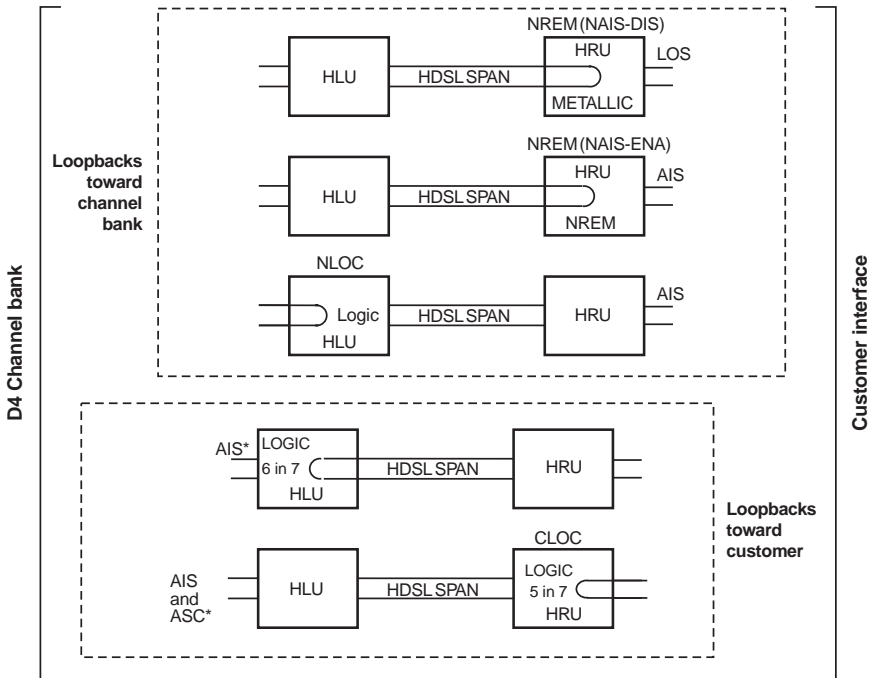
Figure 13.   *HiGain-FT1 Loopback Configurations*

When testing the fractional T1 circuit, the HRU DS1 data always occupies time slot 1 through the number of time slots used. Data at the HLU begins with the time slot assigned to the physical channel unit position into which the HLU is installed. If the HLU is installed in position 8B of the D4 bank and the circuit is provisioned for four contiguous DS0 time slots of bandwidth, the data is in HLU DS0 time slots 8, 9, 10 and 11 and in HRU-512 List 1 DS0 time slots 1, 2, 3 and 4.

When T1 loopback tests are made on the system with external metallic loopback connections across the HRU-512 List DS1 XMT and RCV ports, the DS1 code that exists at these ports may be different from the one being sent at the distant end when the DS1 code option is set to AUTO. If the HRU-512 List 1 has a metallic loopback and it is in its AUTO/AMI mode, and then the distant end switches from an AMI pattern to an all zero B8ZS pattern, the HRU-512 List 1 will remain in its AMI mode causing it to transmit all 0's. This causes the HRU-512 List 1 to indicate a LOC LOS alarm condition. This will force the HLU to output all ones on all provisioned DS0 time slots for the user selected bandwidth. Non-provisioned DS0 channels are not affected.

SPECIFICATIONS

HDSL Line Code	784 kbps 2B1Q full duplex
HDSL Output	+13 dBm ± 0.5 dB at 135 Ω
HDSL Line Impedance	135 Ω
HDSL Line DC resistive signature	180 k Ω across Tip and Ring
Maximum Provisioning Loss	35 dB at 196 kHz, 135 Ω
Line Clock Rate	Internal Stratum 4 clock
HDSL Startup Time	15 seconds (typical), 60 seconds (maximum)
One Way DS1 Delay	<220 microseconds
DS1 Line Impedance	100 Ω
DS1 Pulse Output	0 dB (LBO=0), -15 dB (LBO = -15)
DS1 Input Level	>-22.5 dB
DS1 Line Rate	1.544 Mbps ± 200 bps
DS1 Output Wander (MTIE and TVAR)	Compliant with Section 7.2.1 of the T1X1.3/90-026R7 SONET committee report.
DS1 Line Format	AMI or B8ZS
DS1 Frame Format	ESF or SF
Power Consumption	7 Watts (maximum)
Electrical Protection	Secondary surge and power cross protection on all DS1 and HDSL ports
Operating Temperature and Humidity (non-condensing)	-40º to +65º C, 5-95% humidity
Mounting	Single wide 400 type mechanics
Dimensions	
Depth:	5.6" (14.22 cm)
Height:	5.6" (14.22 cm)
Width:	1.4" (3.5 cm)

ABBREVIATIONS

AMI	Alternate Mark Inversion
BER	Bit Error Rate
BPV	Bipolar Violations
B8ZS	Binary Eight Zero Substitution
CO	Central Office
CRC	Cyclic Redundancy Check
CSA	Carrier Service Area
ES	Errored Seconds
ESF	Extended Superframe
HDSL	High-bit-rate Digital Subscriber Line
HLU	HiGain Line Unit
HRU	HiGain Remote Unit
SF	Super Frame
SNR	Signal-to-Noise Ratio
SPLB	Special Loopback
ZBTSI	Zero Byte Time Slot Interface

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

Corporate Office

14402 Franklin Avenue
Tustin, CA 92780

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

For Technical Assistance:

(800) 638-0031

ISO 9001

DNV Certification, Inc.
Certificated Firm

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