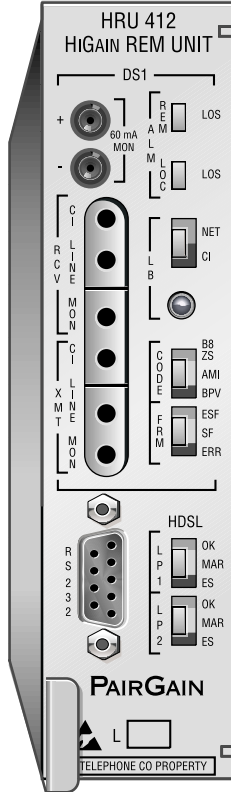


HIGAIN REMOTE UNIT

Model	List Number	Part Number	CLEI Code
HRU-412	7A	150-1103-71	T1L2CL0A



PAIRGAIN TECHNOLOGIES, INC.
ENGINEERING SERVICES TECHNICAL PRACTICE
SECTION 150-412-171-04

Revision History of This Practice

Revision	Release Date	Revisions Made
01	September 18, 1997	Initial release
02	September 18, 1998	Reformat
03	February 19, 1999	Update local and line powering
04	November 23, 1999	Correct line powering specifications

©Copyright 1999 PairGain Technologies, Inc.

PairGain and HiGain are registered trademarks of PairGain Technologies, Inc. Other product names mentioned in this practice are used for identification purposes only and may be trademarks or registered trademarks of their respective companies.

Information contained in this document is company private to PairGain Technologies, Inc., and shall not be modified, used, copied, reproduced or disclosed in whole or in part without the written consent of PairGain.

Information furnished by PairGain Technologies is believed to be accurate and reliable. However, no responsibility is assumed by PairGain Technologies for its use; nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of PairGain Technologies. PairGain Technologies reserves the right to change specifications at any time without notice.

USING THIS TECHNICAL PRACTICE

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



Notes contain information about special circumstances.



Caution symbols indicate the possibility of equipment damage or the possibility of personal injury.



The Electrostatic Discharge (ESD) Susceptibility symbol indicates that a device or assembly is susceptible to damage from electrostatic discharge.

DOCUMENTATION

If you have comments on this PairGain document, send an email to technical_publications@pairgain.com. Type the product name and the section number of the document in the subject area of the email message.

INSPECTING THE SHIPMENT

Upon receipt of the equipment:

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

TABLE OF CONTENTS

Overview	1
Applications	2
Front and Rear Panel	3
Installation	9
Install the HRU-412 List 7A.....	9
Installation Test.....	10
Remote Login	11
Connecting to a Maintenance Terminal.....	11
Logging On and Off.....	13
Remote Terminal Main Menu.....	14
Loopbacks	15
Appendix A - Specifications	18
Pinouts.....	19
Craft Port.....	20
Insertion Loss.....	21
Appendix B - Functional Description	22
Operational Capabilities.....	22
Local and Line Powering.....	22
Appendix C - Product Support	24
Technical Support.....	24
World Wide Web.....	24
Returns.....	25
Appendix D - Glossary	27
Certification and Warranty	Inside Back Cover

LIST OF FIGURES

1. HRU-412 List 7A Front Panel.....	3
2. HRU-412 List 7A Rear Panel	7
3. Connecting to a Maintenance Terminal.....	11
4. HRU-412 List 7A Loopbacks	15
5. HRU-412 List 7A Pinouts.....	19
6. Craft Port Wiring	20

LIST OF TABLES

1. HRU-412 List 7A Front Panel Components.....	4
2. Rear Panel Components.....	8
3. Remote Terminal Main Menu Items.....	14
4. HDSL Loss Over Cables.....	21

OVERVIEW

The PairGain® HiGain® Remote Unit, Model HRU-412 List 7A, is the remote end of a repeaterless T1 transmission system. An HRU-412 List 7A connects to a HiGain Line Unit (HLU-231, HLU-232, HLU-319, or HLU-388), creating a HiGain system that 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 (3658 m) of AWG 24 wire or 9,000 feet (2743 m) 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 7A features:

- Customer Interface (CI)
- Front-panel DS1 and HDSL LEDs
- Front-panel loopback button
- Signature resistance on DS1 and HDSL ports
- Generic and addressable repeater loopback activation codes
- Metallic SmartJack loopback (conforms to TR-TSY-00312)
- Provisioning switches for customer premise equipment current, receive level, and transmit loss of signal-initiated loopback or alarm
- Line or local power options
- Support for 3 span line powering
- Sealing current
- Front panel jacks for test access
- Craft port
- CPE current monitoring test points
- Front-panel HDSL margin threshold indicator for each loop
- Lightning and power cross protection on HDSL and DS1 interfaces
- 784 kbps full-duplex 2B1Q HDSL transmission on two pairs
- DSO blocking support

The HRU-412 List 7A supports PairGain's 1-by-1 Protection Switching System, and it can be line powered or locally powered with a metallic sealing current option that is compatible with all HiGain line and doubler units. The HDSL line resistive signature across both HDSL ports is 180 k Ω .

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.

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.

FRONT AND REAR PANEL

Figure 1 shows the front view of the HRU-412 List 7A. Table 1 describes the unit's front panel components.

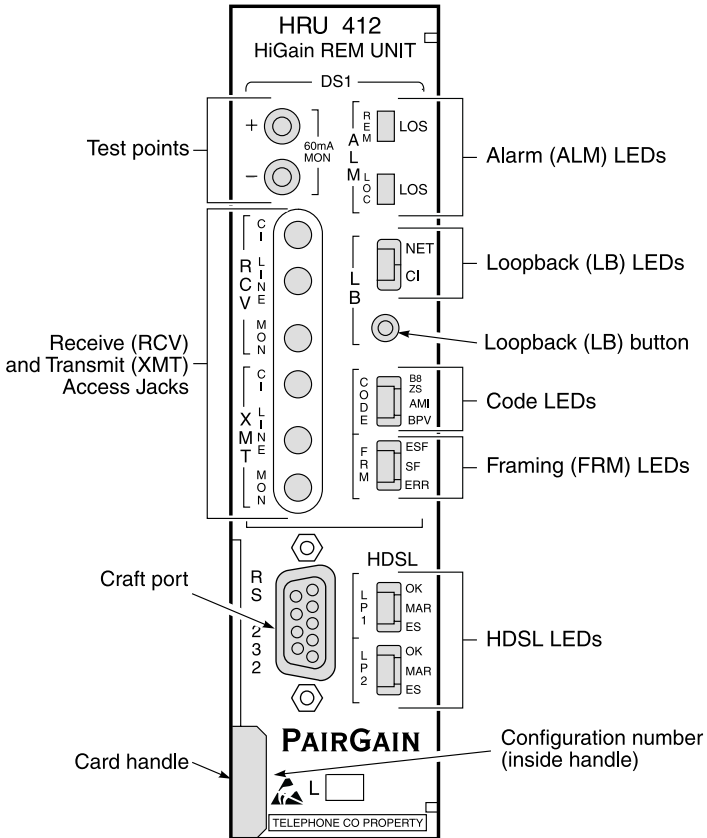


Figure 1. HRU-412 List 7A Front Panel

Table 1. HRU-412 List 7A Front Panel Components

Name	Function
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 isolated from the CPE DS1 metallic interface by a transformer.
Alarm LEDs	The REM LOS LED is steady red indicating a loss of signal (LOS) at the T1 input to the HLU. This LOS condition causes the HRU-412 to transmit the alarm indicating signal (AIS) pattern toward the CPE. The LOC LOS LED is steady red indicating a loss of signal (LOS) at the T1 input to the HRU-412. This LOS condition transmits the AIS pattern toward the DSX-1 (TLOS Disabled) or to execute a logic loopback in the HRU-412 (TLOS Enabled).
Loopback (LB) LEDs	The NET LED is steady green indicating the HRU-412 is in a loopback state in which the signal from the network is looping back to the network. The CI LED is steady yellow indicating the HRU-412 is in a loopback state in which the signal from the customer interface (CI) is looping back to the CI.
CODE LEDs	The B8ZS LED is steady green indicating that the user DS1 code option is set to B8ZS. The AMI LED is steady yellow indicating that the user DS1 code option is set to AMI. The BPV LED is steady red indicating 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 the settings are made on the HLU.
Framing LEDs	The framing option is set on the HLU. The ESF LED is steady green indicating that the framing pattern of the received signal is Extended Super Frame (ESF). The SF LED is steady yellow indicating that the framing pattern of the received signal is Super Frame (SF). The ERR LED is steady red indicating that a DS1 frame error has occurred. No frame LED lights when the HRU-412 input pattern is unframed or when the framing option is set to UNFR (unframed).

Table 1. HRU-412 List 7A Front Panel Components (Cont.)

Name	Function
HDSL LEDs	<p>The LP1 OK LED flashes green while HDSL Loop 1 is synchronizing with the HLU. The LED is a steady green indicating that Loop 1 is properly synchronized with the HLU.</p> <p>The LP1 MAR LED is steady yellow when the HRU-412 margin on HDSL Loop 1 has dropped below the user-defined margin threshold value. This indicator flashes yellow at a slow rate indicating that loss of sync word (LOSW) exists in Span 1, Loop 1 of the HDSL pair between the HLU and the doubler or HRU-412. If using doublers, this indicator flashes yellow at a rapid rate indicating that LOSW problem exists in Span 2, Loop 1 of the HDSL pairs.</p> <p>The 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>The LP2 OK LED flashes green while HDSL Loop 1 is synchronizing with the HLU. The LED is steady green indicating that Loop 2 is properly synchronized with the HLU.</p> <p>The LP2 MAR LED is steady yellow when the HRU-412 margin on HDSL Loop 2 has dropped below the user defined margin threshold value. This indicator flashes yellow at a slow rate indicating 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 indicating that a LOSW problem exists in Span 2, Loop 2 of the HDSL pairs between the first and second doublers.</p> <p>The 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 maintenance terminal. The terminal allows access to the maintenance, provisioning, and performance monitoring menus and screens.
Loopback button	Places the HRU-412 in loopback mode.
Card handle	Pull the card handle to remove the HRU-412 from the shelf slot.

Table 1. HRU-412 List 7A Front Panel Components (Cont.)

Name	Function
Configuration number	<p>For some products the configuration number may contain either a five- or six-digit warranty configuration number or a standalone two- or three-digit configuration number as follows:</p> <p>Digit 1 - Last digit of shipment year.</p> <p>Digit 2 and 3 - Shipment month.</p> <p>Digits 4, 5, and 6 - Configuration number.</p> <p>The configuration number identifies the version of the product. New configuration numbers usually accompany changes in the last two characters of the CLEI code.</p> <p>The configuration number can also be found on a small bar label that also contains the Julian date code. The configuration number appears as either a stand-alone CFG xx number or as a 15-character number comprised of the part number and a 3-character extension. For example, the number 150-2404-15-x03 is comprised of the part number and an x03 configuration number. This gummed label may be attached to the PC board or to the front panel.</p>

The HRU-412 List 7A rear panel features are shown in [Figure 2](#) and described in [Table 2](#).

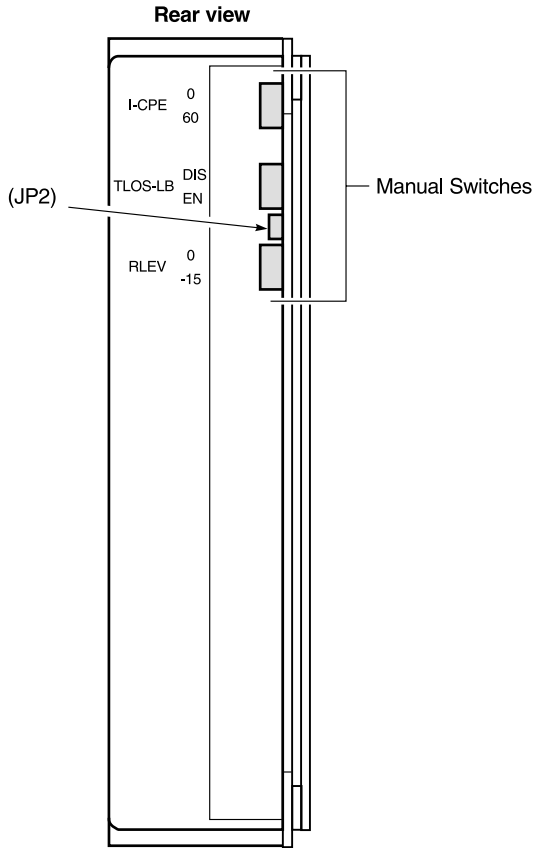




Figure 2. HRU-412 List 7A Rear Panel

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.
 <p>The CPE current control signals terminate on pins 32 and 34 of the card-edge converter. These access pins are for factory test only. Single-slot remote enclosures and seven-slot enclosures use the pins to control the CPE options. These enclosures must be optimized for 0 mA current to prevent a conflict between external connections to pins 32 and 34 and the settings of the I-CPE switch.</p>		
TLOS-LB	DIS	Prevents the HRU-412 from entering 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-412 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-412 transmits the AIS signal toward the CPE and returns the network signal back to the network. The HLU displays TLOS on 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 by the CO. 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-412 from oscillating into and out of TLOS loopback when a loopdown command is issued in the absence of a T1 signal from the CPE.
 <p>Do not enable the TLOS option when the HRU-412 is used with List 6 line units that do not support this feature. These line units cannot loopdown an HRU-412 that is in a TLOS loop-up state when they receive the 3-in-5 in-band loopdown command.</p>		
RLEV	0	Configures the T1 RCV level to 0 dB. This sets the T1 output signal level from the HRU-412 toward the NI to 0 dB. Use this setting when the HRU-412 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-412 toward the NI level to -15 dB. This setting is recommended when the HRU-412 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.

INSTALLATION

INSTALL THE HRU-412 LIST 7A



Be sure to wear an antistatic wrist strap. Avoid touching static-sensitive components on the circuit board.

For indoor installation, the HRU-412 List 7A mounts in the following PairGain shelves:

- HRE-421 (double-width, single mount)
- HRE-422 (double-wide, double mount)
- HRE-424 (double-wide, four-unit wall mount)
- HRE-420 (single-wide, single mount)
- HRE-427 (seven-unit wall or rack mount)
- HRE-425 (12-slot wall or rack mount).

For outdoor installation, the HRU-412 List 7A mounts in the following shelves:

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

To install the HRU-412:

- 1 Ensure that the shelf is correctly mounted and wired (refer to the shelf's technical practice for additional information).
- 2 Slide the unit 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 front panel and push the unit into the card-edge connector until it is secured in the card guides.

When locally powered, the HRU-412 can be configured to provide 15 mA (short loop) to 10 mA (long loop) metallic sealing current toward all versions of the HLU over the two HDSL pairs. JP2, shown in [Figure 2](#), allows the sealing current to be enabled or disabled. To enable the sealing current, connect JP2 across both terminals. To disable the sealing current, remove the jumper from the inner terminal and attach it to the outer terminal. The factory default setting is disabled.

INSTALLATION TEST

Perform the following procedure to test the HRU-412.

- 1 Press the loopback button (see [Figure 1](#) for the location of this button) for at least 5 seconds.

Verify that the LB NET LED is steady green, indicating that the HRU-412 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 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.

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. 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 ohmmeter to verify that the HDSL ports have a 180 k Ω transmit-to-receive resistive signature and that the DS1 ports 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 Network Interface Device (NID), set the I-CPE switch (On the back panel of the HRU-412 List 7A; see [Figure 2](#)) to 60 mA and verify the NID has power. Check that 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.

REMOTE LOGIN

The HRU-412 List 7A supports remote login through a maintenance terminal or PC connected to its front-panel RS-232 craft port. Remote login creates menus and screens for the HRU-412 that are identical to those at the HLU. Once logged on you can access the Remote Terminal Main Menu screens to view system settings and status, and initiate loopbacks. You can also access the HRU-412 performance monitoring capabilities.

CONNECTING TO A MAINTENANCE TERMINAL

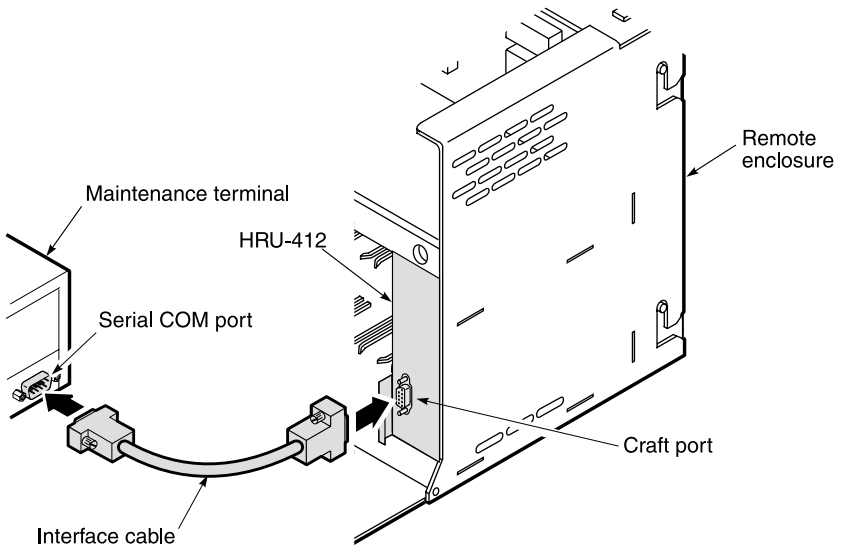


Figure 3. Connecting to a Maintenance Terminal

The HRU-412 front-panel craft port allows you to use a standard serial cable to connect your system to a maintenance terminal or PC running a terminal emulation program.

- 1 Connect a standard 9-pin serial terminal cable to the craft port, a DB-9 female connector, on the HRU-412.
- 2 Connect the other end of the terminal 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:
 - 9600 baud
 - No parity
 - 8 data bits
 - 1 stop bit
 - Hardware flow control to OFF



If using the Microsoft Windows terminal emulation program, from the Settings, Terminal Preference menu, deselect *Show Scroll Bars* and *Use Function, Arrow, and Ctrl Keys for Windows*.

LOGGING ON AND OFF

To log on and access the Remote Terminal Main Menu screens using the maintenance terminal:

- 1 Press the **SPACEBAR** several times to activate the autobaud feature and display the Remote Login screen.
- 2 Press the **ENTER** key to perform a remote login to the HiGain Maintenance Terminal screens.
 - The Remote Terminal Main Menu items (see [Table 3 on page 14](#)) are replications of the HLU screens. Depending on the HLU attached to the HRU-412 List 7A, remote provisioning may be available. Refer to the HLU technical practice for details.
 - The Performance Monitoring Menu items provide special network surveillance features that monitor network performance and help track problems.
- 3 From the Remote Terminal Main Menu screen, type the appropriate letter to select the item you wish to view. ([Table 3 on page 14](#) shows an example of different screens which may be available. The HLU determines the screens available for viewing at the remote unit.)
- 4 When completed, terminate the remote session by pressing **L** for remote logoff. Terminating the remote session allows other units in the circuit, such as doublers, or the HLU itself, to initiate an RS-232 session. An active session at any module prohibits active sessions at all other circuit modules.

REMOTE TERMINAL MAIN MENU

The Remote Terminal Main Menu items are explained in [Table 3](#).

Table 3. *Remote Terminal Main Menu Items*

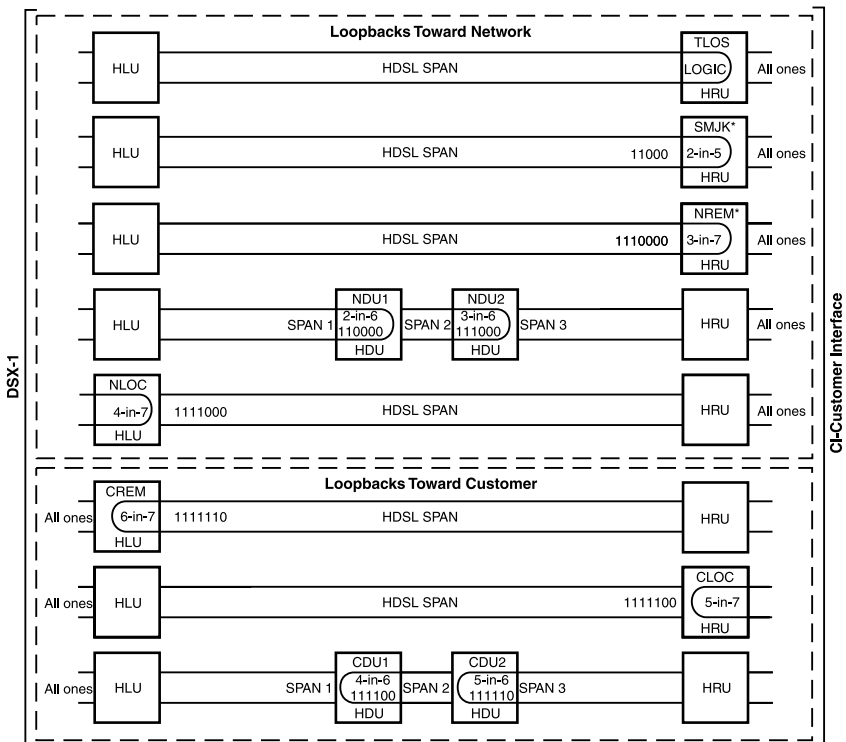
Name	Function
View Span Status	Allows viewing of span status between the HLU and the HRU-412 including span status for doubler devices (multi-span applications).
Set Clock	Allows setting of time and date parameters at the HRU.
System Settings	Allows viewing of all system settings.
View Performance Data	Allows viewing of the Errored Seconds (ES) and Unavailable Seconds (UAS) for the HLU to HRU-412 span (non-doubler applications) and any additional spans (doubler applications) in 15-minute intervals over a 4-hour time period.
View Performance History	Allows viewing of the ES and UAS for the HLU to HRU-412 span (non-doubler applications) and any additional spans (doubler applications) in 24-hour intervals over a 7-day period.
View Alarm History	Allows viewing of alarm conditions for the HLU to HRU-412 span (non-doubler applications) and any additional spans (doubler applications).

LOOPBACKS

The HRU-412 List 7A supports 4 types of loopbacks (see Figure 4).

- TLOS (transmit loss of signal)
- NREM (network remote loopback)
- CLOC (customer local loopback)
- SMJK (SmartJack)

Loopback tests can be initiated by using in-band codes or maintenance terminal commands, or by faceplate pushbutton activation.



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

Figure 4. HRU-412 List 7A Loopbacks

A SmartJack loopback causes the T1 interface chip to transmit the AIS pattern to the NI and back to the HRU-412 List 7A T1 receiver circuit. The T1 input to the HRU-412 List 7A at the XMT port is disconnected and terminated in 100 Ω . The AIS pattern is examined by the HRU-412 List 7A for its overall integrity. The SmartJack 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 7A. The HLU declares an HRU pre-loopback fail condition. This terminates the loopback test and returns the HRU-412 List 7A to its unlooped normal state, indicating a defective HRU-412 List 7A 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 7A 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 SmartJack 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 7A is in the AIS/ENA SmartJack 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 Ω . 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 7A is in an AIS/DIS SmartJack 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 Ω . 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 7A 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; 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 7A 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.

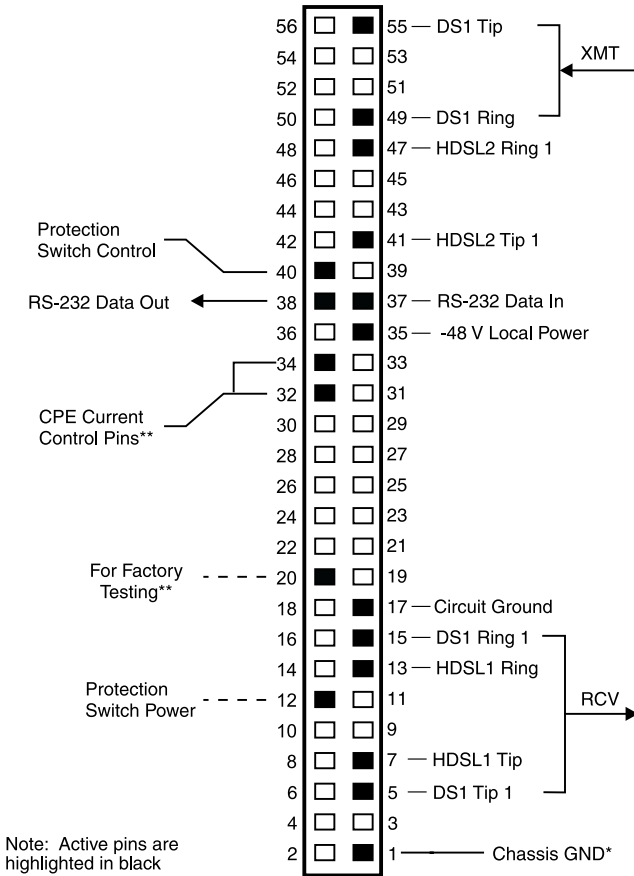
The HRU-412 List 7A remains in AMI mode and loops all 0s causing the HRU-412 List 7A to indicate an LOS condition. The result is that the HLU outputs an AIS pattern.

APPENDIX A - 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 Startup Time	15 seconds (typical), 60 seconds (maximum)
Maximum Provisioning Loss	35 dB at 196 kHz, 135 Ω
Line Clock Type	Internal Stratum 4 clock
Power Consumption	5.5 Watts (typical), 7 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 μ s per span
Line Impedance	100 Ω
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)

PINOUTS

The HRU-412 List 7A pinouts are shown in Figure 5. The active pins are shown in black.



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

** Factory use only

Figure 5. HRU-412 List 7A Pinouts

CRAFT PORT

Figure 6 shows the craft port wiring diagram.

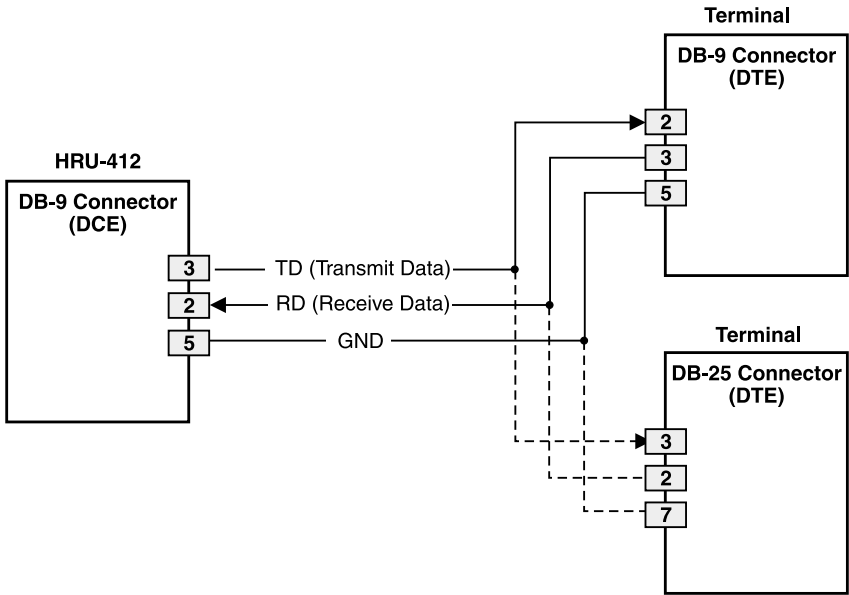


Figure 6. Craft Port Wiring

INSERTION LOSS

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

Table 4 provides a guide for the loss over various cable gauges at 196 kHz and 135 Ω . 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 Ω over two HDSL simplex loops. This means, for example, where 12 kft of AWG 24 wire equal 34.08 dB (insertion loss), resistance is at 622 Ω which is well below the limit of 800 Ω .

Table 4. HDSL Loss Over Cables

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

APPENDIX B - FUNCTIONAL DESCRIPTION

OPERATIONAL CAPABILITIES

HiGain uses 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 7A. 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 (or the -48 Vdc input when locally powered) 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 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.

The HRU-412 can be used with an HLU-232 line unit to form an automatic 1 x 1 protection switch system. For this application, the HRU-412 must be installed in a two-slot HRE-422 remote enclosure. This enclosure provides access to the HRU-412 protection switch output on pins 12 and 40, which control the protection switching function.

LOCAL AND LINE POWERING

The HRU-412 List 7A unit can be line powered or local powered. It defaults to the local -48 Vdc power source, if present. It defaults to line power only in the absence of local power. The newer HLUs automatically turn off line powering when connected to the HRU-412. The older versions of the HLU-231 (Lists 1, 2, 3, 3A, and 4) must have their PWRF user option disabled for them to work properly with a locally-powered HRU-412. Refer to the appropriate HLU technical practice if you need more information about its local and line powering capabilities.

If local power to an HRU-412 is lost, the last span loses sync. When the HLU or HDU attempts to reestablish sync, it detects that the HRU-412 is not locally powered and applies line power to it. The HRU-412 then powers up and operates normally if within range to support line powering.

The -48 Vdc local power supply must have a 105 mA output current capacity (5 W) to power each HRU-412 when the I-CPE option is set to 0 mA. The -48 Vdc local power supply must have a 150 mA output current capacity (7 W) to power each HRU-412 when the I-CPE option is set to 60 mA.

A Teltrend WPS-2005 Wall-Mount Power Supply, or equivalent, is capable of powering two HRU-412 units with the I-CPE option switch set to 0 mA or one HRU-412 with the I-CPE option switch set to 60 mA. The HRU-412 can be used in limited (2000 Ω) and unlimited (full CSA) three-span line-powering applications. The line units and doublers compatible with limited and unlimited line powering are shown below:

1 Limited: loop resistance < 2000 Ω

- Line units: HLU-231 List 7D and 7B; HLU-431 List 1D; HLU-231
- List 8, List 8D, and List 8E; HLU 319 List 5, List 5D, and List 5E; HLU-388 List 5 and List 5D
- Doublers: HDU-438 List 1 and List 1B; HDU-439 List 1 and List 1B
- Doublers: HDU-409; HDU-408; HDU-406.

2 Unlimited: full CSA range on all spans

- Line units: HLU-231 List 8, List 8D and List 8E; HLU 319 List 5, List 5D, and List 5E; HLU-388 List 5 and List 5D
- Doublers: HDU-409; HDU-408; HDU-406.



The HRU-412 List 7A supports up to three spans (with the use of two doublers).

For more information on doublers, see the technical practices for the HiGain Mini Doublers and the HiGain Micro Doubler.

APPENDIX C - PRODUCT SUPPORT

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

TECHNICAL SUPPORT

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

Telephone:	800 638.0031 or 714.832.9922 The 800 telephone support line is toll-free in the U.S. and Canada.
Fax:	714.832.9924
Email	support@pairgain.com

During normal business hours (7:30 AM to 5:30 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. To download PairGain product manuals from the Customer Site portion of the PairGain web page, you need to provide a customer password. If you do not have a password, contact your PairGain sales representative.

RETURNS

To return equipment to PairGain:

- 1 Locate the number of the purchase order under which the equipment was purchased. To obtain a return authorization number, you need to provide the original purchase order number to PairGain's Return Material Authorization (RMA) Department.
- 2 Call or write PairGain's RMA Department to ask for an RMA number and any additional instructions. Use the telephone number, fax number or email address listed below:
 - Telephone: 800.370.9670
 - Fax: 714.832.9923
 - Email Address: rma@pairgain.com
- 3 Include the following information, in writing, along with the equipment you are returning:
 - Company name and address.
 - Contact name and telephone number.
 - The shipping address to which PairGain should return the repaired equipment.
 - The original purchase order number.
 - A description of the equipment that includes the model and part number of each unit being returned, as well as the number of units that you are returning.
 - 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.

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

- 4 Pack the equipment in a shipping carton.
- 5 Write PairGain's address and the RMA Number you received from the RMA Department clearly on the outside of the carton and return to:

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

Attention: **RMA (Number)**



All shipments are to be returned prepaid. PairGain will not accept any collect shipments.

APPENDIX D - GLOSSARY

Abbreviations used throughout this manual are defined below:

2B1Q	2 Binary, 1 Quaternary
ACO	Alarm Cut Off
AIS	Alarm Indication Signal indicated by transmission of an all ones pattern
AMI	Alternate Mark Inversion
AWG	American Wire Gauge
B8ZS	Bipolar with 8-zero Substitution
BPV	Bipolar Violation
CI	Customer Installation
CLEI	Common Language Equipment Identifier
CLOC	Customer Local Loopback
CO	Central Office
CPE	Customer Premises Equipment
CRC	Cyclic Redundancy Check
CREM	Customer Remote Loopback
CSA	Carrier Service Area
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
ES	Errored Seconds

ESF	Extended SuperFrame
HCDS	High Capacity Digital Service
HDSL	High-bit-rate Digital Subscriber Line
HDU	HiGain Doubler Unit
HLU	HiGain Line Unit
HRE	HiGain Remote Enclosure
HRU	HiGain Remote Unit
I-CPE	Current (amperes) requirements for Customer Premises Equipment
LED	Light Emitting Diode
LOS	Loss of Signal
LOSW	Loss of Sync Word
NI	Network Interface
NID	Network Interface Device
NLOC	Network Local Loopback
NREM	Network Remote Loopback
POTS	Plain Old Telephone Service
PPM	Pulse Position Modulation
PWRF	Power Feed
RCV	Receive
RLOS	Remote Loss of Signal
RMA	Return Material Authorization
SF	Super Frame
SMJK	SmartJack
TLOS-LB	Transmit Loss of Signal-Loopback
UAS	Unavailable Seconds
XMT	Transmit

CERTIFICATION AND WARRANTY

FCC CLASS A COMPLIANCE

This equipment has been tested and found to comply with the limits for a Class A digital device, 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, may 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.

LIMITED WARRANTY

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

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

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

PairGain Technologies, Inc.
14352 Franklin Avenue
Tustin, CA 92780-7013
ATTN: Repair and Return Dept.
800.638.0031

Refer to the instructions under [“Returns” on page 25](#) for complete return instructions.

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

MODIFICATIONS

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

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

The HRU-412 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
- UL-1459

For technical assistance, refer to [“Appendix C - Product Support” on page 24](#).

Corporate Office

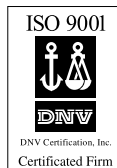
14402 Franklin Avenue
Tustin, CA 92780

Tel: 714.832.9922

Fax: 714.832.9924

For Technical Assistance:

800.638.0031



PAIRGAIN