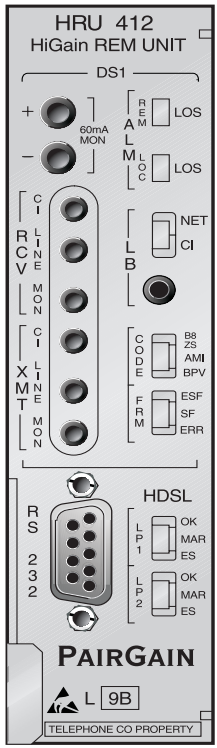
HiGain Remote Unit

Model	List Number	Part Number	CLEI Code
HRU-412	9B	150-1103-92	T1L2CCTAAA



PairGain Technologies, Inc.

Engineering Services Technical Practice

Section 150-412-192-02

PairGain

Revision History of This Practice

Revision	Release Date	Revisions Made
01	May 27, 1998	Initial Release
02	November 18, 1998	Updated table information

USING THIS TECHNICAL PRACTICE

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

Notes contain information about special circumstances.

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

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PRODUCT OVERVIEW

This technical practice describes the PairGain® HiGain® HRU-412 List 9B for doubler and non-doubler applications. The HRU functions as the remote end of a repeaterless T1 transmission system. When used with HiGain Line Units (HLUs) and HiGain Doubler Units (HDUs), the HiGain system provides 1.544 Mbps data transfer on two unconditioned copper pairs over the full Carrier Service Area (CSA) range.

Figure 1 shows a basic HiGain configuration for a T1 High-bit-rate Digital Subscriber Line (HDSL) circuit. The HLU is installed at the Central Office (CO) shelf and the remote unit is housed in a remote enclosure at the Customer Premises Equipment (CPE) site. Optional HDUs provide the ability to double or even triple the distance range for customer applications located outside the CSA.

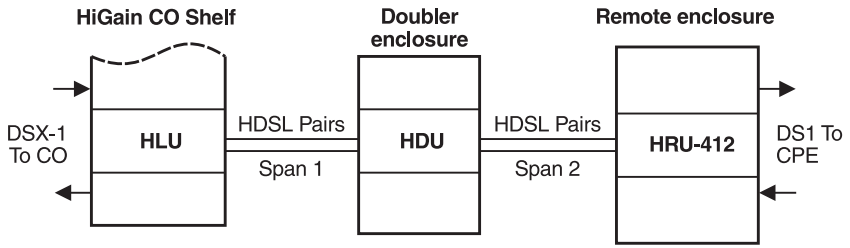


Figure 1. *Typical HiGain System*

HRU-412 List 9B features:

- Front panel:
- CPE current monitor test points
- Receive (RCV) and Transmit (XMT) access jacks for testing
- DS1 and HDSL status LEDs
  - HDSL margin threshold indicator
  - RS-232 Craft port for connection to a maintenance terminal

- Performs SuperFrame (SF) and Extended SuperFrame (ESF) conversion
- ANSI T1.403 Performance Report Messages (PRM)
- Supplemental Performance Report Messages (SPRM), Alarm Indication Signal-Customer Interface (AIS-CI), and Remote Alarm Indicator-Customer Interface (RAI-CI) per T1E1.4/92-00R2R
- ANSI T1.403 DS1 Customer Interface (CI)
- Generic and addressable repeater loopback activation codes
- Provisioning switches for Interface-Customer Premises Equipment (I-CPE) current, SuperFrame-Remote Alarm Indication (SF-RAI) signal, and Receive Level (RLEV) for the T1 output signal
- Line or local power options
- Optional sealing current
- Lightning and power cross protection on HDSL and DS1 interfaces
- 784 kbps full-duplex 2-Binary-1-Quaternary (2B1Q) HDSL Transmission on each of 2 pairs
- DS0 blocking
- Compatible with PairGain 1 x 1 Protection Switching System

The Transmit Loss of Signal Loopback (TLOS-LB) option in the HRU-412 List 8 has been replaced by the SF-RAI option.

FRONT PANEL

Figure 2 and Table 1 identify the HRU-412 front panel components. Table 2 describes how to read the different system status LEDs.

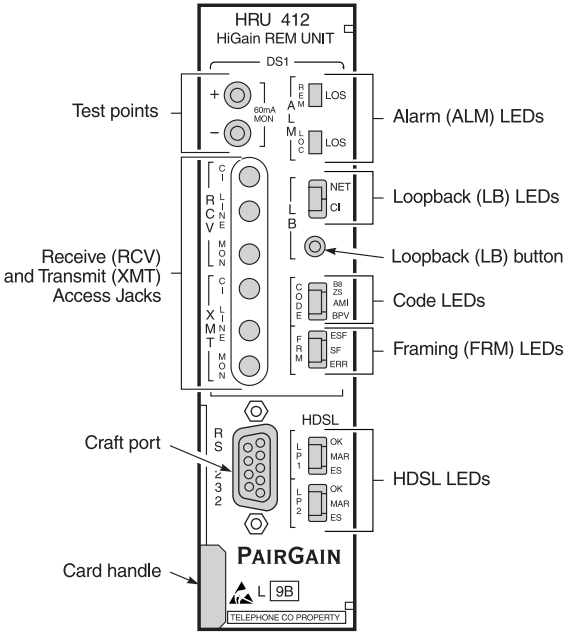


Figure 2. *Front Panel*

Table 1. *Front Panel Components and Functions*

Name	Function
Test points	60 mA MON test points which allow the 60 mA CPE current option, if selected, 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.
RCV and XMT Access Jacks	Splitting and monitor access jacks to the CPE DS1 interface. See Figure 3 for circuit details. These jacks are transformer-isolated from the CPE DS1 metallic interface: CI: Customer Interface, LINE: Line Interface, MON: Monitor Interface
LB button	Activates the remote unit metallic loopback state by pressing the button for five (5) seconds. The unit can be unlooped by either pressing the button again for five seconds or via the standard loopdown coded messages.
Craft port	Provides bi-directional communication between the unit and an external dumb terminal through an RS-232 interface to allow configuration and performance monitoring through the Maintenance Terminal menus. See Section 10 for operating procedures.

Table 2. *Reading the Front Panel LEDs*

Name	Mode	Description
ALM LEDs		Remote and Local (LOC) Loss Of Signal (LOS).
Remote (REM) Loss of Signal (LOS)	Steady red	LOS detected at the T1 input to the remote HLU unit. This condition causes the HRU to transmit the AIS pattern towards the CPE.
	Off	Normal transmission of data.
LOC LOS	Steady red	LOS detected at the T1 input to the local HRU unit. This condition causes the HLU to transmit the AIS pattern towards the network.
	Off	Normal transmission of data.
Loopback (LB) LEDs		Loopback to/from the Network (NET) and to/from the Customer Interface (CI)
NET	Steady green	The HRU is in a loopback state in which the signal from the NET is being looped back to the NET.
	Off	No NET loopbacks are active.
CI	Steady yellow	The HRU is in a loopback state in which the signal from the CI is being looped back to the CI.
	Off	No CI loopbacks are active.
CODE		Indications for code options.
Bipolar with 8-zero Substitution (B8ZS)	Steady green	DS1 line code option set to B8ZS. If however the user DS1 line code option is set to Auto, LED indicates that the code of the DS1 signal being received at the HRUs DS1 input is B8ZS.
Alternate Mark Inversion (AMI)	Steady yellow	DS1 line code option set to AMI. If the user DS1 line code option is set to Auto, LED indicates that the code of the DS1 signal being received at the HRUs DS1 input is AMI.
Bipolar Violation (BPV)	Blinking red	Blinks every time a BPV, other than those associated with a B8ZS code, is received at the HRUs DS1 input.
FRM		Indications for framing patterns.
ESF	Steady green	Indicates that framing pattern of the signal being received at the HRUs DS1 input is ESF.
SF	Steady yellow	Indicates that framing pattern of the signal being received at the HRUs DS1 input is SF.
ERR	Steady red	Indicates a DS1 frame error has occurred.

Table 2. *Reading the Front Panel LEDs (Cont.)*

Name		Mode	Description
HDSL LEDs			Displays HDSL Loop 1 and Loop 2 Conditions.
LP1			
	OK	Blinking green	HDSL Loop 1 is synchronizing with the HLU.
		Steady green	HDSL Loop 1 is synchronized and ready to receive and transmit data.
	MAR	Blinking yellow	Indicates a problem in Loop 1 (doubler applications only) of the HDSL cable pairs that are non-adjacent to the HRU. Blinking once per second indicates a Loss of Sync Word (LOSW) problem in Span 1's Loop 1 HDSL pair between the HLU and doubler. Blinking twice per second indicates a LOSW problem in Span 2's Loop 1 HDSL pair between the first and second doublers.
	ES	Blinking red	Blinks every second in which at least one HDSL CRC error is detected on Loop 1 from the upstream module.
LP2			
	OK	Blinking green	HDSL Loop 2 is synchronizing with the HLU.
		Steady green	HDSL Loop 2 is synchronized and ready to receive and transmit data.
	MAR	Blinking yellow	Indicates a problem in Loop 2 (doubler applications only) of the HDSL cable pairs that are non-adjacent to the HRU. Blinking once per second indicates a LOSW problem in Span 2's Loop 2 HDSL pair between the HLU and doubler. Blinking twice per second indicates a LOSW problem in Span 2's Loop 2 HDSL pair between the first and second doublers.
	ES	Blinking red	Blinks every second in which at least one HDSL CRC error is detected on Loop 2 from the upstream module.

CARD EDGE PIN-OUT DIAGRAM

The HRU-412 occupies one slot in a remote enclosure. The card edge pin-out diagram for the remote unit is shown in Figure 3.

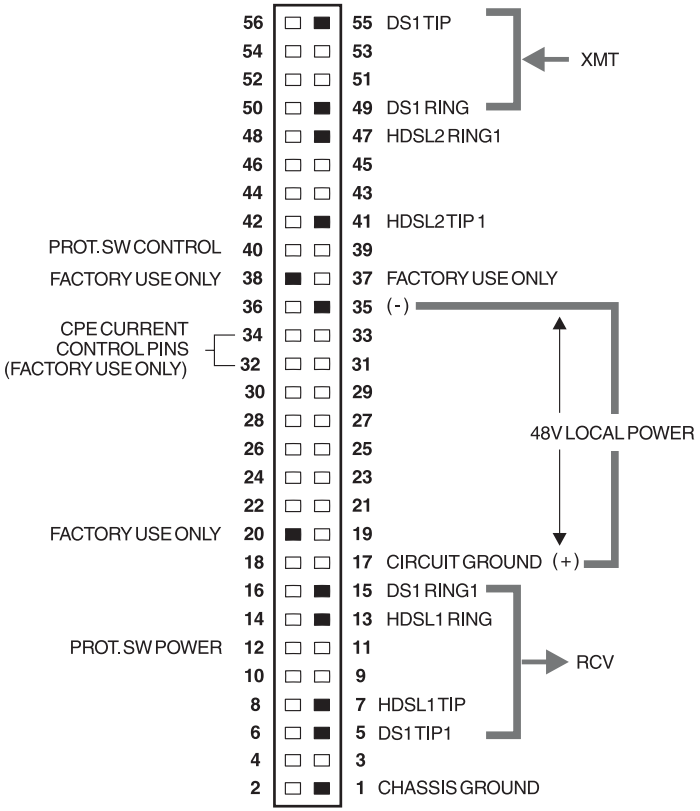


Figure 3. *HRU-412 Card Edge Pin-outs*

BACKPLANE USER OPTIONS

The remote unit has four user options that must set before you install the unit into a shelf or enclosure. Three of these options are set by using manual switches and the fourth (sealing current) is set using jumper JP2 (Figure 4). These options are located on the backplane of the unit.

HiGain systems also have several special loopback (SPLB) options that are set at the HLU. Refer to the specific technical practice for the HLU used in your configuration for more details.

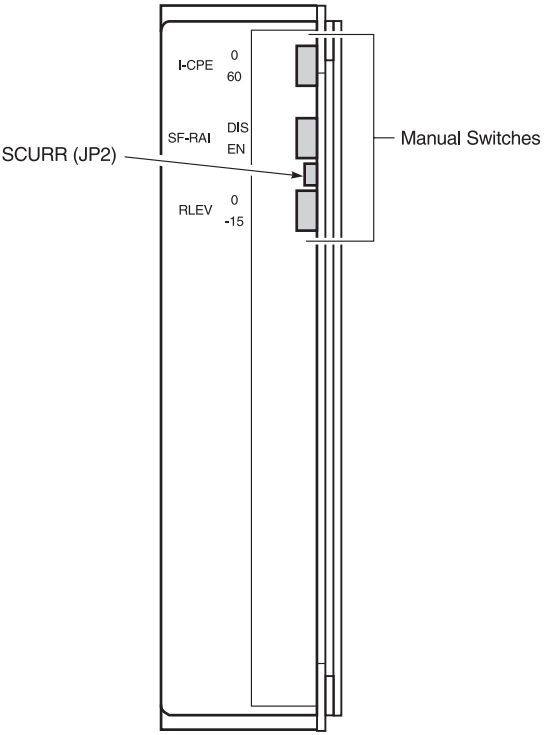


Figure 4. *Backplane User Option Locations*

Sealing Current (SCURR)

The two-prong male JP2 jumper allows you to disable or enable the sealing current. The default is disable. To set the sealing current, do one of the following:

- To enable the sealing current, connect JP2 across both terminals using the supplied female jumper block header.
- To disable the sealing current, remove the jumper block header from both terminals and insert it on the outer terminal for future use.

This simplexed sealing current is polarity sensitive and does not flow if the two HDSL loops adjacent to the HRU are reversed. Reversed loops are indicated by a Channel Reverse (CHREV) message in the Alarms line of the Span Status Maintenance screen shown in Maintenance/Remote section, View Span Status paragraphs.

Interface-Customer Premises Equipment (I-CPE)

The I-CPE switch allows you control the current settings for the interface at the customer premises equipment. The default is 0. To set the I-CPE, do one of the following:

- To set the CPE current to 0 mA, move the I-CPE switch to *0*.
- To set the CPE current to 60 mA, move the I-CPE switch to *60*.

The CPE current control signals terminate on pins 32 and 34 of the card-edge converter. These access pins are provided for factory test only and must never be used. Older single slot HRE-421 remote enclosures and the HRE-427 seven-slot enclosure use these pins to control the CPE options in older HRU units. These enclosures must be optimized from 0-CPE current to prevent a conflict between external connections to pins 32 and 34 and the settings of the I-CPE switch.

Superframe Remote Alarm Indicator (SF-RAI)

The SF-RAI switch allows you to enable or disable the generation of an SF-RAI signal towards the CI in response to an ESF-RAI signs from the network. The default is disable. To set the SF-RAI, do one of the following:

- To enable the SF-RAI signal activation, (which occurs in response to an ESF-RAI message from the network and which in turn transmits an SF-RAI Yellow Alarm to the CI), move the switch to ENA. All three of the following conditions must be met:
  - The signal from the network must be ESF.
  - The signal from the network must contain the RAI Yellow Alarm Bit-patterned message in the facility data link (FDL).
  - The signal being transmitted to the CI must be SF.

If all of these conditions are not met, the SF-RAI signal activation cannot be enabled.

- To disable the SF-RAI signal activation, move the switch to DIS.

Receive Level (RLEV)

The RLEV switch allows you to control the configuration of the T1 RLEV. The default is 0. Setting RLEV to 0 configures the T1 output signal level from the remote unit towards the Network Interface (NI) to 0 dB. This setting is recommended when the HRU does not function as the NID but is connected to an external NID, and allows the external NID to set the appropriate NI level. Setting RLEV to -15 configures the T1 RLEV to -15 dB, and sets the T1 output signal level from the remote unit towards the NI level to -15 dB. This setting is recommended when the remote unit functions as the NID. To set the RLEV do one of the following:

- To set the T1 output signal level to 0 dB, move the RLEV switch to 0.
- To set the T1 output signal level to -15 dB, move the RLEV switch to 15.

APPLICATIONS

The HiGain system provides a cost-effective, easy-to-deploy method for delivering T1 service over two metallic pairs. Conventional in-line T1 repeaters are not required. Cable pair conditioning, pair separation and bridged tap removal are not required.

General guidelines require that the loop has less than 35 dB of loss at 196 kHz, with 135Ω driving and terminating impedances. Table 3 provides a guide for the loss of various cable gauges at 196 kHz and 135Ω. The table applies to the HDSL cable pairs between the HLU, HRU and HDU modules. Without specific insertion loss measurement data, add 3 dB for each bridged tap and 1 dB for each cable gauge change.

Table 3. *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

HiGain systems:

- Operate with any number of other T1, Plain Old Telephone Service (POTS), or other HiGain systems sharing the same cable binder group.
- Can be used with customer applications requiring T1 service on a temporary or permanent basis.
- Provide a means of quickly deploying service in advance of fiber-optic transmission systems.
- Are easily installed allowing service to be provided within hours. Fiber optic systems can be installed at a leisurely pace and cut-over from the installed HiGain system when convenient to do so. The installed HiGain system can then be easily removed and utilized elsewhere.

INSTALLATION

This includes information on inspection, the card edge pin-out diagram, user options and connections.

INSPECTING YOUR SHIPMENT

When you receive the equipment, inspect it for signs of damage. If damage has occurred, immediately report the extent of damage to the transportation company and to PairGain Technologies, Inc. (see "Appendix B: Product Support" on page 92 for more information).

Your shipment should consist of:

- One HRU-411 List 1
- *PairGain Technologies HiGain Remote Unit 412 List 9B* technical practice

SHELF COMPATABILITY

The HRU-411 List 1 mounts in the following shelves (indoor use):

- HRE-420 (single-wide, single mount)
- HRE-422 (double-wide, double mount)
- HRE-425 (12 slot wall or rack mount)
- HRE-427 (seven-unit wall or rack mount)
- 400 Mechanics type shelves
- SLIM (1/2 400 Mechanics) type shelves

For outdoor applications, the HRU-411 List 1 mounts in the following shelves:

- HRE-450 List 5 (single-unit, which is required for PACS applications)
- HRE-454 (four-unit)

INSTALLING THE HRU-412

The HRU-412 can be mounted into a PairGain HiGain Remote Enclosure (HRE) and in any industry standard 400 mechanics shelf.

To install the remote unit (Figure 5):

1 Set the user options as described in the section "Backplane User Options" on page 8.

2 Slide the remote unit into the card guides for the desired slot, then push the unit into the enclosure until it touches the backplane card edge connector. The unit should snap into place, indicating that it is properly seated.

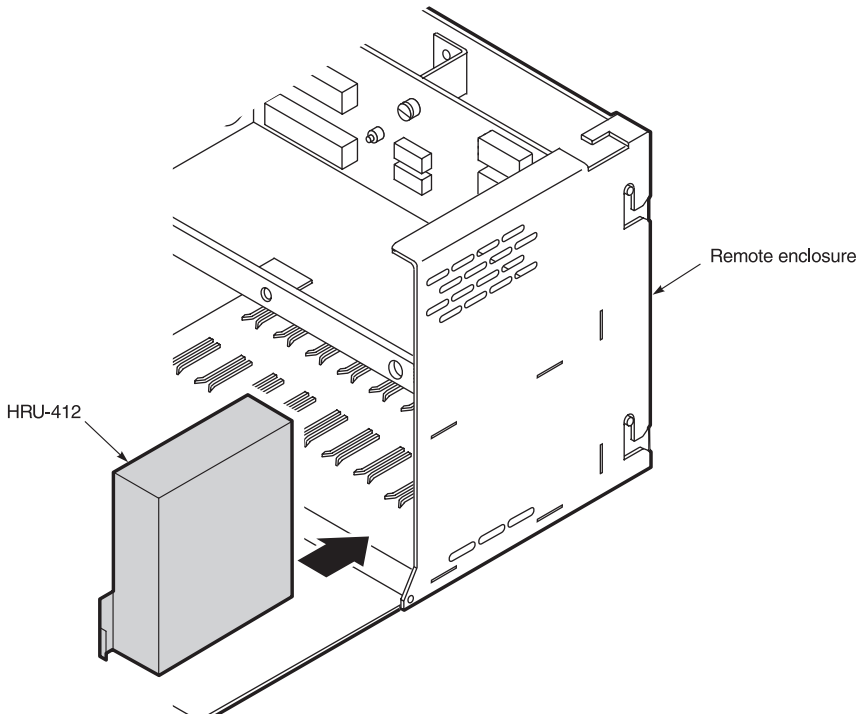


Figure 5. *HRU-412 Installed in a Remote Enclosure*

CONNECTING TO A TERMINAL EMULATOR

This section covers the terminal emulator or dumb terminal screens for both doubler and non-doubler applications. The front panel 9-pin Craft port (RS-232 DB-9 connector) allows you to use a RS-232 cable to connect your system to a dumb terminal or PC running a terminal emulation program. Once connected, you can access the Maintenance and Remote Terminal menus (the Set Clock and Loopback are the only interactive options available on the remote unit).

To connect a terminal emulator:

1 Connect a standard 9-pin serial terminal cable to the HRU-412 List 9B Craft port. Figure 6 shows the HRU-412 DB-9 RS-232 input and output.

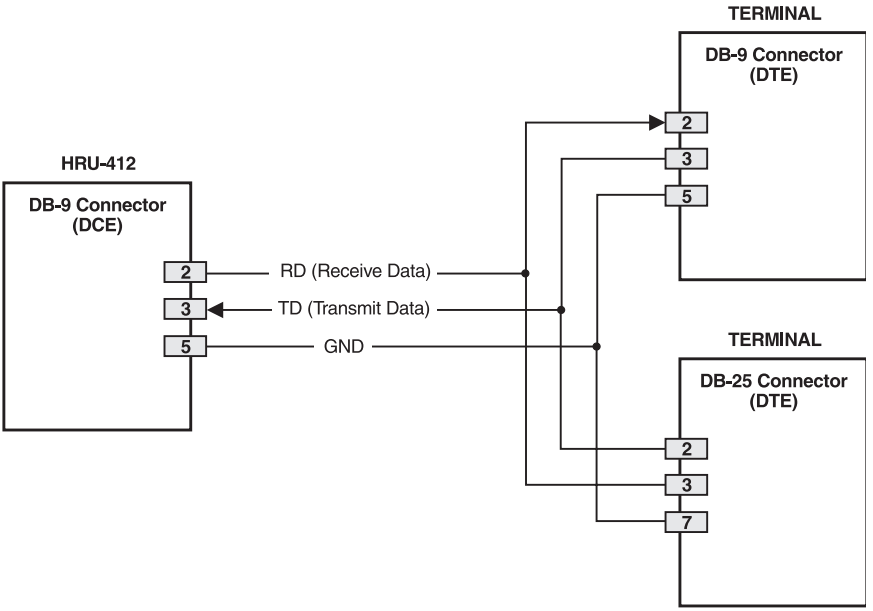


Figure 6. *DB-9 RS-232 Input/Output*

2 Once the serial cable is connected to the Craft port (RS-232 connector) on the HRU-412 List 9B, connect the other end of the cable to the 9-pin COM port (RS-232) of the dumb terminal (Figure 7). The dumb terminal is configured as Data Circuit-Terminating Equipment (DCE).

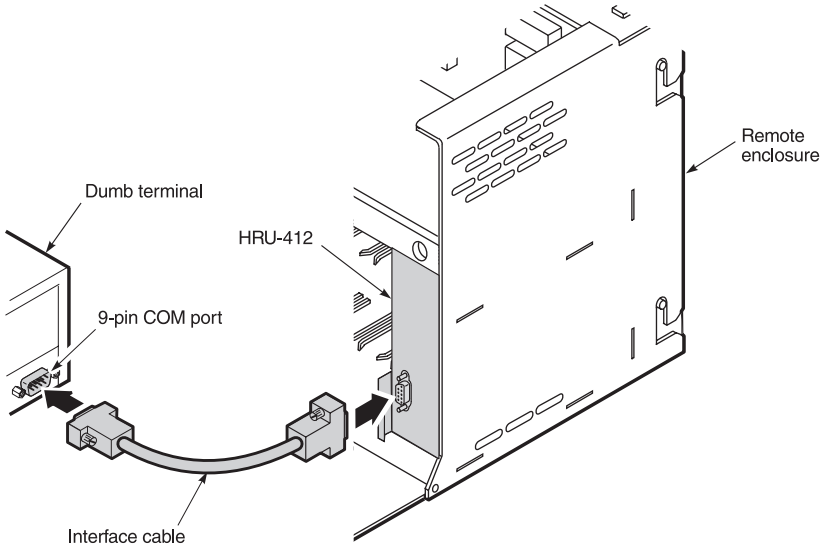


Figure 7. *Connecting to a Terminal Emulator*

3 Configure the dumb terminal to the following communication settings:

- 1200 to 9600 baud (9600 baud is recommended)
- Parity: None
- 8 data bits
- 1 stop bit
- Hardware Flow Control set to None
- VT Terminal Emulation

If using the Microsoft Windows 3.1 terminal emulation program, from the Settings, Terminal Preference menu, you must deselect *Show Scroll Bars and Use Function, Arrow, and Ctrl Keys for Windows.*

LOGGING ON AND USING THE TERMINAL MENUS

This section covers both the local Maintenance Terminal craft port menus (for non-doubler applications) and the Remote Terminal menus (for doubler applications). The screens for either application are identical, except for the Set Clock option which is set from the local Maintenance Terminal menu only.

To log on and access the menus and screens using the dumb terminal:

1 Press the **SPACEBAR** several times to activate the autobaud feature and to display the log on screen. When using doubler units, the remote log on screen displays when the remote unit and the HLU synchronize. The initial remote unit session after power-up is always local log in (Figure 8 shows the Main Menu of a local session). The Main Menu heading *HiGain HRU-412 Maintenance Terminal Main Menu* identifies the screen as a local log in session. However, after the remote unit and HLU establish synchronization, the port interface resets to a remote session. First generation HLUs do not support remote log in sessions.

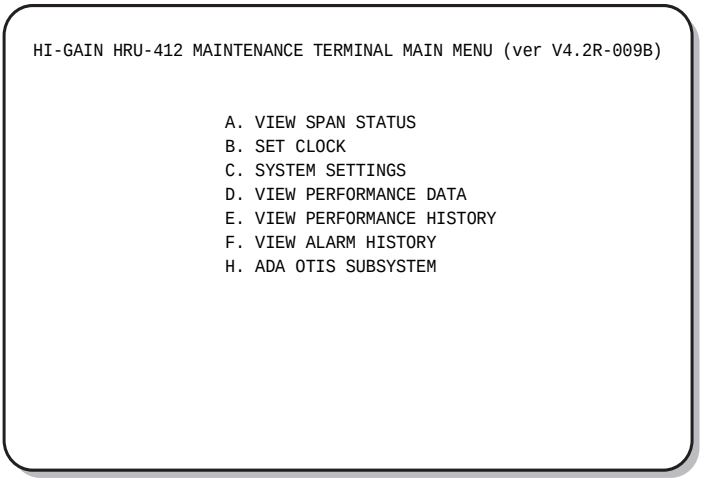


Figure 8. *Main Menu Local Log in Screen*

2 Once the remote unit and HLU have established synchronization, the remote log in screen (Figure 9) displays. Press the ENTER key to bring up the remote log in Main Menu (shown in Figure 10) as identified by the heading *HiGain HLU-231 Remote Terminal Main Menu* or the HLU to which the HRU is connected. This is the remote unit you will be connected to.

3 At this point, you may choose to terminate the remote session by pressing I under the remote logoff option (Figure 10). Terminating the remote session allows other units in the circuit, such as doublers, or the HLU itself, to initiate a RS-232 session. This is necessary because a HiGain circuit can only support one RS-232 session at a time. An active session at any module prohibits active sessions at all other circuit modules.

The HRU-406 List 1 automatically performs a remote log off if no activity at the keyboard is detected after five minutes. This prevents remote sessions that were not properly terminated from blocking access to the Craft port at other locations.

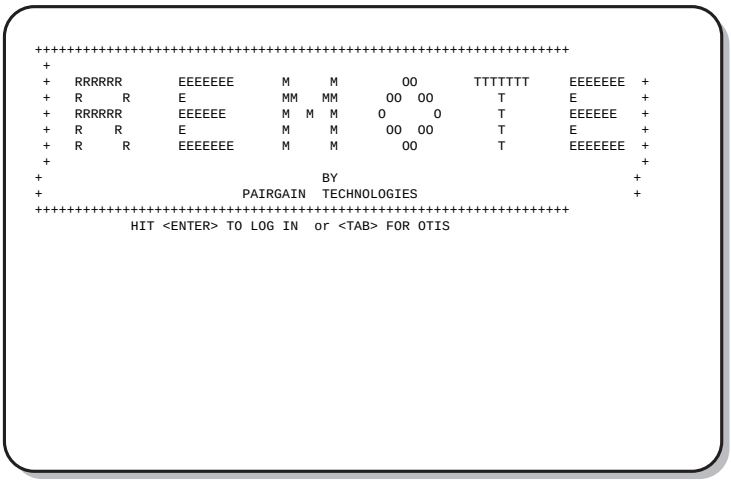


Figure 9. *Remote Log in Menu Screen*

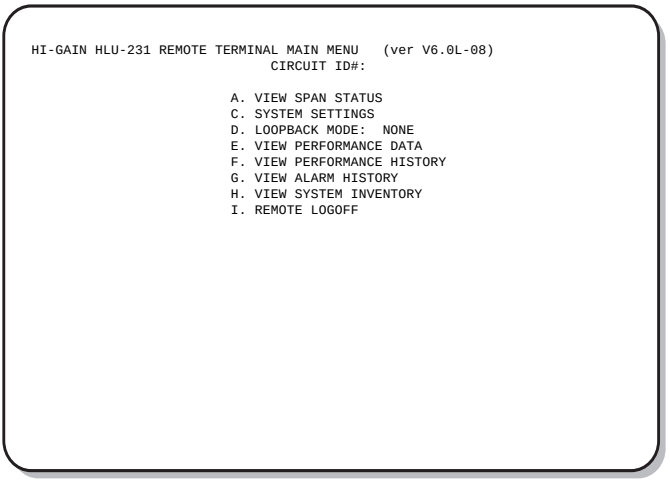


Figure 10. *Main Menu Remote Log in Screen*

Maintenance Terminal Main Menu Descriptions

Table 4 describes the function of each menu selection shown in Figure 8 and Figure 10.

Table 4. *Maintenance and Remote Terminal Menus*

Menu	Function	See
View Span Status	Provides access to a submenu that allows you to monitor the HDSL line between the HLU and the HRU-412 span (non-doubler applications), and the HLU, HDU and HRU-412, Spans 1 and 2 (for one doubler applications), and Spans 1, 2 and 3 (for two doubler applications).	"View Span Status" on page 20
Set Clock*	Allows you to set both the time and the date parameters at the HLU and HRU-412.	"Set Clock" on page 26
System Settings	Allows you to view all system settings.	"System Settings" on page 27
View Performance Data	Provides access to submenus that allow you to view the ES and UAS between the HLU and the HRU-412 span (non-doubler applications), and the available spans (doubler applications) in 15-minute intervals over a four-hour time period.	"View Performance Data" on page 30
View Performance History	Provides access to submenus that allow you to view the ES and UAS between the HLU and the HRU-412 span (non-doubler applications) and the available spans (doubler applications) in 24-hour intervals over a seven-day period.	"View Performance History" on page 32
View Alarm History	Provides access to submenus that allow you to view alarm conditions between the HLU and the HRU-412 span (non-doubler applications) and the available spans (doubler applications).	"View Alarm History" on page 35
Inventory Screen†	Displays the model number and ID of all circuit plugs.	"Inventory Screen" on page 38
Loopback† ‡	Allows system loopbacks to be initiated.	"Loopback Menu" on page 39

* Set the Local Log-in mode only.
† Only available when the remote unit is connected to the HLU-231 List 8x, HLU319 List 5x or HLU-388 List 5x.
‡ Only available when the remote unit is connected to the HLU-231 List 7B.

Navigating the HRU Maintenance Menus

Table 5 describes keys you can use on the dumb terminal's keyboard to navigate within the Maintenance/Remote Terminal menus.

Table 5. *Dumb Terminal Navigational Keys*

Key	Function
ENTER	Logs into the Remote Terminal menus
E	Exits the current menu
U	Updates a report
S	Selects the next Span Status screen
P	Selects the previous page of a report
N	Selects the next page of a report
D	Selects the default settings

View Span Status

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

From each span you can:

- Press E to exit and return to the previous menu.
- Press C to clear the current values.
- Press U to update the current values.
- Press S to view the next available span.

Span Status Screen: Non-Doubler Applications

From the Remote Terminal Main Menu, type **A**. The Span Status screen displays (Figure 11).

```
                    SPAN STATUS
               (HLU/ver6.0-0008:HRU/ver4.2-009B)
TIME: 00:04:43
DATE: 02/11/98
ALARMS:   NONE
LOOPBACK: OFF
                     HLU                        HRU
                 HDSL-1       HDSL-2       HDSL-1       HDSL-2
           cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:   21/20/22             21/20/22  21/19/22  21/20/22 dB
PULSE ATTN:        04            05           01           00    dB
PPM OFFSET:        00            00           -07           -06    ppm
24 HOUR ES:       00006        00003        00003        00002  seconds
24 HOUR UAS:      00001        00004        00011        00015  seconds
DS1 STATUS
                     HLU                  HRU
24 HOUR BPV Seconds:        00000                00000
24 HOUR UAS Count:          00000                00000
Frame type:                Unframed             Unframed
Code type:                   B8ZS                 B8ZS
                           (E)xit (U)pdate
```

Figure 11. *View Span Status Screen for Non-doubler Applications*

The remote unit can be forced into a Remote Log-in session by pressing G (hidden command) from the Local Log-in Main remote screen in Figure 10. This feature is not supported by the same prior models of the Line Unit.

Span Status Screen: Doubler Applications

If doublers have been added, status is also reported for these. After pressing **A** to access the Maintenance Terminal Main Menu, press **S** to navigate through the span status screens. Span status can have from one to several screens, depending on the number of HDUs. Figure 12 shows the status between an HDU and its remote unit. If there are additional doublers, the Span Status screen reports status on each span.

For two doubler configurations, Span 3 is the span between the second doubler (HDU2) and the HRU-412. Press **S** to view the Span 3 Status Screen:

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

```
                              SPAN 3 STATUS
TIME: 00:14:11
DATE: 03/06/98
ALARMS:   CHREV
LOOPBACK: OFF
POWER LEVEL: HIGH
                          HDU2                        HRU
               HDSL-1       HDSL-2       HDSL-1       HDSL-2
             cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:        21/20/2221/19/22         21/19/23 22/20/23 dB
PULSE ATTN:       00          00         00         01 dB
INS LOSS:         00          00         00         01 dB
PPM OFFSET:       00          00         02         02 ppm
24 HOUR ES:      00000       00000      00000      00000 seconds
24 HOUR UAS:     00000       00000      00000      00000 seconds
                             DS1 STATUS
                            HLU                    HRU
24 HOUR BPV Seconds:       00000        00000
24 HOUR UAS Count:         00000        00001
Frame type:                 ESF                   ESF
Code type:                  B8ZS                  B8ZS
(E)xit (C)lear (U)pdate
```

Figure 12. *Two Doublers, Span 3 Screen*

Span Status Fields

Table 6 lists the Span Status fields and descriptions.

Table 6. *Span Status Fields and Descriptions*

Field	Description
Time	Time of day when Span Status was checked.
Date	Date when Span Status was checked.
Alarms	Presence or absence of alarm conditions. See Table 8.
Loopback	Indicates Off condition or identifies specific active loopback. See Table 9.
Margins	Indicates the excess signal to noise ratio at either the HLU or HRU, relative to a 10^{-7} Bit Error Rate. First value is current margin. Second value is minimum margin since last cleared. Third value is maximum margin since last cleared and NA means that the margin is not available.
Pulse Attenuation	Indicates the attenuation of the 2B1Q pulse from the distant end. HiGain operates with pulse attenuations up to 28 dB. This value is related to the cable pair's 196 kHz loss. The pulse attenuation is a more direct indication of the loop attenuation to the 2B1Q signal than the 196 kHz loss.
INS Loss *	Indicates the approximate attenuation of the HDSL loop at 196 kHz. It is generated by multiplying the pulse attenuation by 1.25.
PPM	Indicates the relative offset of the crystal oscillator in the HRU-412 from the HLUs crystal oscillator. Any value between ± 64 is adequate.
HDSL 24 Hour ES	The number of one second intervals that contained at least one CRC error. This value is a running total of the last 24 Hours.
HDSL 24 Hour UAS	The number of seconds the HDSL loop was out of synchronization.
DS1 BPV Seconds (ES)	The number of seconds in which at least one bipolar violation was detected on the DS1 input.
DS1 UAS Count	The number of seconds during which the DS1 input signal was absent (125 or more consecutive 0s).
Frame type	Type of DS1 framing used on the input stream (SF, ESF, Unframed or No Activity).

Table 6. *Span Status Fields and Descriptions (Cont.)*

Field	Description
Code type	Type of DS1 line coding used (AMI, B8ZS, AMI: ZBTSI or B8ZS: ZBTSI). The latter two conditions indicate the code type that is being received when HiGain is set to its ZBTS mode. In either the AMI or B8ZS DS1 code mode, it displays the selected code as opposed to the code type that is actually being received.
HLU/Ver w.x-y	"w.x" = the software version number of the HLU. "y" = List # of the HLU.
HRU or HDU/w.x-y	"w.x" = the software version number of the HRU or HDU. "y" = List # of the HRU or HDU.

* INS Loss displayed only in the Span Status screen for the HLU-231 List 7B, 7D and 8x models. It is also displayed for the HLU-319 List 5x and HLU-388 List 5x models.

Table 7 lists all possible alarms and their descriptions. Table 8 lists all possible loopbacks and their descriptions.

Table 7. *Alarm Field Messages and Descriptions*

Message	Full Name	Description
NONE	No Alarms	No alarm conditions present in system.
LLOS	Local Loss of Signal	No signal from HRUs T1 interface.
LOSW	Loss of Sync Word	One of the HDSL loops has lost synchronization.
H1ES	HDSL Loop 1 Errored Second	Loop 1's CRC have exceeded the ES threshold.
H2ES	HDSL Loop 2 Errored Second	Loop 2's CRC have exceeded the ES threshold.
DS1	Digital Service 1	BPVs have exceeded the ES threshold.
ACO	Alarm Cut Off	An ACO is in effect.
AIS	Alarm Indicating Signal	Indicates an AIS (all ones) pattern is being transmitted from the local T1 output port.

Table 8. *Loopback Field Messages and Descriptions*

Messages	Full Name	Description
SMJK	SmartJack Loopback	Loopback at HRU towards network initiated by 2 in 5 in-band loopback code or out-of-band ESF data link code when *SMJK* is enabled.
NREM	Network Remote Loopback	Loopback at HRU (remote) towards network initiated from CO (network) by intelligent line repeater #1 code, HRU front panel loopback button or maintenance terminal.
NLOC	Network Local Loopback	Loopback at HLU (local) towards network initiated from CO (network) by intelligent office repeater code or by pressing both the HLU Mode and Sel front panel pushbuttons.
CLOC	Customer Local Loopback	Loopback at HRU (local) towards CI initiated from CPE (customer) by intelligent line repeater #1 code.
CREM	Customer Remote Loopback	Loopback at HLU (remote) towards customer initiated from CPE (customer) by intelligent office repeater code.
ARM	Armed	HiGain has detected the intelligent repeater loopback (2 in 5) arming code.
NDU1	Network Doubler 1 Loopback	Loopback at first doubler towards network initiated by HLU.
CDU 1	Customer Doubler 1 Loopback	Loopback at first doubler towards CI initiated by HLU.
NDU2	Network Doubler 2 Loopback	Loopback at second doubler towards network initiated by HLU.
CDU 2	Customer Doubler 2 Loopback	Loopback at second doubler towards CI initiated by HLU.

Set Clock

This option is available during local log in only (see Figure 13).

1 From the local log in screen, press **B** to display the Set Clock screen.

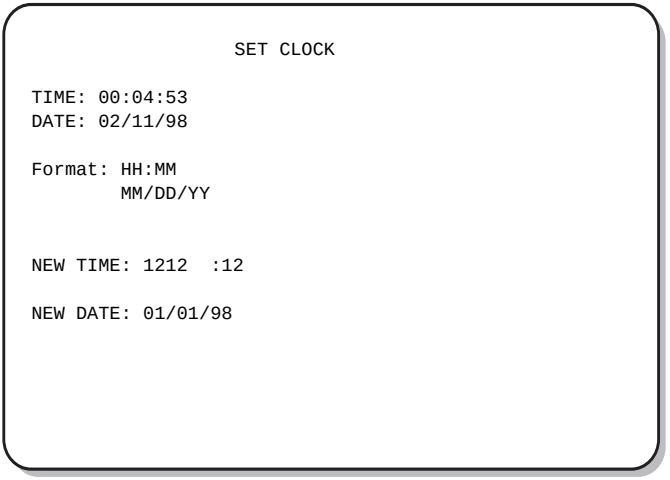


Figure 13. *Set Clock Screen*

2 At the Time prompt, enter the time (in 24 hour format) by pressing the **ENTER** key. The cursor defaults to the New Time field. Setting the seconds is optional.

3 At the Date prompt, enter the date (mm/dd/yy) by pressing the **ENTER** key. The cursor defaults to the New Date field.

4 Type **E** to exit the Set Clock menu. The system date and time is updated and the Remote Terminal Main Menu is displayed.

If you input an invalid entry, the following messages display followed by the name of the field where the invalid entry occurred:

```
>error
```

The Set Date option sets the date at the HRU unit only. All other units have this option set by the HLU.

System Settings

The System Settings screen allows you to analyze and view configurable parameters set at the HLU. These screens are for viewing only and cannot be altered. The system settings can only be set at the HLU.

1 Type **C** from either the Maintenance Terminal Main Menu or the Remote Terminal Main Menu to view the System Settings screen:

```
                    SYSTEM SETTINGS
TIME: 12:46:06
DATE: 02/02/98      CIRCUIT ID#:
A. EQUALIZATION....: 0        P. MARGIN ALARM THRESH: 4
B. SmartJack LPBK.: ENABLED   Q. RLOS ALARM..........:ENABLED
C. SPECIAL LPBK....: GNLB     R. ALARM PATTERN..............:AIS
F. POWER...........: AUTO S. BPVT...................:DISABLED
G. ZBTSI...........: OFF
H. BER ALARM THRESH: NONE
I. LOOPBACK TIMEOUT: 60
J. ALARM...........: DISABLED
K. DS1 LINE CODE...: AUTO
L. FRAMING.........: AUTO
M. AIS ON HDSL LOSW: 2 LOOPS
N. AIS ON SMJK/NREM: ENABLED
O. DS0 BLOCKING: xx = Blocked Channels

          O. 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
                    (D)efaults, (E)xit
          Enter the option letter to change setting
(C)onfirm
```

Figure 14. *System Settings*

2 View HRU-406 List 1 system settings. Change system settings at the HLU connected to the remote unit.

3 Type **D** to set the default settings.

4 Type **E** exit and return to the previous screen.

Table 9 lists the System Setting fields and descriptions.

Table 9. *System Settings Fields and Descriptions*

Field	Description
Time	Time of day when System Settings were checked.
Date	Date when System Settings were checked.
Equalization	Indicates settings for equalizer of either EX1, 0 (DSX-1 for 0-133 ft), 133 (DSX-1 for 133-266 ft), 266 (DSX-1 for 266-399 ft), 399 (DSX-1 399-533 ft), 533 DSX-1 for 533-655 ft).
SmartJack LPBK	Indicates settings of either *ENA* or *DIS* for SmartJack loopback: where signal from DS1 is looped back at the HRU to the DSX-1.
Special LBPK	Indicates the special loopback settings of either: Generic loopback (GNLB), where the HiGain system responds to the generic in-band loopback codes, or A1LB and A2LB, A3LB, A4LB, or A5LB.
Power	Indicates whether power feed to the HRU-406 from the HLU is either OFF, AUTO, HIGH, or LOW.
Zero Byte Time Slot Interface (ZBTSI)	Indicates whether ZBTS is either *On* or *Off*. An *On* setting tells the system that the ESF frame is operating in its ZBTSI mode. An *Off* setting tells the system that the ESF frame is operating in its normal non-ZBTSI mode.
BERT	Indicates whether the Bit Error Rate Threshold is set to either 10^{-7}, 10^{-6}, or none.
Loopback Timeout	Indicates one of four settings: None (DIS automatic time-out cancellation of all loopbacks) or a choice of either 20, 60, or 120, which sets automatic cancellation (timeout) of all loopbacks to either 20, 60 or 120 minutes after initiation.
Alarm	Indicates whether alarms are EN or DIS.
DS1 Line Code	Indicates one of three settings: Auto, B8ZS, or AMI.
Framing (FRM)	Indicates whether framing is either Auto or UNFR (unframed).
AIS on HDSL LOSW	Indicates the settings for alarm indication signals on HDSL LOSW on the HDSL loops.
AIS on SMJK/NREM	Indicates settings of either ENA or DIS for alarm indication signals for the SmartJack Network Remote Loopback (NREM).
DS0 Blocking	Indicates status of DS0 blocked channels and identifies the channels that have been blocked (using “xx” symbols underneath each blocked channel). A *None* setting indicates no channels are blocked. A *BLK* setting indicates some channels are blocked.

Table 9. *System Settings Fields and Descriptions (Cont.)*

Field	Description
Margin Alarm (ALM) Threshold (THRES)	Indicates the settings for the margin alarm thresholds.
Remote (DS1 LOS) Alarm (RDA)	Indicates whether a LOS (Loss of Signal) at the HRU DS1 input will generate an AIS and Alarm or LOS and no Alarm condition at the HLU.
BPVT Transparency	Indicates whether the Bi-polar Violation Transparency option is enabled or disabled.
Alarm (ALM) Pattern	Indicates whether the Alarm Pattern option is set to AIS or LOS.

View Performance Data

The View Performance Data screen shows the number of Error Seconds (ES) and Unavailable Seconds (UAS) occurrences in 15-minute increments for a 24-hour period. The presentation format is: Errored Seconds/Unavailable Seconds (ES/UAS) for the HLU and the HRU-406 List 1 for the DS1 signal, HDSL Loop 1 and HDSL Loop 2 (non-doubler applications). For doubler applications, the available View Performance Data screens displayed are dependent upon the configuration (one doubler or two doublers).

1 From the Remote Terminal Main Menu, type **E** to display the Performance Data screen. You can also access this screen through the Maintenance Terminal Main Menu by typing **D**. When no doublers are in use, the following Performance Data screen displays:

```
Date: 01/01/98           PERFORMANCE DATA
          ERRORED SECONDS/UNAVAILABLE SECONDS
               DS1              HDSL-1            HDSL-2
          HLU       HRU      HLU      HRU      HLU      HRU
08:15    000/000  000/000  000/000  000/000  000/000  000/000
08:30    000/000  000/000  000/000  000/000  000/000  000/000
08:45    000/000  000/000  000/000  000/000  000/000  000/000
09:00    000/000  000/000  000/000  000/000  000/000  000/000
09:15    000/000  000/000  000/000  000/000  000/000  000/000
09:30    000/000  000/000  000/000  000/000  000/000  000/000
09:45    000/000  000/000  000/000  000/000  000/000  000/000
10:00    000/000  000/000  000/000  000/000  000/000  000/000
10:15    000/000  000/000  000/000  000/000  000/000  000/000
10:30    000/000  000/000  000/000  000/000  000/000  000/000
10:45    000/000  000/000  000/000  000/000  000/000  000/000
11:00    000/000  000/000  000/000  000/000  000/000  000/000
11:15    000/000  000/000  000/000  000/000  000/000  000/000
11:30    000/000  000/000  000/000  000/000  000/000  000/000
11:45    000/000  000/000  000/000  000/000  000/000  000/000
12:00    000/000  000/000  000/000  000/000  000/000  000/000
          (E)xit (P)revious (N)ext
```

Figure 15. *Performance Data Screen*

You can do the following:

- Press **P** to view the previous screen.
- Press **N** to view the next screen.
- Press **E** to exit.

Doubler Applications

HDU 1 (one doubler) and HDU2 (two doublers) appear in the Span Status screen for doubler applications.

Two Doublers, Span 3 Performance Data

Press **S** again to view the Span 3 Performance Data screens (two doublers):

```
Date: 03/06/98        SPAN 3 PERFORMANCE DATA
CIRCUIT ID#:
ERRORED SECONDS/UNAVAILABLE SECONDS
               DS1             HDSL-1            HDSL-2
          HLU      HRU     HDU2      HRU     HDU2      HRU
21:15    000/000  000/000  000/000  000/000  000/000  000/000
21:30    000/000  000/000  000/000  000/000  000/000  000/000
21:45    000/000  000/000  000/000  000/000  000/000  000/000
22:00    000/000  000/000  000/000  000/000  000/000  000/000
22:15    000/000  000/000  000/000  000/000  000/000  000/000
22:30    000/000  000/000  000/000  000/000  000/000  000/000
22:45    000/000  000/000  000/000  000/000  000/000  000/000
23:00    000/000  000/000  000/000  000/000  000/000  000/000
23:15    000/000  000/000  000/000  000/000  000/000  000/000
23:30    000/000  000/000  000/000  000/000  000/000  000/000
23:45    000/000  000/000  000/000  000/000  000/000  000/000
00:00    000/000  000/000  000/000  000/000  000/000  000/000
00:15    000/001  000/000  000/000  000/000  000/000  000/000
00:30    000/000  000/000  000/000  000/000  000/000  000/000
00:45    000/000  000/000  000/000  000/000  000/000  000/000
01:00    000/000  000/000  000/000  000/000  000/000  000/000
         (E)xit (P)revious (N)ext (S)pan
```

Figure 16. *Two Doublers, Span 3 Performance Data*

The presentation format is: ES/UAS for the HLU and the remote unit's DS1 signal, and ES/UAS for the HDU2 and remote unit over both HDSL Loop 1 and HDSL Loop 2.

You can do the following:

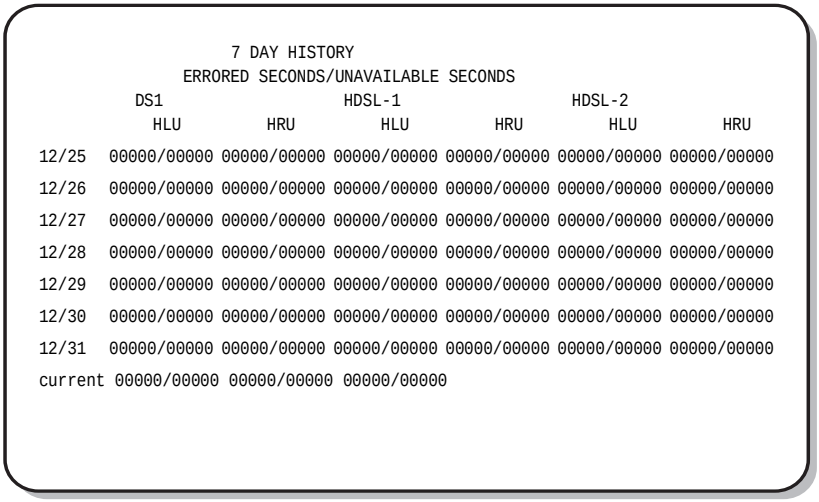
- Press P to view the previous screen.
- Press N to view the next screen.
- Press E to exit.
- Press S to view the next available span.

View Performance History

The View Performance History screen shows the number of ES and UAS occurrences in 24-hour increments for a seven-day period. The presentation format is: ES/UAS for the HLU and the HRU-412 for the DS1 signal, HDSL Loop 1 and HDSL Loop 2 (for non-doubler applications). For doubler applications, the available View Performance History screens displayed are dependent upon the configuration (one doubler or two doublers).

Non-Doubler Applications

Press F from the Maintenance Terminal Main menu to open the Performance History screen for non-doubler applications.



```
                    7 DAY HISTORY
               ERRORED SECONDS/UNAVAILABLE SECONDS
          DS1                  HDSL-1                  HDSL-2
            HLU         HRU         HLU         HRU         HLU         HRU
12/25  00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
12/26  00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
12/27  00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
12/28  00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
12/29  00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
12/30  00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
12/31  00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00000/00000 00000/00000 00000/00000
```

Figure 17. *Performance History Screen (Non-Doubler)*

Doubler Applications

HDU 1 (one doubler) and HDU2 (two doublers) appear in the Performance History screen for doubler applications.

Two Doublers, Span 3 Performance Data

Press **S** again to view the Span 3 Performance Data screens (two doublers):

```
Date: 03/06/98        SPAN 3 PERFORMANCE DATA
CIRCUIT ID#:
          ERRORED SECONDS/UNAVAILABLE SECONDS
               DS1             HDSL-1            HDSL-2
          HLU      HRU     HDU2      HRU     HDU2      HRU
21:15    000/000  000/000  000/000  000/000  000/000  000/000
21:30    000/000  000/000  000/000  000/000  000/000  000/000
21:45    000/000  000/000  000/000  000/000  000/000  000/000
22:00    000/000  000/000  000/000  000/000  000/000  000/000
22:15    000/000  000/000  000/000  000/000  000/000  000/000
22:30    000/000  000/000  000/000  000/000  000/000  000/000
22:45    000/000  000/000  000/000  000/000  000/000  000/000
23:00    000/000  000/000  000/000  000/000  000/000  000/000
23:15    000/000  000/000  000/000  000/000  000/000  000/000
23:30    000/000  000/000  000/000  000/000  000/000  000/000
23:45    000/000  000/000  000/000  000/000  000/000  000/000
00:00    000/000  000/000  000/000  000/000  000/000  000/000
00:15    000/001  000/000  000/000  000/000  000/000  000/000
00:30    000/000  000/000  000/000  000/000  000/000  000/000
00:45    000/000  000/000  000/000  000/000  000/000  000/000
01:00    000/000  000/000  000/000  000/000  000/000  000/000
               (E)xit (P)revious (N)ext (S)pan
```

Figure 18. *Two Doublers, Span 3 Performance Data Screen*

The presentation format is: ES/UAS for the HLU and the HRU-412 DS1 signal, and ES/UAS for the HDU2 and the HRU-412 over both HDSL Loop 1 and HDSL Loop 2.

You can do the following:

- Press **E** to exit.
- Press **S** to view the next available span.

View Alarm History

The View Alarm History screen allows you to view alarms that are currently active.

Non-Doubler Applications

Press G from the Maintenance Terminal Main menu to view the Alarm History screen for non-doubler applications:

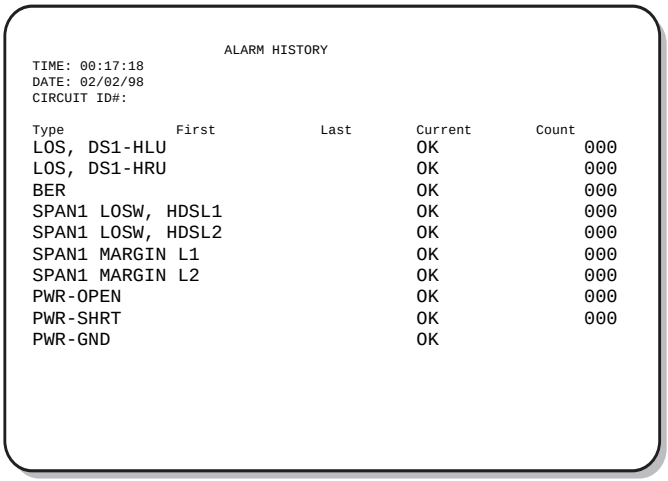


Figure 19. *Alarm History Screen (Non-Doubler)*

Table 10 lists the Alarm History fields and descriptions. These descriptions apply to the Alarm History for doubler applications as well.

Table 10. *Alarm History Fields and Descriptions*

Field	Description
Type	Identifies the type of alarm
LOS, DS1-HLU	First and last instance of LOS at the HLU; Current condition, number of alarms
LOS, DS1-HRU	First and last instance of LOS at the HRU; Current condition, number of alarms
Span 1 LOSW, HDSL1	First and last instance of LOSW on HDSL1; Current condition, number of alarms
Span 1 LOSW, HDSL2	First and last instance of LOSW on HDSL2; Current condition, number of alarms
BER	The user-selected BER setting of 10^{-7} 10 -8 has been executed.
Span 1 ES, HDSL2	First and last instance of ES on HDSL2; Current condition, number of alarms
Span 1 Margin L1	First and last instance of exceeded margin on Loop 1; Current condition, number of alarms
Span 1 Margin L2	First and last instance of exceeded margin on Loop 2; Current condition, number of alarms
PWR Open	Power condition: Open or Closed
PWR SHRT	Power short condition
PWR-GND	A ground fault has been detected on one of the HDSL loops connected to the remote unit.
Last Cleared: None	Last time Alarm History cleared

You can do the following

- Press U to update the screen.
- Press S to view another span.
- Press E to exit from the Alarm History screen.

Doubler Applications

Depending upon the doubler configuration, Spans 1, 2 and 3 appear in the Alarm History screen using similar fields as shown in Table 11. The Span 2 Alarm History screen displays for one doubler applications, and the Span 3 Alarm History screen displays for two doubler

Two Doublers, Span 3 Alarm History

Press S from the Alarm History screen to view the Span 3 Alarm History screen:

```
Time: 01:17:41                    7 DAY HISTORY
CIRCUIT ID#:
                              SPAN 3
                ERRORED SECONDS/UNAVAILABLE SECONDS
                DS1                    HDSL-1                  HDSL-2
          HLU         HRU        HDU2         HRU        HDU2         HRU
02/27 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
02/28 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
03/01 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
03/02 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
03/03 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
03/04 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
03/05 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00010/00000

                                (E)xit (S)pan
```

Figure 20. *Two Doublers, Span 3 Alarm History*

You can do the following:

- Press U to update the screen.
- Press S to view another span.
- Press E to exit from the Alarm History screen.

Inventory Screen

Press H to select the System Inventory screen. It lists each circuit module by model and version number.

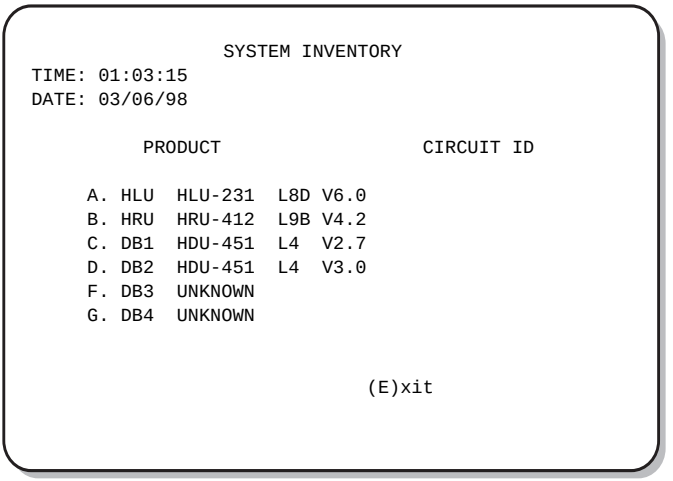


Figure 21. *System Inventory*

The circuit ID assigned to each module at the HLU is also displayed.

Loopback Menu

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

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

In all instances, press **D** from the Maintenance Terminal Main Menu to display the Loopback Menu. Figure 22 shows an example of a Loopback Menu when no doublers are present; Figure 23 shows an example when four doublers are present.

Loopback Menu: No Doubler

Figure 22 shows the Loopback Menu when no doublers are present.

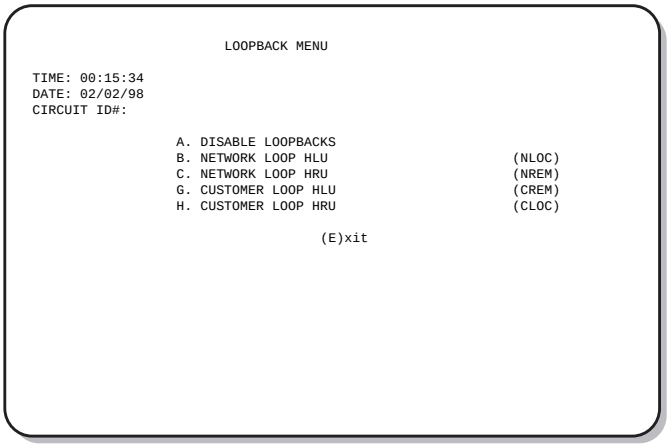


Figure 22. *Loopback Menu: No Doubler*

Loopback Menu: Four Doublers

Figure 23 shows the Loopback Menu with four doublers.

```
                              LOOPBACK MENU
TIME: 00:03:33
DATE: 02/02/98
CIRCUIT ID#:

A. DISABLE LOOPBACKS
B. NETWORK LOOP HLU (NLOC)     M. NETWORK LOOP DOUBLER 4   (NDU4)
C. NETWORK LOOP HRU (NREM)     N. CUSTOMER LOOP DOUBLER 4  (CDU4)
D. NETWORK LOOP DOUBLER 1  (NDU1)
F. NETWORK LOOP DOUBLER 2  (NDU2)
G. CUSTOMER LOOP HLU       (CREM)
H. CUSTOMER LOOP HRU       (CLOC)
I. CUSTOMER LOOP DOUBLER 1 (CDU1)
J. CUSTOMER LOOP DOUBLER 2 (CDU2)
K. NETWORK LOOP DOUBLER 3  (NDU3)
L. CUSTOMER LOOP DOUBLER 3 (CDU3)

                                   (E)xit
```

Figure 23. *Loopback Menu with Four Doublers*

Initiating a Loopback

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

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

A series of dots moves from left to right indicating that the command has been issued. When this process completes, the system returns to the Maintenance Terminal Main Menu. The selected loopback four letter designation now appears in the Loopback Mode field in the Maintenance Terminal Main Menu (see Figure 8 in which an NLOC loopback is in progress). The loopback continues to cycle in the system depending upon your Loopback Timeout setting.

Disable Loopbacks

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

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

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

Remote Logoff

Press **I** from the Remote Terminal Main Menu to log off from the system. The Remote Logoff screen displays indicating that you have logged off from the remote unit.

LOOPBACK DESIGN DESCRIPTION

Loopbacks permit you to perform a isolated diagnostic tests on specific areas of the circuit. The transmitted signal is returned to the sending device after passing through a data communications link or network. This allows you to compare the returned signal with the transmitted signal and to determine if there is a problem with the circuit. Ideally, personnel performing loopback testing are in direct communication with each other in order to correlate messages displayed at both the remote unit and HLU during the test. Figure 9 shows the loopback diagram (see the View Span Status paragraph of the Maintenance/Remote Terminal section for a comprehensive description of loopback messages).

HiGain supports a variety of Special Loopback (SPLB) modes. Refer to the HLU practice for details regarding the SPLB functions.

The HRU 412 List 9B responds to the Query command of SPLB modes A1LB, A2LB and A5LB with an error burst every 10 seconds. This is twice the normal rate of an error burst period of 20 seconds found in other remote units. This is due to the fact that both the HDSL section and the ADA sections of the remote unit are responding to are same Query commands.

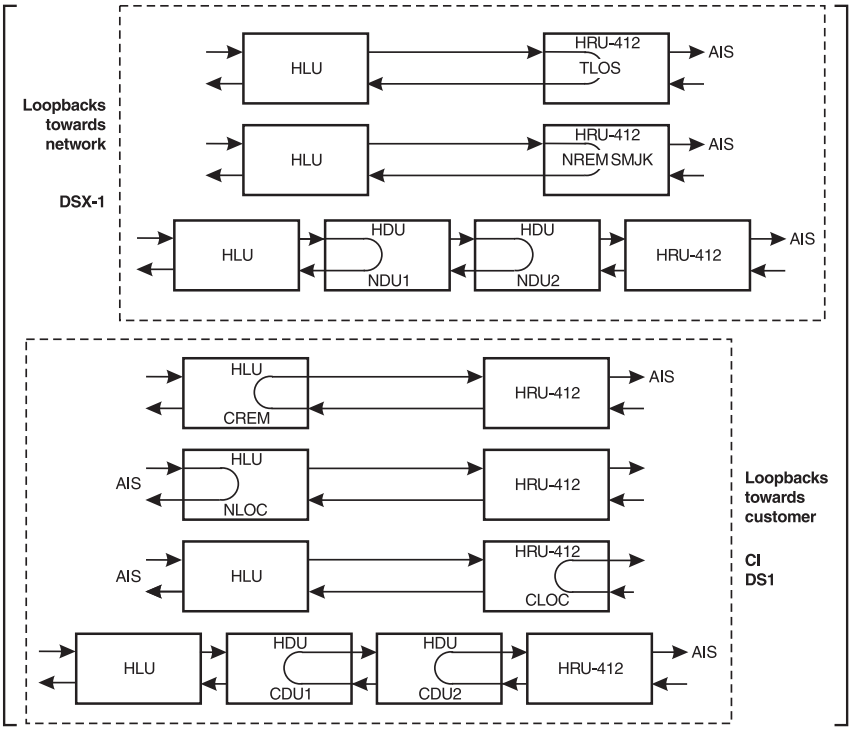


Figure 24. *HiGain System Loopbacks*

HRU Loopbacks

The HRU loopbacks are:

- Network Remote (NREM): The DSX-1 signal is looped back to the DSX-1 at the remote unit.
- TLOS: The DSX-1 signal is logically looped back to the DSX-1 at the remote unit when the Remote's DS1 input signal is lost. Request the TLOS option to be evaluated.
- SmartJack (SMJK): Loopback at the remote unit towards the network initiated by a 2 in 5 in-band loopback code or out of band ESF data link code.
- Customer Local Loopback (CLOC): Signal from CI is looped-back to customer at HRU-412.

HLU Loopbacks

The HLU loopbacks are:

- Network Local Loopback (NLOC): The DSX-1 signal is looped back to the DSX-1 at the HLU.
- Customer Remote Loopback (CREM): Signal from the customer is looped back to the customer at the HRU.

The SmartJack loopback shown in Figure 24 are the standard NID metallic loopback. It has two modes of operation as determined by the SAIS user option settings at the HLU (ENA or DIS). The ENA option causes the HRU to transmit the AIS signal towards the CPE. The DIS option turns off the AIS/CPE signal. To send the AIS pattern to the CI during SmartJack or NREM loopbacks, set the SAIS to ENA.

SAIS Set to ENA

Upon detection of a valid SmartJack loopback command, a metallic loopback relay (see Figure 37) is energized and the T1 interface chip transmits the AIS pattern to the CPE and also back to the HRU-412 T1 receiver circuit. In addition, the customer's T1 XMT input is disconnected and terminated into 100 Ω. The AIS pattern is examined by the HRU for its overall integrity. This pre-looped test lasts for about 100 ms and terminates in one of the following two conditions:

- Pre-loop Failed - If the transmit and receive AIS patterns do not match, a problem in the HRU is indicated and HiGain declares an HRU PRE-LOOPBACK FAIL condition. This terminates the loopback test and returns the HRU to its unlooped normal state. This indicates a defective HRU.
- Pre-loop Passed - If the transmit and receive patterns match, the system declares an HRU Pre-loop Passed condition. All active circuits are working. The metallic loopback relay remains closed and, in addition, enables a logic loopback within the remote unit. This logic loopback is required in order to present the AIS pattern to the NI and at the same time to loop the signal being received from the network back towards the network. This puts the HiGain system in its AIS/ENA SmartJack loopback state. It remains in this state until a loopdown command is detected or the default time out period (if enabled) expires.

When the remote unit is in its AIS/ENA SmartJack metallic loop back state, its 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 being monitored since its input circuit has been opened and terminated into 100Ω. This forces the FRM LED off, the LOC LOS LED off and the Code LED to indicate AMI if the HLU Code option is set to either AUTO or AMI. The HRU-412 LED indicates B8ZS if the Code option is set to B8ZS.

SAIS Set to DIS

This metallic loopback state is initiated in the same manner as when the ENA option is chosen. However, once initiated, the AIS signal is not sent to the CPE. Instead the network signal is sent both towards the CPE and through the relay back towards the network. As before, the customer's T1 transmit input port is opened and terminated into 100Ω. No logic loopback is required since the relay is performing the network signal loopback function. This simple metallic loopback state remains until a loopdown command is issued or the default timer (if enabled) expires.

When the remote unit is in its AIS/DIS SmartJack metallic loop back state, its T1 input LOS, Code and Frame monitoring circuits are connected to the network's signal which is being looped back to these circuits through the 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 and LOC LOS LED indicate the status of this signal from the network. The Code LED also indicates the code (AMI or B8ZS) of this signal if the Code option is set to AUTO. It indicates AMI or B8ZS if the Code option is set to either AMI or B8ZS respectively.

All of the remote unit loopbacks towards the network (NREM and SMJK) are metallic/logic (AIS/ENA) or metallic only (AIS/DIS). The SMJK and NREM loopbacks are identical. They differ only in how they are initiated. The SMJK identifying label indicates that the loopback was initiated by the 3 in 5 in band command. NREM is used to indicate that the metallic loopback was initiated by other than the 3 in 5 command (3 in 7, 16 bit addressee repeater commands or front panel push-button).

The remote unit front panel loopback (LB) button can be used to terminate any HRU loopback, irrespective of how it was initiated.

Loopback Test Procedures

Testing of your HiGain system allows you to verify the integrity of the HDSL channels to the HLU as well as the DS1 channels to the customer and the HLU DSX-1 interface. While the HRU-412 displays system condition messages at the Remote and Maintenance Terminals, and via color-coded LED displays on the front panel, the HLU displays system conditions via four-character LCD messages. To facilitate test messaging with CO test personnel, HLU Front Panel Display Messages are provided in Table 11.

If there is any trouble at the T1 interface, verify that the unit is making a positive connection with the mounting assembly connector.

1 Press the loopback LB button on the remote unit front panel for at least five seconds.

2 Verify that the Green remote unit front panel loopback LB NET LED turns on, indicating that the it is in its digital (NREM) loopback state. Also verify, if possible, that the remote unit displays the message NREM, which also indicates that it is in loopback.

3 Have the CO tester transmit a T1 test signal into the HLU and measure that the returned (looped) signal is error free.

4 If the above test fails, remove the remote unit from its loopback state by again pressing the loopback button for five seconds. Verify that the loopback NET LED is off.

5 Have the CO tester send the remote unit (4 in 7) in-band loop-up (NLOC) for five seconds. Verify that the HLU displays the message NLOC indicating that the HLU is in its network loopback state.

6 Repeat Step 3. If the test passes, the problem is in the cable pair or the remote unit. If it fails, the problem is at the CO.

7 If the I-CPE 60 mA switch option is set to 60 mA, verify that the external NID is under power and that the voltage across the front panel “60 mA MON” test points measures between 55 and 65 mV. This indicates that the CPE current is between 55 and 65 mA. The external NIDs Loop Power option must be set to its THRU position when powered by the remote unit.

8 If the sealing current option is enabled (JP2 connected), insert a milliampmeter in service with the Tip or Ring of either HDSL pair and verify that at least 20 mA of sealing current is flowing.

When T1 loopback tests are made using external metallic loopback connections at either end, the DS1 code at the metallic loopback interface may be different from the DS1 code being received at the opposite end when the DS1 user option is set to AUTO. For example, if the remote unit has a metallic loopback, and the HLU's receive pattern's code is changed from AMI to B8ZS, and then the all 0 pattern is sent into the HLU, the HRU-412 remains in its AMI mode and thus loops all 0's. This causes the remote unit to indicate a LOS condition which then causes the HLU to output the AIS pattern.

Table 11 lists and describes the messages seen on the front panel display of the HLU that is connected to the remote unit.

Table 11. *HLU Front Panel Display Messages*

Message	Name	Description
CREM	Customer Remote Loopback	Signal from customer is looped back to customer at the HLU.
NLOC	Network Local Loopback	DSX signal is looped back to DSX at the HLU.
CLOC	Customer Local Loopback	Signal from customer is looped back to customer at the remote unit.
SMJK	Remote SmartJack Loopback	Signal from DSX is looped back at remote unit by its SmartJack.
FERR	Framing Bit Error Occurred	Framing bit error occurred at HLU T1 input.
LBPV	Local Bipolar Violation	A bipolar violation received at the T1 input to the HLU.
SIG 1 or 2	Signal 1 or Signal 2	The HLU and remote unit transceivers are attempting to establish contact.
ACQ 1 or 2	Acquisition 1 or Acquisition 2	The HLU and remote unit multiplexers are trying to establish synchronization over each loop.
H1ES	HDSL CRC Error Loop 1	At least one CRC error on HDSL Loop 1 in last second.
H2ES	HDSL CRC Error Loop 2	At least one CRC error on HDSL Loop 2 in last second.
ARM	HiGain System ARMED	Armed to respond to Intelligent Repeater Loop Codes.
ACO	Alarm CutOff	A MNRALM has occurred, and been retired to an ACO condition, by pressing the Sel button on the HLU front panel.
SELF TEST	Self Test mode	HLU is in self test mode. This occurs every power On/Off cycle.
ALRM	Alarm Condition Exists	A minor alarm MNRALM condition is in effect.
1=xx or 2=yy	HDSL Loop Margins	Indicates the power of the received HDSL signal on each Loop relative to noise. Any value of *06* or greater is adequate.
PWR FEED SHRT	Power Feed Short	Indicates a short between the two HDSL pairs. This same message can occur with a remote unit that is drawing the correct amount of power over good cable pairs, but is not communicating with the HLU.

Table 11. *HLU Front Panel Display Messages (Cont.)*

Message	Name	Description
PWR FEED OPEN	Power Feed Open	Indicates an open circuit in the Tip and Ring of either HDSL pair.
PWR FEED OFF	Power Feed Off	HDSL span power has been turned off by setting the PWFD option to DIS.
PWR FEED GRD	Power Feed Ground	One of the HDSL loops has been grounded.
BER	Bit Error Rate	A system BER alarm is in effect.
BAD RT?	No response from HRU	The HLU does not receive any response from the remote unit.
VER	HLU Software Version #	Displayed during the System Settings review mode by pressing the Mode button at the HLU for three seconds.
LIST 0xL	HLU's List #	Displayed during System Settings review mode defined above.
FRM	Frame:SF,ESF,UNFR,NONE	Defines the type of frame pattern being received from the DSX-1. Displayed during System Settings mode defined above.
CODE	Line Code: AMI, B8ZS	The line code that the HLU is set to receive and transmit at its DSX-1 interface. Displayed during System Settings mode defined above.
LOSW	Loss of Sync Word	One of the HDSL loops has lost synchronization. Causes minor alarm.
LLOS	Local Loss of Signal	No signal detected at the T1 input to the HLU. Causes minor alarm.
RLOS	Remote Loss of Signal	No signal is detected at the T1 input to the remote unit. Minor alarm.
DS1	DS1 BPV errors	Indicates that the number of BPVs at the HLU and HRU DS1 inputs that have exceeded the 24 hour ES threshold. Causes minor alarm.
DS0	DS0 Blocked Channels	Indicates status of DS0 blocked channels. NONE indicates no channels are blocked. BLK indicates some channels are blocked.
MAL1 MAL2	Margin Alarm Loop 1 or 2	The margin on HDSL loop 1 (2) has dropped below the threshold (1 to 15 dB) set by you.

SPECIAL PM AND TEST FEATURES

In addition to the standard features of the HRU-412 List 9B, its functionality has been enhanced to produce unique Performance Monitoring (PM) and testing capabilities. These enhancements are the result of a joint design effort between PairGain and ADA.

GENERAL PM APPLICATIONS

The remote unit can be installed individually or in pairs. When installed individually, or on one end of a T1 circuit, the remote unit provides the following special network benefits:

- Real-time performance monitoring of DS1 signals in both directions of transmission
- Nonintrusive access to real-time performance monitoring data (CPE provided ESF signal)
- On demand front panel, inband or FDL access to stored DS1 PM data including:
  - Sectionalized Events
  - Blockage Indicator
  - ANSI 15-minute and 24-hour statistics
- AIS-CI Insertion toward the network upon detection of incoming LOS or AIS at the network interface
- RAI-CI insertion toward the network upon receiving RAI from the CPE if the signal from the network is not impaired (for CPE-ESF formats only)
- Loopback toward the network with AIS insertion to the CPE equipment

When adding another PairGain or ADA remote unit at the far-end of the DS1 circuit or with the inclusion of a T3AS or other equivalent performance monitoring system in the data path, the remote unit provides all of the benefits mentioned above in addition to the following:

- Adaptive frame format conversion
  - SF to ANSI T1.403 ESF
  - Non-standard to standard ANSI T1.403 ESF (i.e. addition of remote units)
  - AT&T PUB 54016 to ANSI T1.403 ESF (i.e. addition of remote units without interference with the 54016 poll response)
- Nonintrusive access to real-time performance monitoring data (CPE provided SF or ESF signal)

Network Elements (NEs) such as ADAs T3AS Test and Performance Monitoring system can be used to collect the performance monitoring data to allow full-time surveillance of the DS1 signal. By installing T3AS at a network boundary (e.g., interexchange carrier (IEC) point of presence (POP), and a remote unit at the network interface, the LEC can monitor the performance of its portion of the network, and rapidly sectionalize circuit problems. By sectionalizing problems in its network the LEC can know what trouble exists and who is responsible without external involvement.

SUMMARY OF PM FEATURES

The remote unit has the following PM and test features.

Alarm Indicating Signal-Customer Interface (AIS-CI)

This is a new AIS-CI signal that is sent to the network from the HLU DSX-1 interface. It indicates an LOS or AIS signal is being detected at the DS1 interface to the remote unit. This feature is non-provisional and is supported for all operating modes of the remote unit.

Remote Alarm Indication-Customer Interface (RAI-CI)

This is a new RAI-CI signal that indicates an RAI message is being received at the DS1 interface to the remote unit while the signal from the network is without defects. This feature is non-provisional but it is only available when the network signal is being received in ESF frame format.

SuperFrame Remote Indication Signal (SF-RAI)

This is a new SF-RAI user option that is set by a switch located on the remote unit's printed circuit board. It causes a network ESF RAI/Yellow Alarm signal detected in the FDL to be converted into an SF-RAI formatted signal (bit 2 = 0 in all time slots) towards the CI when the CI DS1 payload is in the SF frame format mode.

Real-Time Reporting of PRM and SPRM

When evaluating T1 span integrity using an operational support system such as ITS, NIMA, SARTS, REACT or CMTS, the remote unit provides performance monitoring data that can be observed using standard operating procedures.

Refer to your company's corporate practices for specific instructions on the retrieval and interpretation of performance monitoring statistics using the OSs installed within your network.

The remote unit will function with any network element with PM capability that provides detection of ANSI T1.403 standard ESF Performance Report Messages (PRM). The remote unit transmits ANSI ESF, CRC errors and other performance monitoring data detected at one end of a circuit to the other end of the circuit in PRM transmitted over the Facility Data Link (FDL). Using properly equipped test devices, performance data for both directions of transmission can be read at any point in the circuit and can be used to calculate performance parameters and statistical information regarding that specific circuit.

The remote unit monitors the integrity of its network and CI T1 input payloads in real time, converts this information into PRM and SPRM which are sent towards the network. This feature is automatic and only occurs under certain operating conditions.

On Demand Reporting of Performance Data

The remote unit stores errors and alarms as Sectionalized Events (SEs) and Performance Primitives (PPs), then calculates a Blockage Indicator (BI) parameter. SEs isolate error and alarm conditions to the circuit leg with time of occurrence. With SEs, troubles are pin-pointed without complicated and time-consuming troubleshooting techniques. Up to 100 of the most recent events are stored. PPs are stored for 24 hours in 15-minute registers, and for 7 days in 24-hour registers.

The BI calculates the overall circuit availability in both directions and stores this data for the current hour and three previous hours. BIs are calculated as a function of UAS, SES and ES received at the two T1 ports at the remote unit. These indicators and other performance monitoring data are displayed in a special new set of screens available at the remote unit craft port. BIs can be sent to a remote test center, via coded inband bit error bursts or FDL messages, upon request from the test center. In addition, PM options can be set from the network and test patterns sent toward the network upon request from the network.

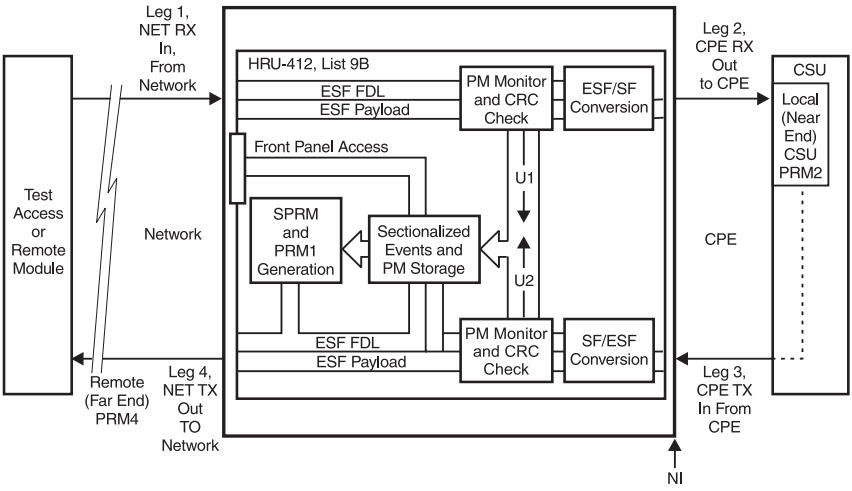


Figure 25. *Remote Unit PM Block and Network System Diagrams*

Figure 25, is a network system block diagram that will be referred to as these remote unit features are discussed.

ALARM INDICATION SIGNAL-CUSTOMER INTERFACE

The Alarm Indication Signal-Customer Interface (AIS-CI) is a variation of the ANSI T1.403 AIS signal (unframed all ones), and is intended to specifically indicate a loss of signal from the customer installation. AIS-CI meets the T1.403 requirements for AIS so that equipment which does not support detection of AIS-CI will still detect AIS.

The AIS-CI signal is a repetitive interleaving of 1.11 seconds of an unframed all ones pattern and 0.15 seconds of all ones modified by the AIS-CI signature. The AIS-CI signature is a repeating 6176 bit pattern in which bit numbers 3088, 3474 and 5790 are set to zero.

The CPE signal may be in either SF or ESF format.

To prevent the HLU from transmitting its AIS signal, which would interfere with the AIS-CI signal being sent from the remote unit, a local remote unit LOS condition is not transmitted to the HLU. Thus the HLU does not indicate an RLOS alarm status when this condition exists.

The ADA T3AS Test and Monitoring System is capable of detecting AIS-CI.

REMOTE ALARM INDICATION-CUSTOMER INTERFACE

The Remote Alarm Indication-Customer Interface (RAI-CI) is a variation of the ANSI T1.403 ESF bit patterned RAI/Yellow Alarm message, and is intended to specifically indicate that RAI has been detected in the signal from the CI when no defect or failure is detected in the signal from the network. RAI-CI meets the T1.403 requirements for RAI so that equipment which does not support detection of RAI-CI will still detect RAI.

The RAI CI is only transmitted if the following conditions exist:

- The RAI -Yellow Alarm is being received from the CI in either the SF or ESF frame format
- The T1 payload being received is error free.
- The network signal is using the ESF frame format.

The RAI-CI signal is identical to the T1.403 ESF bit patterned RAI/Yellow Alarm message except that for a period of 90 milliseconds, every 1.08 seconds, the standard RAI pattern of "0000000011111111" is replaced by "0011111011111111." The transmit directions are from right to left.

The ADA T3AS Test and Monitoring System is capable of detecting RAI-CI.

Please refer to the following documents for more information on all the performance monitoring and test features: ANSI T1.403 and ANSI T1.231-1997. Model 2011 List 2 Remote Model User Guide ADA #02-0210-4500.

SUPERFRAME-REMOTE ALARM INDICATOR

If the ESF signal from the network contains the bit-patterned RAI/Yellow Alarm message in the ESF Facilities Data Link (FDL), and the signal to the CI is in the SF format, then SF format RAI/Yellow Alarm (bit 2 = 0 in all time slots), signal will be sent towards the CI if the SuperFrame - Remote Alarm Indicator (SF-RAI) option switch, described in the User Options part of the Installation section, is enabled.

REAL TIME REPORTING OF PRM AND SPRM

The unique performance monitoring features of the HRU-412 List 9B provide the functionality of the Genius Jack, an intelligent Network Interface Unit (NIU) that provides nonintrusive, real-time performance monitoring and sectionalizing of DS1 circuits and standard loopback functionality. The Genius Jack is installed at the NI between the local exchange carrier and the customer premise networks.

SF to ESF Frame Format Conversion

The remote unit, in conjunction with a similar HRU-412 List 9B remote unit or an ADA remote unit connected at the far end of the circuit, performs frame format conversion. In this mode the network side of the remote unit operates in the preferred ANSI T1.403 ESF with PRM while the customer premises side continues to operate in the SF frame format provided by the CPE. Frame format conversion extends the benefits of ANSI ESF and PRM to all network elements. Such benefits allow service affecting faults to be isolated to either the networks, CPE or to the transmit or receive paths within the networks or CPE.

The HiGain and ADA remote units are equipped with patented and robust auto frame capabilities which enable them to be installed sequentially and to begin proper operation without additional site visits or special coordination. The units auto provision to frame format conversion after detecting installation of a second remote unit at the distant end of the circuit. If no compatible Remote unit is detected, the HRU-412 becomes transparent to its input frame patterns and SF to ESF frame format conversion is inhibited.

A pair of such units is transparent to the CPE. Incoming network signals are returned to their original format before hand-off from the service provider. The CPE has no access to ESF formatted signals if ESF formatted signals are not provided to the network. Frame format conversion and the addition of the FDL maintenance channel do not affect the payload data or signal integrity. Unframed signals are passed by the remote unit without modification.

Table 12 lists the six possible frame combinations that can occur at the remote unit Leg 1 and Leg 3 T1 input ports (see Figure 24) and the response of the remote unit to each of them. In all but Mode 5, the remote unit transmits PRM or SPRM toward the network on Leg 4.

Frame Bit Error Transparency

The remote unit passes through Frame Bit Errors (FBE).

When frame format conversion is being performed, it may not be possible to transfer all the received SF FBEs to the outgoing ESF stream.

FBE pass-though is performed whether or not frame format conversions are being performed.

Performance Report Messages

ANSI T1.403 PRM are 13-byte message-oriented signals sent once per second in the ESF DL and provide an indication of the quality of the signal from the network at the network interface.

If the signal from the CPE does not contain PRM, as in Modes 1, 2 and 3 in Table 12, then the remote unit generates PRM and inserts them into the FDL of the signal towards the network. SPRM are generated in all modes except Mode 5.

Table 12. *Network vs. CPE Frame Format Modes*

	Remote Unit Input Signal Format		**PM Data Sent Towards Network**		
Mode No.	**From CPE**	**From Network**	**Parameter Generated by remote unit from Network Signal Quality**		**Parameter Generation by remote unit from CPE Signal Quality**
			PRM	U1	U2
1	SF	ESF-ANSI with PRM	Yes	No	FE, BPV or EXZ
2	ESF without PRM	ESF-ANSI with PRM	Yes	No	CRC-6, FE, BPV or EXZ
3	ESF with AT&T ESF	ESF-ANSI with PRM	Yes	No	CRC-6, FE, BPV or EXZ
4	ESF-ANSI with PRM	ESF-ANSI with PRM	No	Yes, CRC-6, FE or EXZ	CRC-6, FE, BPV or EXZ
5	SF	SF	No	No	No
6	Unframed	Unframed ESF-ANSI with PRM	Yes	No	BPV or EXZ

PRM generation by the remote unit does not interfere with AT&T Pub 54016 poll and response messages generated by the CPE in Mode 3.

Commonly available network elements and test equipment are capable of reading PRM and providing both real-time and historical performance information.

Supplemental Performance Report Messages

Supplemental Performance Report Messages (SPRM) make use of the normally unused U1, U2 and R bits of the PRM, and provide a means for test equipment to sectionalize circuit failures or impairments. SPRM are generated by the remote unit when the PRM are either being generated by the remote unit's Modes 1, 2 or 3, or when PRM are present in the signal from the CI, Mode 4.

The U1 bit in Mode 4 is set in a PRM in the event that one or more CRC-6 errors or framing errors were detected by the remote unit in the signal from the network since the last PRM was transmitted. In the instance where PRM are present in the signal from the CI (Mode 4), the U1 bit is used in lieu of remote unit generated PRM to identify impairments or faults in the signal from the network.

The U2 bit is set in a PRM in the event that one or more CRC-6 errors, framing errors, BPVs or excessive zeros (EXZ) were detected by the remote unit in the signal from the CI, since the last PRM was generated.

Examination of PRM and SPRM generated by the remote unit allows the technician to isolate the fault to a maximum of two. Most often however, the technician will isolate the fault to one leg.

The R bit is used to provide further information about HRU-412 operation, as defined in Table 13.

Table 13. *R-Bit Patterns*

R-bit Pattern	Description
11111111	The HRU-412 is generating PRM
10001000	The HRU-412 is passing through PRM at the CI
10101010	An HRU-412 hardware fault has been detected
00000000	No HRU-412 List 9B or equivalent ADA Remote model is installed or the PRM and SPRM generating functions are disabled.

The Applied Digital Access (ADA) T3AS Test and Monitoring System is capable of processing SPRM. Please refer to the ADA application note (23-0000-0002) for more information on SPRM. You can reach ADA at (800) 854-2242.

Mode Analysis and SF/ESF Conversion

The following section describes the various modes and SF/ESF conversions.

Mode 1: CPE = SF: Network = ESF ANSI

In Mode 1 of Table 12, the signal from the CI is in SF format and the network signal is ANSI ESF. This indicates the presence of a comparable PRM generation module at the other end of the circuit. The remote unit converts the signal to ESF format and enhance it with PRM and SPRM it generates from the T1 signal it receives from the network prior to transmission to the network. In this case, the ESF signal from the network is converted to SF prior to transmission to the CI.

Table 14 shows how the data from this Mode is used to sectionalize unit problems.

PRM1 in Figure 25 are PRM generated by the remote unit that measure the integrity of the incoming signals on Leg 1. PRM2 or PRM generated by the CSU that measure the integrity of the incoming CSU signal on Leg 2. PRM4 are PRM generated by the far end Test Access or remote unit that measures the integrity of their incoming signal on Leg 4.

Mode 2: CPE = ESF without PRM: Network = ESF ANSI

The remote unit's response is the same as in Mode 1 except that CRC-6 monitoring is now available and is used by the U2 bit to measure the integrity of the CPE signal. Table 14 shows how the data from this Mode is used to sectionalize unit problems.

Mode 3: CPE = ESF per AT&T Pub 54016: Network = ESF ANSI

AT&T ESF allows for path commands and responses in the FDL. Because the path commands and responses are typically infrequent and the FDL path is otherwise unused for AT&T ESF, AT&T ESF (Mode 3) and ANSI without PRM (Mode 2) are treated as equivalent by the remote unit. Table 14 also shows how the data from this Mode is used to sectionalize circuit problems.

Mode 4: CPE = ESF-ANSI: Network = ESF-ANSI

In this mode the remote unit does not generate any PRM. It simply passes the PRM through but adds the SPRM information. If a remote unit or ADA equivalent module is present at the far end of the circuit, it will remove SPRM from the PRM data sent to the CPE.

Table 15 shows how the data from this Mode is used to sectionalize circuit problems.

Mode 5: CPE = SF: NET = SF

No special performance monitoring or fault isolation can be done in this mode.

Mode 6: CPE = Unframed: NET = Unframed

No special performance monitoring or fault isolation can be done in this mode.

Table 14. *Mode 1, 2 and 3 Fault Analysis*

Error Indicating Parameter			Fault Location
Locally Generated (Near End, HRU) PRM1	Remotely Generated (Far End) PRM4	U2	
BAD	X	X	NET - Leg 1
X	X	BAD	CPE - Leg 3
X	BAD	GOOD	NET - Leg 4
X	BAD	BAD	CPE - Leg 3 and possibly NET Leg 4
X = Don't care			

Table 15. *Mode 4 Fault Analysis*

Error Indicating Parameter				Fault Location
U1	Remote (Far End) PRM 4	U2	Locally Generated (near end, CSU PRM2)	
BAD	X	X	X	NET - Leg1
Good	X	X	Bad	CPE-Leg2
X	BAD	BAD	X	CPE - Leg3 and possibly NET - Leg 4
X	BAD	GOOD		NET Leg 4
X = Don't Care				

ON DEMAND REPORTING OF PERFORMANCE DATA

In applications where real time performance monitoring is not available, the remote unit provides remote, on-demand access to stored PM information. The primary data stored by the remote unit are Sectionalized Events (alarms and payload errors).

These events can be retrieved via local craft port access, standard test and maintenance procedures and, when the ESF FDL is available, they can be retrieved using FDL transported TL1 commands.

On-demand Reporting extends the benefits of real time PM to SF circuits and ESF circuits without a real time, in-line T3AS or other similar PM collecting device. In these applications, the remote unit continues to monitor the performance of DS1 circuits in both directions of transmission, but stores the PM data internally. Then, as the need arises for PM information on the circuit, the data can be retrieved remotely via standard inband or FDL test and measurement techniques. The data is available locally via the front access panel.

Monitored Events

The alarms and failures which can be monitored by the remote unit depend on the frame formats of the signals from the network and from the CPE. Failures and errors are recorded directly by observation of the signals from the CPE. Failures and errors in the signals transmitting away from the remote unit toward the network and the CPE are determined by inferences from other measurements. For the purposes of this section, the circuit legs interfacing the remote unit to the DS1 line are labeled as shown in Figure 25.

Performance primitives and additional information are collected from legs 1 and 3 as shown in Table 16.

Table 16. *Performance Primitives measured by the Remote Unit*

Circuit Leg	Alarms	Errors
NET Rx (IN)	LOS	BPV
Leg 1	AIS	EXZ
	OOF	FE (SF)
	DS1 idle	CRC6 (ESF)
		PRM Parameters
CPE Tx (IN)	LOS	BPV
Leg 3	AIS	EXZ
	OOF	FE(SF)
	DS1 idle	PRM Parameters

This information is used to develop performance and alarm statistics for all four legs as described in the following sections.

STORED SECTIONALIZED EVENTS

Following are definitions of sectionalized events along with access, retrieval and clearing information.

Sectionalized Event Definitions

The information described in Table 17 is collected by the remote unit and is used to tally the alarm and error events for all four legs as listed in the following table.

Information on input legs 1 and 3 must be used to help determine the integrity of the less obtrusive output leg 2 and leg 4.

Table 17. *Remote Unit Sectionalized Event Parameters*

Circuit Leg	Alarms	Errors
NET Rx (IN) Leg 1	LOS AIS OOF DS1 idle	 EXZ FE (SF) CRC6 (ESF)
CPE Rx (OUT) Leg 2	RAI on Leg 3 and Leg 1 normal	PRM 2 received on leg 3 reports errors (s) and Leg 1 normal (CPE ESF only)
CPE Tx (IN) Leg 3	LOS AIS OOF DS1 idle	BPV EXZ FE (SF) CRC6 (ESF)
NET Tx (OUT) Leg 4	RAI on Leg 1 and Leg 3 normal	PRM 4 received on Leg 1 reports error(s) and Leg 3 normal network (ESF only)

Alarms and error events are recorded at the times of their occurrences and are stored along with relative time stamps. Up to 100 individual occurrences are stored by the remote unit.

Inband Retrieval of Stored Sectionalized Events

Inband retrieval of stored sectionalized events is intrusive and requires the interruption of traffic on the DS1 path. A network element or a portable test set is used to generate a command which is transmitted toward the remote unit as an unframed 11-bit repetitive test pattern. The 11-bit pattern sent requests the return of a particular event among the ten most recent events recorded.

Upon receipt of the 11-bit pattern, the remote unit transmits a framed all ones signal (FAOS) back toward the network. The remote unit changes the logic states of a predetermined number of bits in the all ones payload to zeroes to convey the requested event(s) back to the network element or portable test set. The information returned includes an identification of the alarm condition or error event along with a time stamp in minutes relative to the time of transmission of the request. Due to the limitations of this method, only certain combinations of events can be uniquely identified. However, all will be captured. Refer to your company's corporate practice for interpreting this data.

ESF DL Retrieval of Stored Sectionalized Events

Any network element which is capable of accessing the ESF DL without interrupting the DS1 payload can retrieve stored sectionalized events without interrupting customer traffic. Up to 100 events may be retrieved via the ESF DL. Full sectionalization or raw data retrieval is available in this mode.

Retrieval is initiated by transmitting the appropriate command in the ESF DL toward the remote unit. The command takes the form of an LAPB frame with a TL1 command carried in the information field. Commands are provided to retrieve various information and to retrieve any or all of the maximum of 100 stored sectionalized events.

The remote unit responds with a LAPB frame within the FDL carrying a TL1 response in the information field. The response will carry either the sectionalized events requested, the number of events currently stored by the remote unit, other information requested, or an error response indicating why the command could not be carried out as specified.

Front Panel Access to Stored Sectionalized Events

The remote unit provides nonintrusive local access to the stored PM data and sectionalized events via the front panel access. Any VT-100 terminal emulator can connect to the remote unit via a 9-Pin D-Sub connector. Once connected, the remote unit will auto-baud and presents to the user the HRU main menu shown in Figure 8. Select the ADA option H (or press TAB in doubler applications) to display a submenu of ADA screen options. These options include access to current status (last one hour of data); 24-hour and 7-day PM registers, Blockage Indicator summary statistics, and the last 100 sectionalized events. This data may be displayed in real time or downloaded for future use. See the section on Performance Monitoring Screen Displays.

Clearing of Sectionalization and PM Data

Clearing of sectionalized and PM data is also available via inband or ESF FDL commands. Refer to your company's corporate practices for specific instructions on using inband or ESF FDL commands within your network.

Blockage Indicator

Blockage Indicator (BI) is a quality of service (QoS) summary statistic which provides a quick indicator of circuit performance. The BI weights and averages PM primitives to give a relative index of performance for each leg of transmission (NET Rx or CI Tx).

BI is calculated using the following formula:

BI = [(UAS + .4 SES+.2 ES) / MON†] x 100

where:	BI = 0%	indicates the circuit leg is clean.
	BI = 99%	indicates that the circuit leg is out of service.
	0% <BI<99%	indicates partial trouble in the circuit leg.
		The higher the BI percentage, the more trouble on that particular circuit leg.

† MON = the number of seconds that were monitored in obtaining the UAS, SES and ES data.

PERFORMANCE DATA SCREEN DISPLAYS

The ADA subsystem screens can be selected from selection H of the main menu (Figure 8), for local log-in sessions. It is selected by tab key of the Remote Log-in screen shown in Figure 9.

The header of each screen displays the title of the screen, the date, the time, the circuit identification, current values of various remote unit Options, and a diagram of the four legs associated with the “sectionalizer” view of the remote unit. See Figure 25 for the leg definitions. The first of the screens, the Set Clock screen, is shown in Figure 26.

The time and date must be set when the remote unit is initially powered up.

Refer to the Set Time/Date information later in this section.

Set Clock Screen

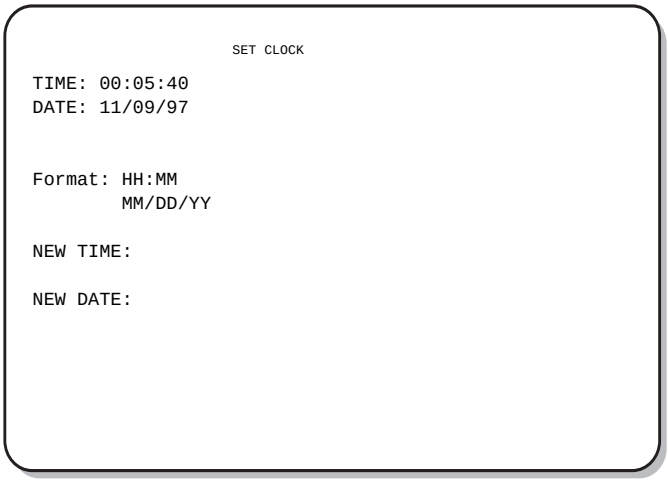


Figure 26. *Set Clock Screen*

Main Menu Screen

Following the initial pass through the Set Clock screen, the Main menu is displayed. The user may then select the following functions from the menu:

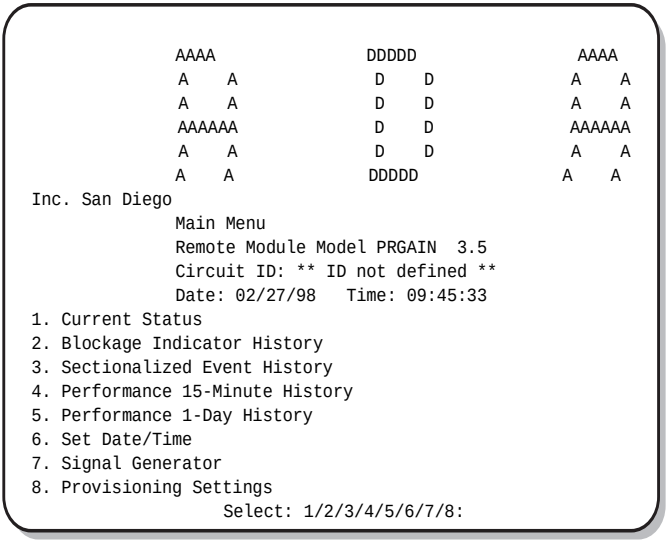


Figure 27. *Main Menu Screen*

Pressing **M** from any screen will initiate a return to the Main menu. Pressing **U** will update the presentation of the display on the terminal but has no effect on the information stored or displayed.

Current Status Screen

The screen is displayed by pressing 1 in the Main Menu.

```
 Current Status
             Remote Module Model PRGAIN  3.5
             Circuit ID: ** ID not defined **
             Date: 02/27/98   Time: 09:47:05
         Conversion:Auto           LBTO:     Off
         CI  Frame:ESF             CI  Line Code: AMI
         NET Frame:ESF             NET Line Code: AMI
             > NET RX (IN)  | CPE RX (OUT) >
             < NET TX (OUT) | CPE TX (IN)  <
             NETWORK        NI             CI
Current      NET RX    CPE RX    CPE TX    NET TX
-------      ------    ------    ------    ------
OK           OK        OK        OK        OK
Current Hour.
         ES        00016     N/A       00000     N/A
         SES       00016     N/A       00000     N/A
UAS       00000     N/A       00000     N/A
MON       01434     N/A       01434     N/A
CV-L      00254     N/A       00000     N/A
BI         N/A      N/A        N/A      N/A
         (M)ain Menu (S)tart Monitoring (U)pdate:
```

Figure 28. *Current Status Screen*

This screen displays the status of various performance indicators for the current hour. Parameters displayed are:

Table 18. *Status Screen Parameters*

Parameter	Abbreviation On Screen
Errored Seconds	ES
Severely Errored Seconds	SES
Unavailable Seconds	UAS
Monitored Seconds	MON
Line Code Violations	CV-L
Blockage Indicator	BI

ES, SES, UAS and CV-L parameters are as defined in Section 6 in ANSI T1-231-1997.

All the parameters except Blockage Indicator are displayed for all four legs.

Blockage Indicator is meaningful only for legs 1 and 3 and no data is accumulated or displayed for legs 2 and 4.

All parameters are displayed in counts for the current hour except for Blockage Indicator which is displayed in percent blockage.

The current settings of several remote unit options are displayed near the top of the screen.

It is possible to update (refresh) the screen by pressing **U** at any time. Pressing **S** clears the display so that counts accumulated since the most recent press of that key may be observed. Note that pressing **S** does not clear BI or performance registers in the remote unit and a correct view of performance for the current hour may be restored by returning to the Main Menu and then reentering the Current Status Screen.

Blockage Indicator History Screen

This screen is displayed by pressing **2** in the Main Menu.

```
              Blockage Indicator History
              Remote Module Model PRGAIN  3.5
              Circuit ID: ** ID not defined **
              Date: 02/27/98   Time: 09:48:51
              > NET RX (IN)  | CPE RX (OUT) >
              < NET TX (OUT) | CPE TX (IN)  <
              NETWORK        NI             CI

HOUR          PERIOD           NET RX        CPE TX
----          ------           ------        ------
Current       09:00-09:48      N/A           N/A
Previous      08:00-09:00      N/A           N/A
2nd Prev.     07:00-08:00      N/A           N/A
3rd Prev.     06:00-07:00      N/A           N/A

              (M)ain Menu (U)pdate:
```

Figure 29. *Blockage Indicator History Screen*

This screen displays the blockage indicator (BI) as a percentage for the current hour and for each of the three preceding hours. Since BI is recorded only for legs 1 and 3 of the remote unit, only those legs are displayed.

Sectionalized Event History Screen

This screen is displayed by pressing **3** in the Main Menu.

```
                Sectionalized Event History
                     Remote Module Model PRGAIN  3.5
                     Circuit ID: ** ID not defined **
                     Date: 02/27/98   Time: 09:50:30
                     > NET RX (IN)  | CPE RX (OUT) >
                     < NET TX (OUT) | CPE TX (IN)  <
                     NETWORK        NI             CI
#   Date       Time      NET RX    CPE RX    CPE TX    NET TX
-   ----       ----      ------    ------    ------    ------
01  02/27/98    09:29     OK        OK        OK        OK
02  02/27/98    09:29     AIS       OK        OK        OK
03  02/27/98    09:23     OK        OK        OK        OK
04  02/27/98    09:23     AIS       OK        OK        OK
05  No Event
06  No Event
07  No Event
08  No Event
09  No Event
10  No Event
                (N)ext (M)ain Menu (U)pdate:
```

Figure 30. *Sectionalized Event History Screen*

This screen displays the 100 most recent sectionalized events for legs 1 through 4 along with their times of occurrence. The screen is divided into 10 sections which are displayed individually (Table 19):

Table 19. *Screen Section Descriptions*

Screen Section	Events	Press N For	Press P For
1	01-10	Section 2	Not Available
2	11-20	Section 3	Section 1
3	21-30	Section 4	Section 2
4	31-40	Section 5	Section 3
5	41-50	Section 6	Section 4
6	51-60	Section 7	Section 5
7	61-70	Section 8	Section 6
8	71-80	Section 9	Section 7
9	81-90	Section 10	Section 8
10	91-100	Not Available	Section 9

Sectionalized events are time stamped and presented in descending order with the most recent event displayed first. Sectionalized events include the following (Table 20):

Table 20. *Sectionalized Event Descriptions*

Screen Section	Events
OK	Signal is clean
ES	Errored Seconds condition
SES	Severely Errored Seconds condition
IDLE	DS1 Idle signal
ALARM	LOS or OOF condition
AIS	AIS condition
RAI	RAI condition
NOT SECT	No Sectionalized Data Available

Sectionalized events isolate troubles to a particular circuit leg. For example, an ‘ES’ listed under the column headed ‘Net Rx’ indicates an errored second condition exists on the Net Rx (in) circuit leg beginning with the time stamp and continuing until an “OK” or other new event is recorded.

On signals without FAR END or NEAR END PRM present, event data in the CPE Rx and NET Tx circuit legs will be limited to trouble alarms.

Performance 15-Minute History Screen

This screen is displayed by pressing 4 in the Main menu.

```
Performance 15-Min History
               Remote Module Model PRGAIN  3.5
               Circuit ID: ** ID not defined **
               Date: 02/27/98   Time: 09:54:10
                    > NET RX (IN)  | CPE RX (OUT) >
                    < NET TX (OUT) | CPE TX (IN)  <
                    NETWORK        NI             CI
                    NET RX                         CPE TX
#  Date     Time  ES   SES  UAS  MON  CV-L  ES   SES  UAS  MON  CV-L
-  ----     ----  --   ---  ---  ---  ----  --   ---  ---  ---  ----
01 02/27/98 09:45 0000 0000 0000 0000 0000  0000 0000 0000 0000 0000
02 02/27/98 09:30 0000 0000 0000 0000 0000  0000 0000 0000 0000 0000
03 02/27/98 09:15 0000 0000 0000 0000 0000  0000 0000 0000 0000 0000
04 02/27/98 09:00 0000 0000 0000 0000 0000  0000 0000 0000 0000 0000
05 02/27/98 08:45 0000 0000 0000 0000 0000  0000 0000 0000 0000 0000
06 02/27/98 08:30 0000 0000 0000 0000 0000  0000 0000 0000 0000 0000
07 02/27/98 08:15 0000 0000 0000 0000 0000  0000 0000 0000 0000 0000
08 02/27/98 08:00 0000 0000 0000 0000 0000  0000 0000 0000 0000 0000
                    (N)ext (M)ain Menu (U)pdate:
```

Figure 31. *Performance 15-Minute History Screen*

The screen displays 15-minute histories for the parameters ES, SES, UAS and MON (monitored time during the 15-minute period) for 32 15-minute periods. Period number 1 is the current period. The periods are grouped into sections as follows:

Table 21. *Performance 15-Minute History Screen Descriptions*

Screen Section	15-Minute Periods	Press N For	Press P For
1	01-8	Section 2	Not Available
2	09-16	Section 3	Section 1
3	17-24	Section 4	Section 2
4	25-32	Section 5	Section 3
5	33-40	Section 6	Section 4
6	41-48	Section 7	Section 5
7	49-56	Section 8	Section 6
8	57-64	Section 9	Section 7
9	65-72	Section 10	Section 8
10	73-80	Section 11	Section 9
11	81-88	Section 12	Section 10
12	89-96	Section 13	Section 11
13	97-104	Section 14	Section 12
14	105-112	Section 15	Section 13
15	113-120	Section 16	Section 14
16	121-128	Not Available	Section 15

Performance 1-Day History Screen

The screen is displayed by pressing **5** in the Main menu.

```
          Performance 1-Day History
                   Remote Module Model PRGAIN  3.5
                   Circuit ID: ** ID not defined **
                   Date: 02/27/98   Time: 09:52:44

                   > NET RX (IN)  | CPE RX (OUT) >
                   < NET TX (OUT) | CPE TX (IN)  <
                   NETWORK        NI             CI

                         NET RX                          CPE TX
#  Date     Time  ES    SES   UAS   MON   CV-L   ES    SES   UAS   MON   CV-L
-  ----     ----  --    ---   ---   ---   ----   --    ---   ---   ---   ----
01 02/27/98 09:52 00000 00000 00000 00000 00000  00000 00000 00000 00000 00000
02 02/26/98 00:00 00000 00000 00000 00000 00000  00000 00000 00000 00000 00000
03 02/25/98 00:00 00000 00000 00000 00000 00000  00000 00000 00000 00000 00000
04 02/24/98 00:00 00000 00000 00000 00000 00000  00000 00000 00000 00000 00000
05 02/23/98 00:00 00000 00000 00000 00000 00000  00000 00000 00000 00000 00000
06 02/22/98 00:00 00000 00000 00000 00000 00000  00000 00000 00000 00000 00000
07 02/21/98 00:00 00000 00000 00000 00000 00000  00000 00000 00000 00000 00000
                            (M)ain Menu (U)pdate:
```

Figure 32. *Performance 1-Day History Screen*

This screen displays one-day histories for the parameters ES, SES, UAS and MON (monitored during each 15-minute period) for eight days. The first day displayed is the current day.

Table 22. *Performance 1-Day History Screen Descriptions*

Screen Section	15-Minute Periods	Press N For	Press P For
1	01-8	Section 2	Not Available
2	09-16	Section 3	Section 1
3	17-24	Section 4	Section 2
4	25-32	Section 5	Section 3
5	33-40	Section 6	Section 4
6	41-48	Section 7	Section 5
7	49-56	Section 8	Section 6
8	57-64	Section 9	Section 7
9	65-72	Section 10	Section 8
10	73-80	Section 11	Section 9
11	81-88	Section 12	Section 10
12	89-96	Section 13	Section 11
13	97-104	Section 14	Section 12
14	105-112	Section 15	Section 13
15	113-120	Section 16	Section 14
16	121-128	Not Available	Section 15

Set Date/Time Screen

When craft port begins or is reset, execution always starts with this screen and then proceeds automatically to the Main Menu. The user may call this screen from the Main Menu by pressing 6. This screen displays the current time recorded by the remote unit in hh:mm format and the current date in mm/dd/yy format.

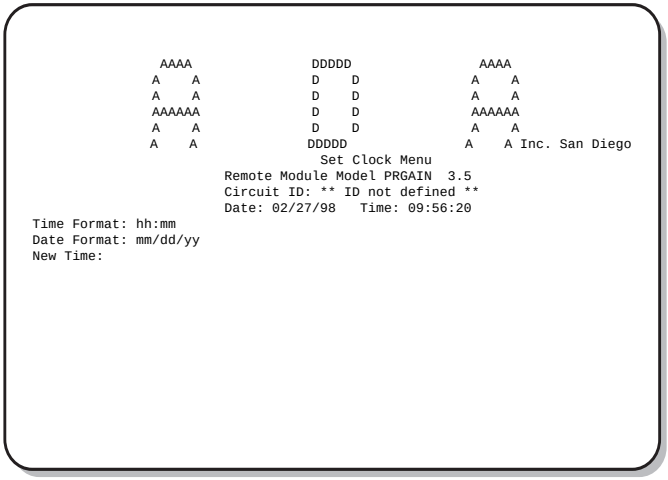


Figure 33. *Set Clock Screen*

The user is invited to enter a new time which must be in the same format as that displayed. The user may retain the current time by pressing ENTER (or <Carriage Return>) at the prompt. Following the “New Time” prompt, the user is asked for a new date. As with the time, the user may retain the currently recorded date by pressing ENTER at the prompt.

Following completion of the entries for the date and time, the Main Menu (Figure 27) is displayed automatically.

This ADA Set Date/Time functions and the HRU Set Clock function discussed in the HRU Craft port section each contain separate and independent time and date clocks. Setting the parameters and menu on one has no effect on those set from the other menu. Thus, both clocks should be set the same to avoid confusion.

Signal Generator Screen

This screen is displayed by pressing 7 in the Main menu.

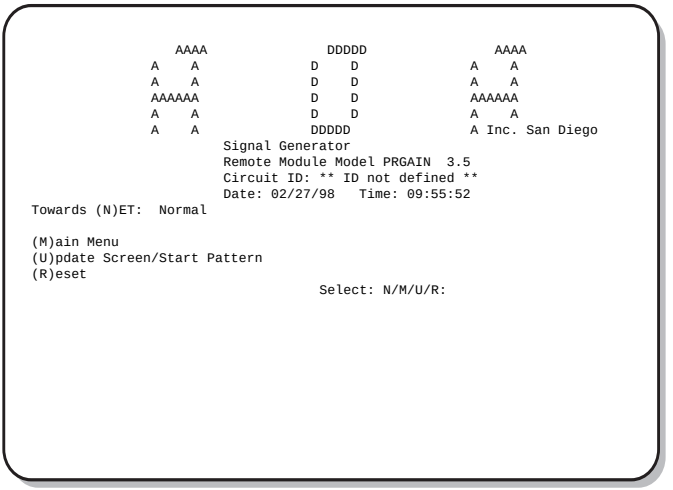


Figure 34. *Signal Generator Screen*

This screen allows the initiation of transmission of a test signal from the remote unit toward either the CI or the network. By pressing N in the screen, Figure 33 appears, and the user may scroll through the following choices for transmission toward the network:

Table 23. *Signal Generator Screen Descriptions*

Signal	Description
Normal	Normal transmission: DS1 path intact
SF All Ones	SF framed signal with all ones payload
ESF All Ones	ESF framed signal with all ones payload

If either the SF All Ones or ESF 0l Ones mode is selected, the U key followed by the C Confirm key must be selected to initiate the test signal and there present the following screen.

```
              AAAA              DDDDD               AAAA
              A    A             D    D             A    A
              A    A             D    D             A    A
              AAAAAA             D    D             AAAAAA
              A    A             D    D             A    A
              A    A             DDDDD              A    A
Inc. San Diego
                    Signal Generator
                    Remote Module Model PRGAIN  3.6
                    Circuit ID: ** ID not defined **
                    Date: 03/29/98   Time: 12:59:28
Towards (N)ET:  SF All Ones  *** Started ***
(B)urst 10 Errors Towards NET

(M)ain Menu
(U)pdate Screen/Start Pattern
(R)eset
                    Select: M/R/B:
```

Figure 35. *Update Screen*

By pressing B, the user will send a burst of 10 errors within the all ones payload. The screen will refresh each time B is pressed. Pressing R returns you to the previous screen.

Note that selection of any option other than NORMAL in Figure 34 will interrupt the transmission path through the remote unit, where U is then selected. Pressing R while in this screen will return the settings in both directions to NORMAL and will restore the DS1 path in both directions. Pressing M while in this screen will return the setting to NORMAL and return to the Main Menu.

Provisioning Settings

This screen is displayed by pressing **8** in the Main Menu. Table 24 lists the screen options available.

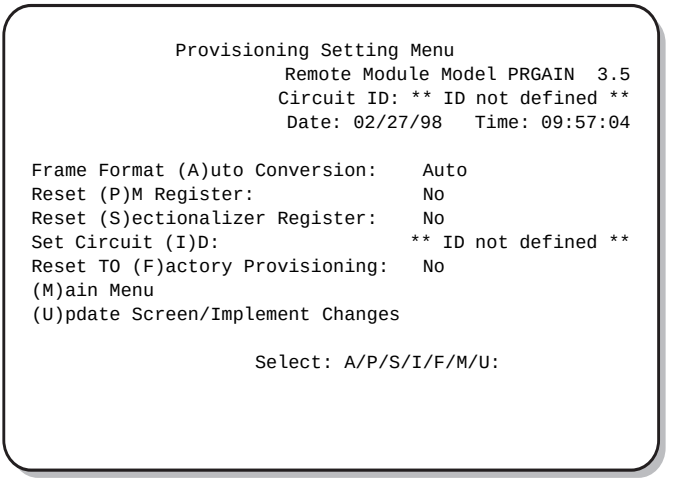


Figure 36. *Provisioning Setting Menu Screen*

Table 24. *Provisioning Setting Menu Screen Descriptions*

Option	Default Value	Alternate Value
Frame Format Auto Conversion	Auto	Forced SF
Reset PM Register	No	Yes
Reset Sectionalizer Register	No	Yes
Reset to Factory Provisioning	No	Yes

Frame Format Auto Conversion

This option allows user to enable/disable SF to ESF frame format conversion at the network interface.

In “Auto”-adaptive mode, the remote unit passes ESF through or convert SF to ESF if it detects ESF coming from the network. At the same time, it will convert a network ESF signal back to SF if it detects SF coming from the CPE. Auto Conversion enables the remote unit to transmit PRM back to the network to aid in network troubleshooting.

In “forced SF” mode, the remote unit passes SF to the CPE with no conversion.

In Forced SF mode, an ESF signal from the network or CPE will cause the remote unit to go out of frame.

Reset PM Registers

This option allows the user to reset to zero the 24 hour/15min and 7day/24hour PM registers.

Reset Sectionalize Registers

This option allows the user to reset to zero any and all Sectionalized Events stored in the registers.

Set Circuit ID

This option allows the user to set the circuit identifier in ASCII characters up to 24 characters in length. Once entered, the Circuit ID displays at the top of each user screen.

The Circuit ID that is set at the HLU does not flow through to the Circuit ID displayed on the ADA screens. The ID must be reentered using the ADA Set Circuit ID option for it to appear on both the HiGain and ADA screens.

Reset Provisioning Option to Default Settings

This option restores all provisioning options, including Circuit ID, to the factory default settings above.

When the user presses U to update the settings, a query displays which allows the user to confirm or discard the changes made from this screen.

APPENDIX A: ADDITIONAL INFORMATION

Appendix A contains technical information about the HRU-412 List 9B.

FUNCTIONAL DESCRIPTION

HiGain utilizes 2B1Q HDSL transceiver systems to establish two full-duplex 784 kbps data channels between the HLU and a remotely-mounted remote unit. This provides a total capacity of 1.568 Mbps between the two units. A block diagram of the remote unit is shown in Figure 37.

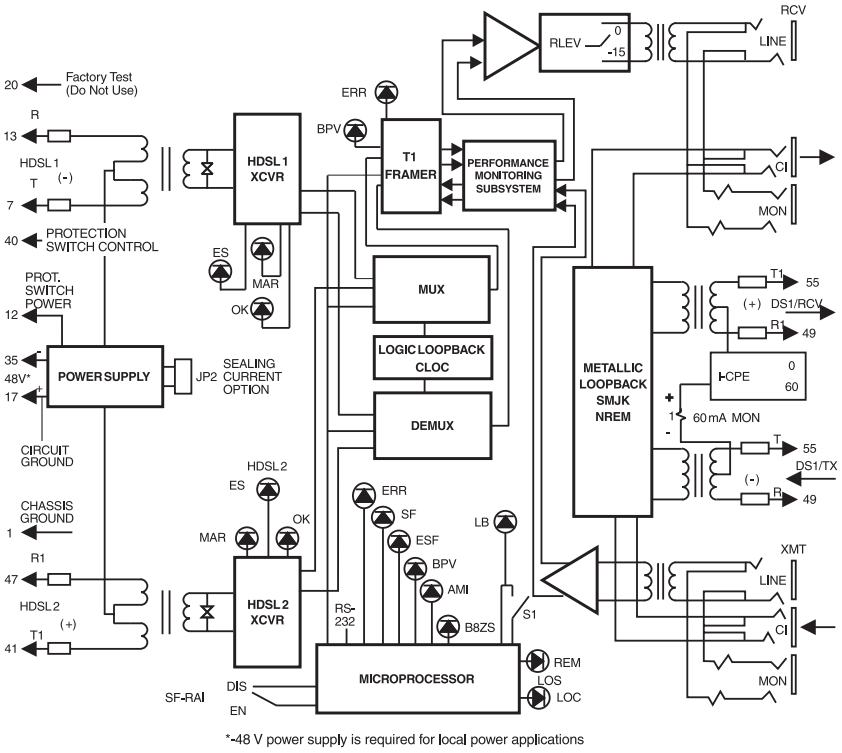


Figure 37. *Block Diagram*

The remote unit power supply converts the 90 to 130 Vdc power feed that is received on the simplex pairs (or the -48V input when locally powered) to voltages and currents required by the remote unit circuitry. The power supply generates +5, -5 and 30 Vdc outputs. The 30 Vdc output is converted to a 60 mA current feed used to simplex power the Network Interface Device (NID).

Caution should be used when the HRU is used to power Channel Service Units (CSUs). Some CSUs require more output voltage than the 30 Vdc provided by the remote unit. The remote unit cannot power both a NID and a CSU at the same time.

The remote unit typically dissipates 6W of power with the I-CPE backplane switch set to 0, and 8W with the I-CPE backplane switch set to 60 (see the User Options paragraphs of the Installation section).

Local and Line Powering

The remote unit can be line or local powered. The unit always uses the local -48 Vdc power source if it is present, and defaults to line power in the absence of local power. List 6 and higher versions of the HLU-231, all versions of the HLU-319 and HLU-388, and versions 6.4 and above of the HLU-231 List 1, 2, 3, 3A and 4 units automatically turn off their line power supply when connected to a locally powered HRU-412 List 9B. The earlier versions of the HLU-231 (Lists 1, 2, 3, 3A and 4) must first have their PWRF user option set to *Disable to work with a locally powered HRU-412 List 9B unit.*

The HRU-412 List 9B only supports three-span line powering when used with the HLU-231 List 8x, HLU-388 List 5x line units and the HDU-409, 407 and 404 doublers.

When locally powered, the remote unit also provides from 20 mA (short loop) to 30 mA (long loop) of simplex sealing current toward all versions of the HLU over the two HDSL pairs. Jumper JP2 allows this sealing current to be enabled or disabled. See the User Options part of the Installation section for further information.

The simplex sealing current is not compatible with the List 1, 2, or 3 HDU-451 doublers. These doublers block the flow of simplexed sealing current. The HDU-451 List 4 or the HDU-409, 407 or 404 doublers must be

used with the remote unit to provide a path through which the simplexed sealing current can flow.

If local power is lost to the remote unit in a non-doubler or a single doubler circuit, the system loses synchronization. When the HLU or HDU attempts to re-acquire synchronization, it detects that the remote unit is not locally powered and applies line power to it. If local power is lost to the HRU in a two doubler application, the circuit is permanently down since the HLU cannot provide line power to the remote unit in circuits with two doublers.

The -48V local power supply must have a 125 mA output current capacity (6 W) to power each HRU-412 when the I-CPE option is set to 0. The 48 Vdc local power supply must have a 175 mA output current capacity (8W) to power each HRU-412 whose 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 unit (with the I-CPE option switch set to 60 mA). Each unit provides spade lugs to access the -48 Vdc output.

The number for Teltrend is: 1 (800) TEL-TREN.

ABBREVIATIONS

2B1Q	2–Bits–1–Quaternary
ADA	Applied Digital Access
AIS	Alarm Indication Signal
AIS-CI	Alarm Indication Signal-Customer Interface
AMI	Alternate Mark Inversion
B8ZS	Binary 8 zeroes Suppression
BPV	Bipolar Violation
CI	Customer Interface
CO	Central Office
CLOC	Customer Local Loopback
CPE	Customer Premises Equipment
CRC	Cyclic Redundancy Check. A process used to check the integrity of a block of data.
CSA	Carrier Service Area
CSU	Channel Service Unit. A device used to terminate a digital channel on a customer's premises.
DCE	Data Circuit-Terminating Equipment
DL	Data Link
DS1	Digital Service, Level 1
DSX	Digital System Cross-Connect frame. A bay or panel to which T-1 lines and DS-1 circuit packs are wired.
ES	Errored Seconds
ESF	Extended SuperFrame
FDL	Extended SuperFrame Facility Data Link
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	Interface-Customer Premises Equipment
LOS	Loss of Signal
LOSW	Loss of Sync Word
MON	Monitors time in seconds
NEBS	Network Equipment Building System
NI	Network Interface
NID	Network Interface Device
NIU	Network Interface Unit
NREM	Network Remote Loopback
POTS	Plain Old Telephone Service
PRM	Performance Report Message
RAI-CI	Remote Alarm Indicator-Customer Interface
RLEV	Receive Level
SCURR	Sealing Current
SF	SuperFrame
S/N	Signal-to-Noise
SF-RAI	SuperFrame-Remote Alarm Indication
SPLB	Special Loopback
SPRM	Supplemental Performance Report Message
TLOS-LB	Transmit Loss of Signal-Loopback
TSGR	Transport System Generic Requirements
UAS	Unavailable Seconds
ZBTSI	Zero Byte Time Slot Interchange

SPECIFICATIONS

Physical

Material	Steel
Finish	Zinc plated
Mounting	Any standard 400 mechanics shelf

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.

Power

Consumption	6W (with I-CPE set to 0)
	8W (with I-CPE set to 0)
Maximum Provisioning Loss	35 dB at 196 kHz, 135 Ω
Electrical Protection	Secondary surge and power cross protection on all DS1 and HDSL ports

Environment

Operating Temperature	- 40 to + 65ºC
Operating Humidity	5 to 95% non-condensing

HDSL

Line Code	784 kbps 2B1Q full duplex
Output	+13 dB ± 0.5 dBm @ 135 Ω
Line Impedance	135 Ω
Line DC resistive signature	14 Ω
Start-up Time (per span)	15 seconds (typical)
	60 seconds (maximum)

DS1

Line Impedance	100 Ω
Pulse Output	0 dB (RLEV = 0), -15 dB (RLEV = 15)
Input Level	>Input level sensitivity >-35 dB
Line Rate	1.544 Mbps ± 200 bps

Output Wander (MTIE and TVAR)

<1.5 U>I> (Unit Interval, 647 nanoseconds)

Line Format	AMI, B8ZS, or ZBTSI
Frame Format	ESF, SF or unframed

Line Clock Rate

Internal Stratum for clock

DS1

APPENDIX B: PRODUCT 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.

CERTIFICATION

FCC compliance. The HRU-412 List 9B has been tested and found to comply 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, 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 their own expense.

UL RECOGNIZED

The HRU-412 List 9B is a UL Recognized component. Use normal caution when installing or modifying telephone lines. Dangerous voltages may be present. It is also considered imprudent to install telephone wiring during a lightning storm. Always disconnect all telephone lines and power connections from wall outlets before servicing or disassembling this equipment.

CSA CERTIFICATION

The HRU-412 List 9B has been tested and found to comply with CSA Standard C22.2-950 with telecommunication features.

STANDARDS COMPLIANCE

The HiGain system uses HDSL transmission technology as recommended by Bellcore TA-TSY-001210. HiGain complies with:

- ANSI T1E1.4, T1.403-1989 and 1995, and T1E1.4/92-00R2R technical standards and recommendations
- TR-TSY-000063 Network Equipment Building System (NEBS) Generic Equipment requirements
- TR-TSY-000499 Transport System Generic Requirements (TSGR) common requirements

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
DNV Certification, Inc.
Certificated Firm

PAIRGAIN