HiGain Line Unit

Model	List Number	Part Number	CLEI Code
HLU-388	2E	150-1141-25	T1L2BBYAAA

PairGain Technologies, Inc.
Engineering Services Technical Practice

Section 150-388-125-01

PairGain

Revision History of This Practice

Revision	Release Date	Revisions Made
01	September 15, 1998	Initial Release

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.

INSPECTING SHIPMENT

Upon receipt of the equipment:

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

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OVERVIEW

The PairGain® HiGain® HLU-388 List 2E is the Central Office (CO) side of a repeaterless T1 transmission system. When used in conjunction with a HiGain Remote Unit (HRU) the system provides 1.544 Mbps transmission on two unconditioned copper pairs over the full Carrier Service Area (CSA) range. This line unit can be used in applications with or without HiGain doubler units (HDUs).

The CSA includes loops up to 12,000 feet of 24 AWG or 9,000 feet of 26 AWG wire, including bridged taps. The HiGain system uses HDSL transmission technology as recommended by Bellcore TA-TSY-001210. The HiGain system complies with TR-TSY-000063 (Network Equipment Building System (NEBS) Generic Equipment Requirements) and TR-TSY-000499 (Transport System Generic Requirements (TSGR) Common Requirements).

FEATURES

- Selectable DS1 pre-equalizer
- 130 to 200 Vdc HDSL line power for doubler and HRU
- Front panel HDSL Signal-to-Noise margin display
- Compatible with high-density Span Terminating Shelves (STS)
- Selectable loopback activation codes
- RS-232 Craft port for connection to a maintenance terminal
- Compatible with PairGain Management System
- Front panel operator setup
- Lightning and power cross protection on HDSL interfaces
- Full duplex 2B1Q HDSL transmission at 784 kbps on two wire pairs
- Front panel status LED
- On/off power cycling from front panel
- DS1 Loss Of Signal (LOS) detector (125 consecutive 0s)
- Margin threshold alarm
- HDSL Alarm Indicator Signal and SmartJack AIS options
- Easily restored factory default settings
- Circuit ID option

APPLICATIONS

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

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

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

Table 1. *HDSL Loss Over Cables*

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

In general, HiGain systems:

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

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

Applications Without HiGain Doublers

For applications without doublers, the HLU-388 is directly connected to the HRU by the two HDSL cable pairs. The HLU-388 is compatible with all HiGain HRUs.

Applications With HiGain Doublers

For doubler applications, one or two doublers may be used in the HDSL loops between the HLU and HRU. When using two doublers, the HRU must be locally powered.

For compatibility guidelines on mixing newer doublers with older HRU and HLU models, refer to "Doubler Deployment" on page 54.

PRODUCT DESCRIPTION

The HLU-388 List 2E includes:

- A front panel featuring:
  - A status display
  - System option buttons
  - Status LED
  - Craft port (RS-232)
  - CLEI/ECI bar code number
  - Configuration number
- A card-edge connector

FRONT PANEL

The HLU-388 List 2E front panel is shown is Figure 1. The front panel components are described in Table 2 on page 4.

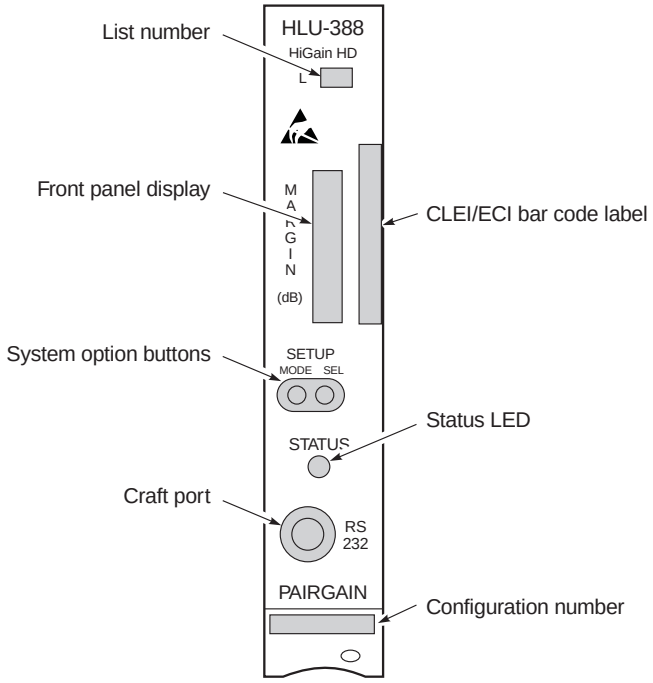


Figure 1. *HLU-388 List 2E Front Panel*

Table 2. *Front Panel Components and Labels*

Front Panel Feature	Function
List number	The HLU-388 version number.
Front panel display	Displays four-character status, provisioning, and alarm system messages.
System option buttons (MODE and SEL)	Permits the user options to be monitored and modified without the need of a maintenance terminal. Used to initiate all HiGain loopbacks and to display DSX-1 line parameters and line unit identity.
Status LED	See Table 3 for status descriptions.
Craft (RS-232) port	Bantam 210 jack provides bidirectional communication between the unit and an external terminal to allow configuration and performance monitoring through the Maintenance Terminal screens.
CLEI/ECI bar code label	Provides the human-readable Common Language Equipment Identifier (CLEI) code number and the Equipment Catalog Item (ECI) bar code number.
Configuration Number	The configuration number is a two or three-digit number that is either the last digits of a five or six-digit warranty control number or a standalone configuration number of two or three digits. For example, a number of “80107” would indicate a warranty beginning in the year 1998 (8), during the month of January (01), and the unit’s configuration number of 7 (07).

Status LED

Table 3 describes the functions of the Status LED on the front panel.

Table 3. *Status LED Descriptions*

LED Status	Description
Green	Normal operation
Flashing green	HDSL acquisition
Red	Fuse alarm
Flashing red	System alarm
Yellow	Self Test is in process or an HLU-388 Customer Remote Loopback (CREM) or a Network Local Loopback (NLOC) is in effect.
Flashing yellow	HLU-388 is in an Armed state.

Front Panel Display

The front panel display is used with the MODE and SEL buttons to display system diagnostic messages. Refer to Table 4 for a listing of the four-character messages.

The front panel display turns on when power is initially applied to the HLU-388. To conserve power, the display only remains on for four minutes. The use of the MODE or SEL buttons activates the front panel display and restarts the four minute, power-control timer.

Table 4. *Front Panel Display Messages*

Message	Full Name	Description
CREM	Customer Remote Loopback	Signal from customer is looped back to the customer at HLU-388.
NLOC	Network Local Loopback	DSX-1 signal is looped back to DSX-1 at HLU.
CLOC	Customer Local Loopback	Signal from Customer is looped back to the customer at the HRU.
NREM	Network Remote Loopback	DS1 signal is looped back to DS1 at the HRU.
SMJK	Remote SmartJack Loopback	Signal from DS1 is looped back at the HRU by the HRU SmartJack module.
TLOS	Transmit Loss Of Signal	HRU is in a logic loopback state caused by a loss of its T1 input from the CI, if enabled at the HRU by its TLOS switch option.
FERR	Framing Bit Error Occurred	Framing bit error occurred at HLU T1 input.
LBPV	Local Bipolar Violation	A bipolar violation has been received at the T1 input to the HLU-388.
SIG 1 or 2	Signal 1 or Signal 2	The transceivers of the HLU, HRU or first doubler are trying to establish contact with each other on loops 1 or 2 of span 1.
S2L1 or 2	Signal 2 Loop 1 or Loop 2	The transceivers of the first doubler and either the HRU or second doubler are trying to establish contact with each other on loops 1 or 2 of span 2.
ACQ 1 or 2	Acquisition 1 or Acquisition 2	The multiplexers of the HLU and HRU or first doubler are trying to establish synchronization over loops 1 or 2 of span 1.
H1ES	HDSL CRC Error Channel 1	HLU HDSL Loop 1 CRC error.
H2ES	HDSL CRC Error Channel 2	HLU HDSL Loop 2 CRC error.
ARM	HiGain System ARMED	Armed to respond to Intelligent Repeater Loop Codes.
ACO	Alarm CutOff	A system alarm has occurred, and has been retired to an ACO condition, by pressing the SEL button on the HLU front panel.
SELF TEST	Self Test	The HLU is in a self-test mode. This occurs every power ON/OFF cycle.
ALRM	Alarm Condition Exists	A system alarm 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 for reliable system operation.
PWR FEED SHRT	Power Feed Short	Indicates a short between the two HDSL pairs. This same message can occur with an HRU that is drawing the correct amount of power over good cable pairs but cannot communicate with the HLU.
PWR FEED OFF	Power Feed Off	HDSL span power has been turned off by setting the PWFD option to DIS or HDSL span power has been turned off by use of the A1LB/A2LB/A5LB Intelligent Office Repeater (IOR) Power Down code.
BAD RT?	No response from HRU	The HLU does not receive any response from the HRU. Thus, the integrity of the HRU or the two HDSL loops (they may be open) is questionable.
FRM	Frame: SF, ESF, UNFR, NONE	Defines the type of frame pattern being received from the DSX-1. Displayed during System Settings review mode.

Table 4. *Front Panel Display Messages (Cont.)*

Message	Full Name	Description
CODE	Line Code: AMI, B8ZS	The line code that HLU-388 is receiving at its DSX-1 interface, if the DS1 option is set to Auto. Otherwise, it mimics either of the other two DS1 line code settings, AMI or B8ZS. Displayed during System Settings review mode.
LOSW	Loss of Sync Word	Indicates that one of the HDSL loops has lost sync. Causes a system alarm.
LLOS	Local Loss of Signal	Indicates that no signal is detected at the T1 input to the HLU. Causes a system alarm.
RLOS	Remote Loss of Signal	Indicates that no signal is detected at the T1 input to the HRU. Causes a system alarm.
DS0	DS0 Blocked Channels	Indicates status of DS0 blocked channels. NONE indicates no channels are blocked. BLK indicates some channels are blocked.
DS1	DS1 BPV Errors	Indicates that the number of BPVs at the HLU or HRU T1 inputs have exceeded the 24-hour ES threshold. Causes a minor alarm.
MNGD	Managed	The HLU-388 is under control of the HMU-319 network management unit. In this state, the front panel Craft port is disabled.
VER xxxx	HLU-388 software version number	The software version number displays during the System Settings review mode. Press the MODE button for three seconds to display the software version.
LIST xxxx	HLU-388 List number	The List number displays during the System Settings review mode. Press the MODE button for three seconds to display the List number.
MAL1 MAL2	Margin Alarm Loop 1 or 2	The margin on HDSL loop 1 (2) has dropped below the threshold (1 to 15 dB), which is set by the operator.

CARD CONNECTOR

Figure 2 shows the card-edge connector on the HLU-388. Active pins are highlighted in black.

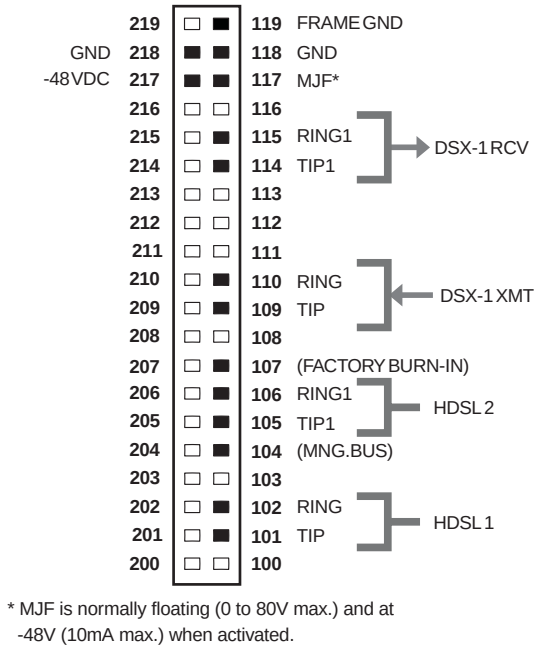


Figure 2. *HLU-388 List 2E Card-Edge Connector*

Network Management Control Bus

The HLU-388 provides a Network Management Control Bus on pin 104 of the card-edge connector. This allows the various PairGain Management System protocols to manage the HLU through the HMU-319 HiGain Management Unit. Whenever the HLU-388 is under management, the `MNGD` message displays periodically on the HLU-388 front panel display.

Fuse Alarm

Pin 117 on the card-edge connector is a Fuse Alarm that is driven to -48 V whenever the onboard fuse opens. It emulates the function of the MJF output of normal high-density DDM+ T1 repeaters. Its normally floating output must never be driven above ground or below -80 V. It can sink a current of 10 mA.

INSTALLATION

This product contains static-sensitive components. Be sure to ground yourself properly before touching the HLU-388.

To install the HLU-388:

1 Slide the HLU-388 into the card guides for the desired slot, then push the unit back until it touches the backplane card-edge connector and the retaining latch on the front panel opens (Figure 3).

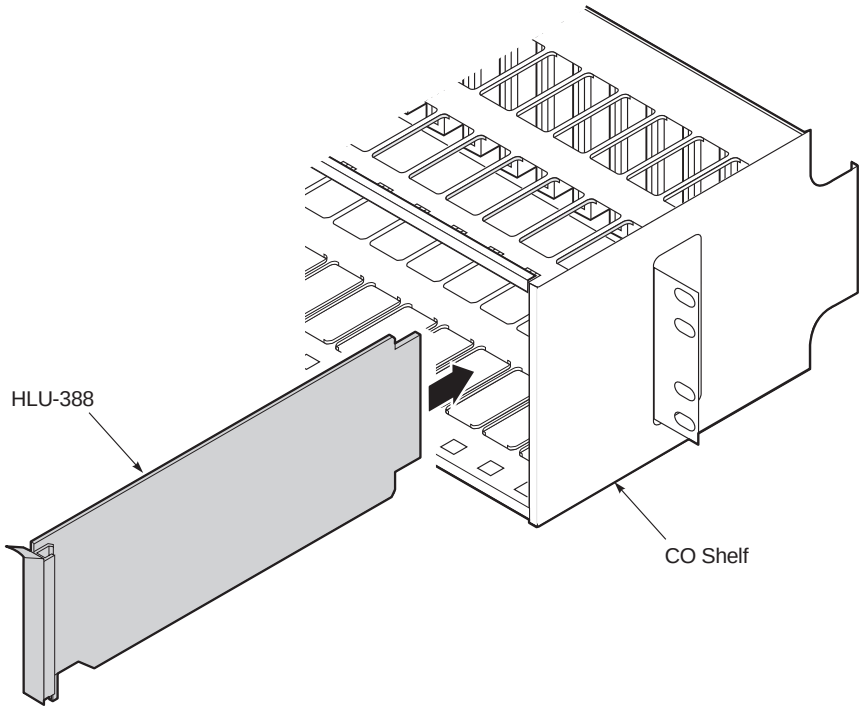


Figure 3. *Installing the HLU-388 into a Shelf*

2 Place your thumbs on the HLU-388 front panel and push the HLU-388 into the card-edge connector until it is entirely within the card guides and the retaining latch closes. This indicates that the card is properly seated.

PROVISIONING

There are two methods for provisioning the HLU-388:

- Use the MODE and SEL buttons on the front panel.
- Access system settings screens through the Craft port.

No dip switches or jumpers are required to provision the HLU-388 as it contains a Non-Volatile RAM (NVRAM) which stores the system option settings. System settings are retained if shelf power is lost or if the HLU-388 is unplugged.

SETTING OPTIONS THROUGH SEL AND MODE

To provision the HLU-388 through the MODE and SEL buttons on the front panel:

1 Press the MODE button and release it after one second.

The message displayed on the front panel alternates between the first system parameter and its current setting.

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

3 After the desired setting has been selected, press the MODE button.

This updates the current displayed mode to the selected setting, and then advances to the next configurable parameter.

After the last parameter has been selected, the following message appears on the front panel display:

`CONF NO`

4 Do one of the following:

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

In either case the display returns to its normal mode.

Factory Default Values

All user options can be set to the factory default values using the SEL and MODE buttons. To set the user options to their default values:

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

`DFLT NO`

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

The message changes to `DFLT YES` indicating the factory default values are now in effect.

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

- Press the MODE button *or*
- Wait 30 seconds for the display to return to its normal state.

Displaying System Inventory

To scroll through an inventory of system parameters, press the MODE button for three or more seconds. The following parameters are displayed:

- HLU software version number
- HLU List number
- Type of frame pattern being received from the DSX-1
- Line code setting of the HLU-388
- All 14 option settings

The line code parameter is the actual DSX-1 line code being received by the HLU if the DSX-1 code pattern is set to AUTO. Otherwise, the line code parameter mimics either of the other two line code settings, AMI or B8ZS.

CONNECTING TO A MAINTENANCE TERMINAL

A miniature, 3-pin, 210 Bantam-type jack on the front panel serves as an RS-232 Craft port and allows connection between the HLU-388 and a maintenance terminal (ASCII terminal or PC running a terminal emulation program). The Craft port is configured as Data Communications Equipment (DCE). A 210 to DB-9 adapter is provided with every unit to facilitate the use of standard RS-232, DB-9 cables. See (Figure 4). Once connected to a maintenance terminal, you can access the maintenance, provisioning, and performance screens.

To connect to a maintenance terminal:

1 Insert the 210-to-DB9 adapter into the RS-232 jack on HLU-388 front panel.

2 Connect an RS-232 cable to the adapter.

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

4 If necessary, start a terminal emulation program.

5 Configure the maintenance terminal to the following communication settings:

- 1200 to 9600 baud (9600 baud is recommended)
- no parity
- 8 data bits
- 1 stop bit
- hardware flow control to OFF

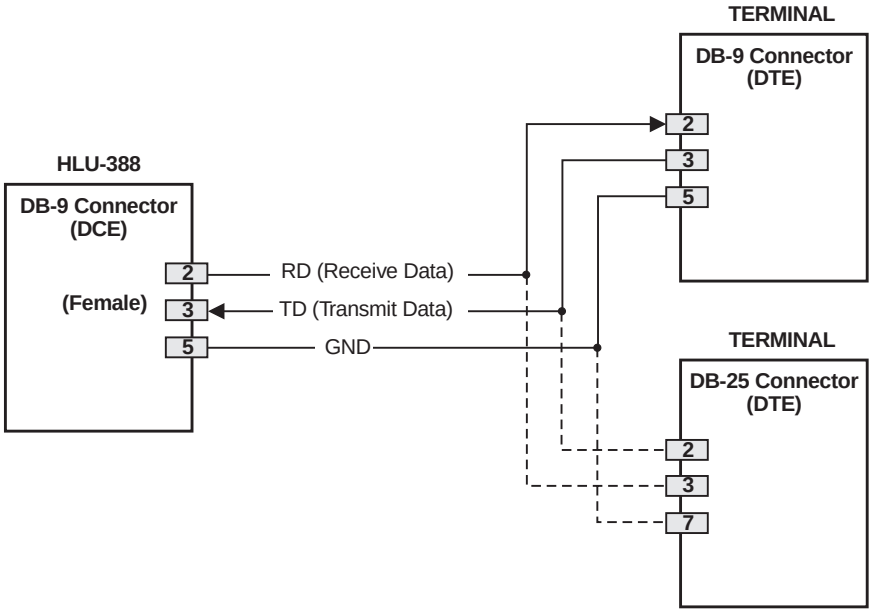


Figure 4. *DB-9 RS-232 I/O Pinouts*

MAINTENANCE

This section explains how to navigate through the Maintenance Terminal screens and describes the Main Menu and its various options.

NAVIGATING THE MAINTENANCE TERMINAL SCREENS

The following sections describe an HLU-388 system with and without doublers, how to navigate through the maintenance screens, and how to select options.

System Spans

As shown in Figure 5, the HLU can support up to two doublers with three HDSL spans. The Span Status, Performance Data, and Performance History may display as many as four screens to depict an HLU-388 system.

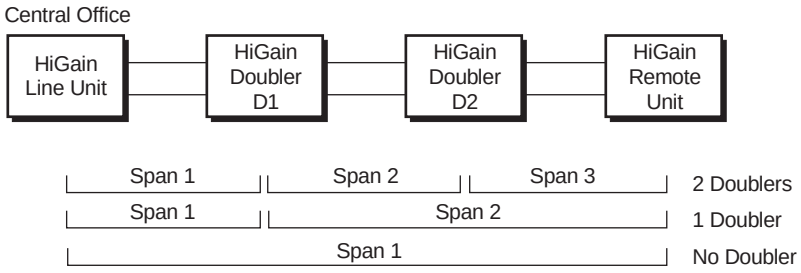


Figure 5. *System Spans*

Navigation Keys

Table 5 lists keys you can use on the maintenance terminal to navigate within the Maintenance Terminal screens.

Table 5. *Navigational Keys on the Maintenance Terminal*

Key	Function
U	Updates a report
C	Clears 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
E	Exits the current screen

Selecting an Option

To select an option within the Maintenance Terminal screens, you can:

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

An invalid entry produces the following message and identifies the name of a field where the invalid entry occurred:

```
> error
```

This happens only for margin alarm threshold or DSO blocking.

INITIALIZING THE MAINTENANCE TERMINAL SCREENS

Press the **SPACEBAR** several times to initiate the autobaud connection and to initialize the Maintenance Terminal screens.

MAINTENANCE TERMINAL MAIN MENU

Figure 6 shows the Maintenance Terminal Main Menu from which you can access eight system administration screens. The function of each screen selection is listed in Table 6.

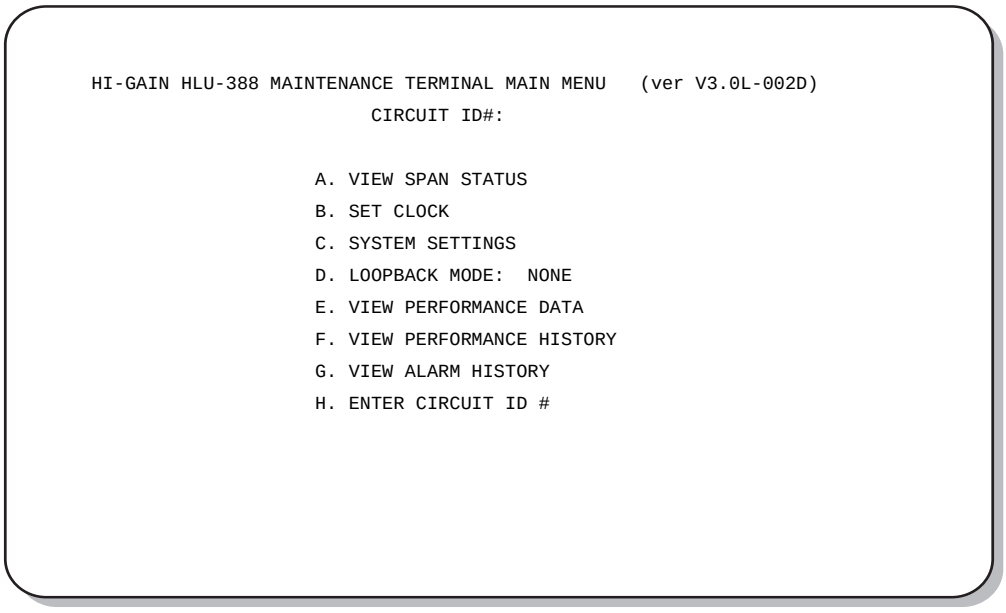


Figure 6. *Maintenance Terminal Main Menu*

Table 6. *Maintenance Terminal Screens*

Screen	Function	See page:
View Span Status	Provides access to subscreens that allow you to monitor the HDSL line between the HLU and the HRU.	14
Set Clock	Allows you to set both the time and the date parameters at the HLU, and to update the same settings at the HRU.	19
System Settings	Allows you to set all user options.	20
Loopback Mode	Provides access to subscreens that allow you to issue and disable loopbacks from both the network and customer side.	25
View Performance Data	Provides access to subscreens that allow you to view the Errored Seconds (ES) and Unavailable Seconds (UAS) between the HLU and the HRU in 15-minute intervals over a four-hour time period.	28
View Performance History	Provides access to subscreens that allow you to view the ES and UAS between the HLU and the HRU in 24-hour intervals over a seven-day period.	30
View Alarm History	Provides access to subscreens that allow you to view alarm conditions between the HLU and the HRU.	32
Enter Circuit ID #	Allows you to enter a unique circuit ID (up to 24 characters).	34

VIEW SPAN STATUS

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

From each Span Status screen you can:

- Press **C** to clear the cur (current), min (minimum) and max (maximum) numeric counts.
- Press **U** to update cur (current) values.
- Press **S** to view the next available span.
- Press **E** to return to the previous screen.

Span Status Screen: Non-Doubler Applications

Press **A** from the Maintenance Terminal Main Menu to open the Span Status screen (Figure 7). If no doubler (HDU) is present, the screen reports span status for the subscriber lines between the HLU and the HRU.

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 up to three screens, depending on the number of HDUs. Figure 8 shows status between an HLU and its first doubler (HDU1). If there is only one doubler, the next screen (Figure 9) shows status between HDU1 and the HRU. If there are additional doublers the Span Status screen will report status on each span.

```
                                SPAN STATUS
TIME: 00:14:11
DATE: 05/02/98                  Circuit ID#:

ALARMS:   LAIS LLOS RLOS LOSW1 LOSW2
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:          N/A          N/A          N/A          N/A   dB
PULSE ATTN:      N/A          N/A          N/A          N/A   dB
OFFSET:          N/A          N/A          N/A          N/A   ppm
24 HOUR ES:    00000        00000        00000        00000  seconds
24 HOUR UAS:   00607        00607        00073        00072  seconds
                                DS1 STATUS
                             HLU                 HRU
24 HOUR BPV Seconds:       00154               00000
24 HOUR UAS Count:         00320               00469
Frame type:             No Activity              N/A
Code type:                 B8ZS                  N/A

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

Figure 7. *Span Status Screen: No Doubler*

```
                              SPAN 1 STATUS
TIME: 00:14:11
DATE: 05/02/98                  Circuit ID#:

ALARMS:   LAIS LLOS RLOS LOSw1 LOSW2
LOOPBACK: OFF
                        HLU                         HDU-1
               HDSL-1       HDSL-2       HDSL-1       HDSL-2
            cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:          N/A          N/A          N/A          N/A   dB
PULSE ATTN:      N/A          N/A          N/A          N/A   dB
OFFSET:          N/A          N/A          N/A          N/A   ppm
24 HOUR ES:    00000        00000        00000        00000  seconds
24 HOUR UAS:   00607        00607        00073        00072  seconds
                                DS1 STATUS
                             HLU                 HRU
24 HOUR BPV Seconds:       00154               00000
24 HOUR UAS Count:         00320               00469
Frame type:             No Activity              N/A
Code type:                 B8ZS                  N/A

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

Figure 8. *Span 1 Status Screen: With Doubler*

The text may change in Figure 7, Figure 8, and Figure 9 on page 16, depending on system components.

```
                                SPAN 2 STATUS
TIME: 00:14:11
DATE: 05/02/96                     Circuit ID#:

ALARMS:   LAIS LLOS RLOS LOSw1 LOSW2
LOOPBACK: OFF
                          HDU-1                      HRU
                 HDSL-1       HDSL-2       HDSL-1       HDSL-2
               cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:            N/A          N/A          N/A          N/A   dB
PULSE ATTN:        N/A          N/A          N/A          N/A   dB
24 HOUR ES:      00000        00000        00000        00000  seconds
24 HOUR UAS:     00607        00607        00073        00072  seconds
                                   DS1 STATUS
                              HLU                 HRU
24 HOUR BPV Seconds:        00154               00000
24 HOUR UAS Count:          00320               00469
Frame type:               No Activity             N/A
Code type:                   B8ZS                 N/A

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

Figure 9. *Span 2 Status Screen*

Span Status Fields, Alarms, and Loopbacks

Table 7 lists the Span Status fields and descriptions. Table 8 on page 18 lists all possible alarms and their descriptions, and all possible loopbacks and their descriptions.

Table 7. *Span Status Fields and Descriptions*

Field	Description
Time	Time of day when Span Status was checked.
Date	Date when Span Status was checked.
Circuit ID	Shows the user-defined circuit ID.
Alarms	Presence or absence of alarm conditions.
Loopback	Indicates Off condition or identifies specific active loopback.
Margin	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, and third value is maximum value. NA means "Not Available." Minimum and maximum margin are cleared and updated every time the Span Status screen is cleared and every day when the system clock passes through at 12 p.m. midnight.
Pulse Attenuation (ATTN)	Indicates the attenuation of the 2B1Q pulse from the distant end. The value is related to the 196 kHz loss of the cable pair. The pulse attenuation is a more direct indication of the loop attenuation to the 2B1Q signal than is the 196 kHz loss. The normal HiGain ATTN operation range is from 0 to 28 dB.
PPM Offset	Indicates the relative offset of the crystal oscillator in the HLU from the HRU or HDU crystal oscillator. Any value between -100 and +100 is adequate.
24-Hour ES	The number of one second intervals that contained at least one CRC error. This value is a running total of the last 24 Hours.
24-Hour UAS	The number of seconds the HDSL loop was out of sync.
24-Hour BPV Seconds	The number of seconds in which at least one bipolar violation was detected on the DS1 input over a 24-hour period.
24-Hour UAS Count	The number of seconds during which the DS1 input signal was absent (125 or more consecutive zeros) over a 24-hour period.
Frame type	Type of DS1 framing used on the input stream (SF or ESF).
Code type	Type of DS1 line coding used (AMI, B8ZS, AMI: ZBTSI or B8ZS: ZBTSI). The latter two conditions indicate the code type that is being received when HiGain is set to its ZBTS1 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.

Table 8. *HLU-388 Status Menu Messages*

Message	Full Name	Description
		ALARMS
LLOS	Local Loss of Signal	No signal from HLU-388 local T1 input.
RLOS	Remote Loss of Signal	No signal from HRU T1 input.
LOSW1 LOSW2	Loss of Sync Word 1 or 2	One of the HDSL loops has lost synchronization.
H1ES	HDSL Loop 1 Errored Second	Loop 1 CRCs have exceeded the user-selected ES threshold.
H2ES	HDSL Loop 2 Errored Second	Loop 2 CRCs have exceeded the user-selected ES threshold.
DS1	Digital Service 1	T1 input BPVs, at either the HLU-388 or the HRU, have exceeded the user-selected ES threshold.
RAIS/LAIS	Remote/Alarm Alarm Indicating Signal	Indicates an AIS (all ones) pattern is being transmitted (XMT) from the remote/local T1 output port.
MAL1	Margin Alarm 1	The margin on the HDSL loop 1 has dropped below the threshold (1 to 15 dB) set by the user. Setting the threshold to zero inhibits the margin alarm.
MAL2	Margin Alarm 2	The margin on the HDSL loop 2 has dropped below the threshold (1 to 15 dB) set by the user. Setting the threshold to zero inhibits the margin alarm.
CHREV	Channels Reversed	The loop 1 and loop 2 HDSL pairs are reversed at the HRU input port. Loop 1 is specified to carry the (-) simplex DC voltage, and loop 2 is specified to carry the (+) simplex DC voltage.
ACO	Alarm Cut-Off	A minor alarm occurred and was retired by pressing the SEL button on the HLU-388 front panel.
		LOOPBACKS
SMJK	SmartJack Loopback	Loopback from HRU to network initiated by (2-in-5) in-band loopback code or out-of-band ESF data link code.
NREM	Network Remote Loopback	Loopback at HRU to network initiated from CO (network) by Intelligent Line Repeater (ILR) #2 code, Manual Loopback buttons on the HLU-388 front panel, HRU front panel button or by the maintenance terminal.
NLOC	Network Local Loopback	Loopback HLU-388 (local) to network initiated from CO by IOR code, the HLU-388 front panel Manual Loopback buttons or maintenance terminal.
CLOC	Customer Local Loopback	Loopback at HRU (local) to CI initiated from CPE by the ILR #2 code or the Manual Loopback buttons on the HLU-388 front panel or by the maintenance terminal.
CREM	Customer Remote Loopback	Loopback at HLU-388 (remote) to customer initiated by IOR code or the Manual Loopback buttons on the HLU-388 front panel or by the maintenance terminal.
ARM	Armed	The HiGain system has detected the IR loopback (2-in-5) arming code.
TLOS	Transmit Loss of Signal Loopback	HRU is in a logic loopback state caused by a loss of its T1 input from the CI (if enabled at the HRU via its TLOS switch option).

SET CLOCK

Press **B** from the Maintenance Terminal Main Menu to open the Set Clock screen (Figure 10).

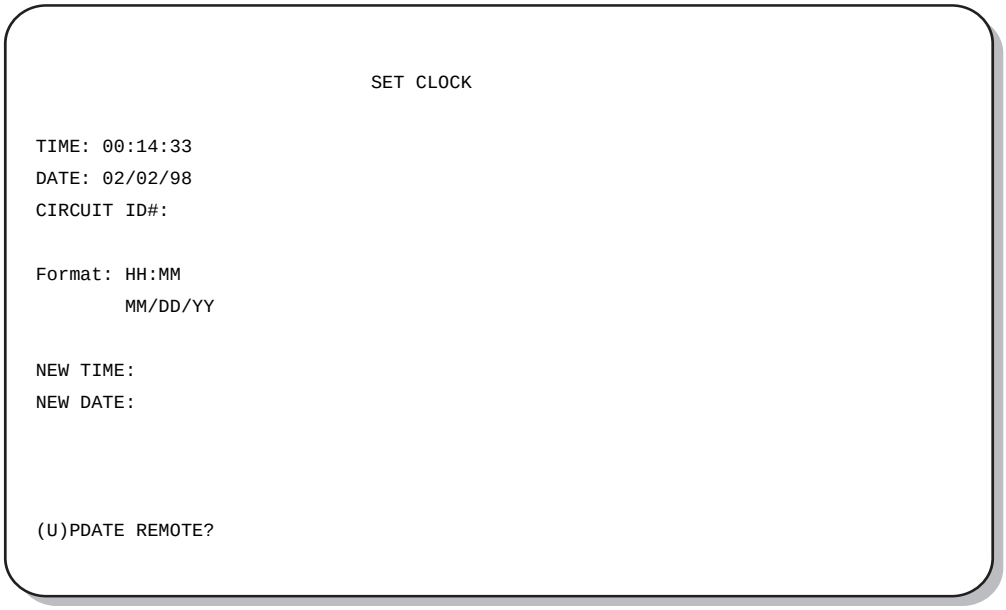


Figure 10. *Set Clock Menu*

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

Set Time

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

Set Date

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

When editing entries in the Clock screen and when using the Terminal emulation program in Windows 3.1, pressing the BACKSPACE key deletes two characters instead of just one.

Update the HRU Time and Date

For HRUs with software version 6.4 or higher, or HRUs List 6 or higher, the remote unit date and time is set by using this option. To update the remote, do one of the following:

- Press **U** to update the HRU to the same date and time set for the HLU-388.
- Press **ENTER**. (The remote unit is not updated.)

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

SYSTEM SETTINGS

The options set from the System Settings menu are the same as the options set through the HLU-388 front panel MODE and SEL buttons (except for Margin Alarm Threshold and DS0 Blocking, which can only be set at this screen). Refer to Table 9 on page 23 for a listing of system setting options.

Press **C** from the Maintenance Terminal Main Menu to open the System Settings menu (Figure 11).

```
                                SYSTEM SETTINGS

TIME: 12:46:06
DATE: 02/02/98                    CIRCUIT ID#:

E(Q)UALIZATION       : 0
SMART-JACK (L)B      : ENABLED
(S)PECIAL LPBK       : GNLB
(P)OWER              : ENABLE
(Z)BTSI              : OFF
ES ALARM TH(R)ESH    : NONE
LOOPBACK (T)IMEOUT   : 60
(A)LARM              : DISABLE
(D)S1 LINE CODE      : AMI
(F)RAMING            : AUTO
AIS ON (H)DSL LOSW   : 2 LOOPS
AIS ON S(M)JK/NREM   : ENABLE
MAR(G)IN ALM THRES   : 4
DS0 (B)LOCKING: xx = Blocked Channels
   01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

                                  (E)xit
               Enter the letter in parenthesis (X) to change any setting
```

Figure 11. *System Settings Menu*

To change any option:

1. Enter its character key, which is shown inside the parenthesis within each parameter description. This causes the screen to refresh with the new settings.
2. After all parameters have been selected, press **E** to exit, then **C** to confirm. The newly selected parameters are now activated.

DS0 Blocking Option

To set the DS0 Blocking option from the Main Menu:

1 Press C to select the Systems Settings menu (see Figure 11 on page 20).

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

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

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

DS1 Line Code Option

The DS1 line code option should always be set to conform to the type of T1 service (AMI or B8ZS) being provided by the HiGain system. The Auto mode, which can adapt to either AMI or B8ZS, should only be used in applications that require it (such as when HiGain acts as a standby circuit to T1 circuits whose line codes are not known or may be both AMI and B8ZS), because it has the following two limitations:

- The Auto mode induces one BPV in the T1 bit stream whenever it switches from AMI to B8ZS.
- The Auto mode allows both the HLU-388 and HRU to set their DS1 mode to the code that is being receiving at the opposite end's T1 input. This makes each unit's code independent of the T1 code, which is sent from the distant T1 input port. Thus, if the line codes being received are different in each of the two T1 directions, the HiGain T1 output codes will not match their respective T1 input codes at the other end. This could cause the customer's received data to be AMI instead of B8ZS, and thus violate the one's density rules by having excessive zeroes.

Margin Alarm Threshold

To set the Margin Alarm Threshold:

1 Select G from the System Settings menu.

2 Enter the desired minimum acceptable alarm threshold from the 0 to 15 dB range.

This causes a system alarm to occur if either the margin on HDSL loop 1 (MAL1) or loop 2 (MAL2) drops below the selected threshold value.

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

HAIS Selections

The HAIS option provides two selections for the T1 transmit outputs at both the HLU-388 and HRU for HDSL loss of sync conditions.

- **1LP** causes the AIS (LOS if ALMP is set to LOS) pattern to be transmitted at both T1 outputs when either of the two HDSL loops experience an out-of-sync (LOSW) condition or when a margin alarm occurs. 1LP causes the 12 channels on the surviving loop to be lost as they are replaced by the AIS/LOS pattern. However, it does notify downstream and upstream equipment of the loss of one HDSL loop or a loop with low margin. This is the preferred setting for initiating an AIS/LOS state with just one conductor open in either of the HDSL pairs. Short loops, below approximately 16 dB of loss at 200 kHz, can remain in sync with one conductor open. Since the loop is still in sync, no LOSW condition occurs. However, the margin on a one-conductor loop drops from 5 to 10 dB. Thus, if the Margin alarm is set to 5 dB below the normal margin at turn-up, when one conductor does open, a system alarm occurs and causes the AIS/LOS condition. This alerts the maintenance personnel of the problem.
- **2LP** requires both HDSL loops to be out of sync (LOSW) before the HAIS signal is transmitted. 2LP preserves the integrity of the 12 surviving channels when just one loop is lost.

SYSTEM SETTINGS MENU OPTIONS

Table 9 describes the System Settings menu options and their counterpart codes for the front panel display.

Table 9. *HLU-388 System Settings Menu Options*

System Settings Menu Options	Front Panel Display Code	Selection	Description
Equalization	EQL	0*	Sets the Equalizer to DSX-1 for 0 to 132 feet.
		133	Sets the Equalizer to DSX-1 for 133 to 265 feet.
		266	Sets the Equalizer to DSX-1 for 266 to 398 feet.
		399	Sets the Equalizer to DSX-1 for 399 to 532 feet.
		533	Sets the Equalizer to DSX-1 for 533 to 655 feet.
SmartJack Loopback	LBPK	DIS	Configures the HiGain system to ignore all in-band SmartJack loopback commands.
		ENA*	Enables the HiGain system to recognize all in-band SmartJack loopback commands.
Special Loopback	SPLB	GNLB*	Configures the HiGain system to respond to the generic (3/4 in 7) in-band loopback codes.
		A1LB and A2LB	Configures the HiGain system to respond to the in-band loopback codes of the Teltrend addressable repeater.
		A3LB	Configures the HiGain system to respond to the in-band loopback codes of the Wescom addressable repeater.
		A4LB	Configures the HiGain system to respond to the in-band loopback codes of the Wescom Mod 1 addressable repeater.
		A5LB	Configures the HiGain system to respond to the in-band loopback codes of the Teltrend Mod 1 addressable repeater.
Power	PWRF	DIS	Disables powering to the HRU and Doubler.
		ENA*	Enables powering to the HRU and Doubler.
ZBTSI	ZBTS	ON	Tells the HiGain system that the ESF frame is operating in its Zero-Byte Time Slot Interchange (ZBTSI) mode.
		OFF*	Tells the HiGain system that the ESF frame is operating in its normal non-ZBTSI mode.

Table 9. *HLU-388 System Settings Menu Options (Cont.)*

System Settings Menu Options	Front Panel Display Code	Selection	Description
ES Alarm Thresh	ESAL	17	Lights the red Status LED when 17 Errored Seconds occur within a 24-hour period.
		170	Lights the red Status LED when 170 Errored Seconds occur within a 24-hour period.
		NONE*	Prevents generation of a system alarm due to excessive Errored Seconds.
Loopback Timeout	LBTO	NONE	Disables automatic time-out cancellation of all loopbacks.
		20	Sets automatic cancellation of all loopbacks to 20 minutes after initiation.
		60*	Sets automatic cancellation of all loopbacks to 60 minutes after initiation.
		120	Sets automatic cancellation of all loopbacks to 120 minutes after initiation.
Alarm	ALM	DIS*	This option is not supported by the HLU-388 List 2E.
		ENA	
DSX-1 Line Code	DS1	AUTO	The HLU-388 and remote HRU monitor their incoming HRU T1 bit streams for the B8ZS pattern. If either detects a valid B8ZS sequence, it switches to its B8ZS mode and also forces the end unit's output into B8ZS mode. Each reverts back to its Alternate Mark Inversion (AMI) output mode if no B8ZS patterns are received at its inputs for five seconds. Thus, the HLU's T1 input can detect either AMI or B8ZS patterns when in the AUTO mode.
		B8ZS	Places both the HLU-388 and HRU into their B8ZS modes.
		AMI*	Places both the HLU-388 and HRU into their AMI modes.
Framing	FRMG	AUTO*	Configures the HiGain system to operate in an auto-framing (AUTO) mode in which it continuously searches the input T1 bit stream for a valid SF or ESF frame pattern. This feature is required for fractional T1 applications (DS0 blocking) where it insures proper channel time slot alignment. While the HiGain system can also process unframed data in this AUTO mode, it is recommended that the unframed (UNFR) mode be used for all unframed applications. Using the AUTO mode for unframed applications runs the risk of detecting "pseudo-valid" frame sequences, which can affect the data integrity.
		UNFR	Configures the HiGain system to operate in an unframed mode. This mode disables the auto framing process and forces the HiGain system to function as a transparent bit pipe.
AIS On HDSL LOSW	HAIS	2LP*	Causes the HiGain system to transmit the AIS signal at both the HLU-388 and HRU T1 output ports when both of the HDSL loops are not in sync (LOSW).
		1LP	Causes the HiGain system to transmit the AIS signal at both the HLU-388 and HRU T1 output ports when either of the two HDSL loops is not in sync (LOSW) or if a Margin alarm occurs.
AIS On SMJK/NREM	SAIS	ENA*	Causes the List 6 and 7 HRU-412 to transmit the AIS signal towards the Customer Interface (CI) when in NREM or SmartJack loopback.
		DIS	Causes the HRU-412 List 6 to either transmit the signal from the network towards the CI RCU port or to open and terminate its RCV CI port when an HRU NREM or SmartJack loopback is executed. The AIS signal is not sent (towards the CI).

Table 9. *HLU-388 System Settings Menu Options (Cont.)*

System Settings Menu Options	Front Panel Display Code	Selection	Description
DSO Blocking	DS0	BLK	The DS0 blocking option can only be set via the RS-232 Craft port with a terminal. The four-character line unit front panel only displays the status of the blocking option. BLK indicates at least one channel is blocked.
		NONE*	Indicates no channels are blocked.
Margin Alarm Threshold	MARG	0 to 15 dB	The Margin Alarm Threshold can only be set via the RS-232 Craft port with a terminal. It determines the minimum allowable margin below which a system alarm can occur. Zero disables the alarm.
		4dB*	Default value

*Indicates factory default settings.

LOOPBACK MENU

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

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

In all instances, press D from the Maintenance Terminal Main Menu to display the Loopback Menu. Figure 12 shows an example of a Loopback Menu when no doublers are present; Figure 13 shows an example when one doubler is present.

Loopback Menu: No Doubler

Figure 12 shows the Loopback Menu when no doublers are present.

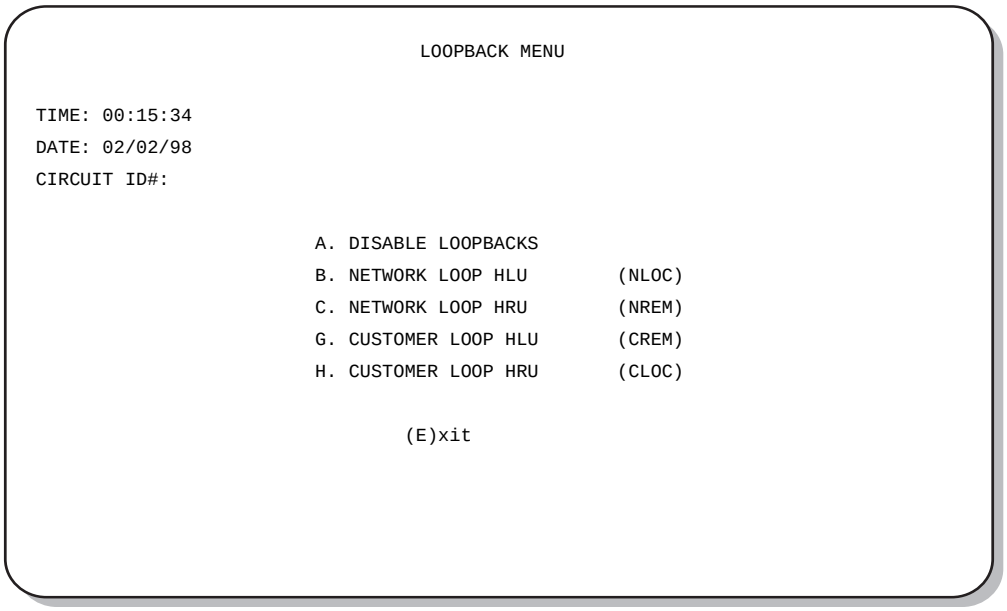


Figure 12. *Loopback Menu: No Doubler*

Loopback Menu: One Doubler

Figure 13 shows the Loopback Menu with one doubler. NDU2 and CDU2 are not available for one-doubler systems.

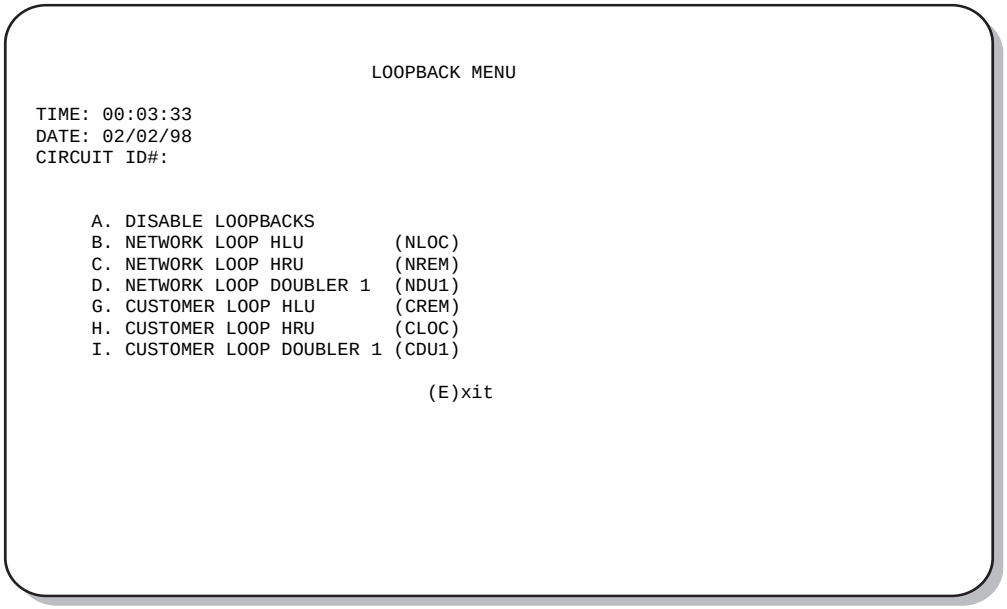


Figure 13. *Loopback Menu: One Doubler*

Initiating Loopbacks

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 14 in which an NLOC loopback is in progress). The loopback continues to cycle in the system depending upon your Loopback Timeout setting.

The Loopback Menu screen is also available at the HRU connected to the HLU-388, thus allowing all HiGain System loopbacks to be initiated from either end of the circuit.

```
HI-GAIN HLU-388     MAINTENANCE TERMINAL MAIN MENU   (ver V5.1L-5)
                         CIRCUIT ID#:

                    A. VIEW SPAN STATUS
                    B. SET CLOCK
                    C. SYSTEM SETTINGS
                    D. LOOPBACK MODE:  NLOC
                    E. VIEW PERFORMANCE DATA
                    F. VIEW PERFORMANCE HISTORY
                    G. VIEW ALARM HISTORY
                    H. ENTER CIRCUIT ID #
```

Figure 14. *NLOC Loopback Mode in the Maintenance Terminal Main Menu*

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.

VIEW PERFORMANCE DATA

The Performance Data screens show the Errored (ES) and Unavailable Seconds (UAS) for both HDSL loops and each T1 input at 15-minute intervals over a four-hour time interval. Earlier and later data, in four-hour time periods on different span screens, can be accessed by pressing **P** (Previous) or **N** (Next) respectively. All Performance Data counters can be set to zero by pressing **C** (Clear) from the HLU-388 Span Status screen shown below.

Since the HLU-388 is considered the master module, this clears *all* performance data screens at both the HLU-388 and the HRU. The RS-232 interface at the HRU does not allow the counters to be cleared.

Errored and Unavailable seconds are defined in Table 10.

Table 10. *Errored and Unavailable Seconds Definitions*

ES and UAS	Definition
HDSL Errored Second	A second in which at least one HDSL CRC has occurred.
HDSL Unavailable Second	A second in which an HDSL loop has loss from sync at least once.
DS1 Errored Second	A second in which at least one BPV has occurred.
DS1 Unavailable Second	A second in which at least one T1 LOS condition (175 ± 75) zeros has occurred.

From each Performance Data screen you can do the following:

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

Performance Data Screen: No Doubler

Press **E** from the Maintenance Terminal Main Menu to view the Performance Data screen for applications (Figure 15) without a doubler. This screen shows the Errored and Unavailable Seconds for the HDSL span between the HLU-388 and the HRU.

```
Date: 02/02/98           PERFORMANCE DATA
CIRCUIT ID#:
                  ERRORED SECONDS/UNAVAILABLE SECONDS

               DS1             HDSL-1            HDSL-2
          HLU      HRU      HLU      HRU      HLU      HRU
20:30    000/000  000/000  000/000  000/000  000/000  000/000
20:45    000/000  000/000  000/000  000/000  000/000  000/000
21:00    000/000  000/000  000/000  000/000  000/000  000/000
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


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

Figure 15. *Performance Data Screen: No Doublers*

Performance Data Screen: With Doubler

The Performance Data Screen displays information by span. With no doubler, there is only one span (Figure 15). With multiple doublers (up to two), there can be as many as three span screens.

1 Press **E** from the Maintenance Terminal Main Menu to view the Performance Data screen.

2 Press **S** from the Performance Data screen to advance through the performance data screens for the various spans.

Figure 16 is an example of a Performance Data screen that lists performance data for the second span (between the first and second doublers).

```
Date: 02/02/98        SPAN 2 PERFORMANCE DATA
CIRCUIT ID#:
                  ERRORED SECONDS/UNAVAILABLE SECONDS

               DS1             HDSL-1            HDSL-2
          HLU      HRU     HDU4      HRU     HDU4      HRU
00:00    000/000  000/000  000/000  000/000  000/000  000/000
00:15    000/000  000/000  000/000  000/000  000/000  000/000
00:30    000/000  000/000  000/000  000/000  000/000  000/000
00:45    000/000  000/000  000/000  000/000  000/000  000/000
01:00    000/000  000/000  000/000  000/000  000/000  000/000
01:15    000/000  000/000  000/000  000/000  000/000  000/000
01:30    000/000  000/000  000/000  000/000  000/000  000/000
01:45    000/000  000/000  000/000  000/000  000/000  000/000
02:00    000/000  000/000  000/000  000/000  000/000  000/000
02:15    000/000  000/000  000/000  000/000  000/000  000/000
02:30    000/000  000/000  000/000  000/000  000/000  000/000
02:45    000/000  000/000  000/000  000/000  000/000  000/000
03:00    000/000  000/000  000/000  000/000  000/000  000/000
03:15    000/000  000/000  000/000  000/000  000/000  000/000
03:30    000/000  000/000  000/000  000/000  000/000  000/000
03:45    000/000  000/000  000/000  000/000  000/000  000/000

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

Figure 16. *Span 2 Performance Data Screen*

VIEW PERFORMANCE HISTORY

The View Performance History option allows you to access the 7 Day History screens that show the number of ES and UAS occurrences in 24-hour increments for a seven-day period. Errored Seconds and Unavailable Seconds for both HDSL loops and each of the two DS1 inputs are listed for the current and previous seven days. The counters on all 7 Day History can be set to zero by pressing **C** (Clear).

Since the HLU-388 is considered the master module, this clears all performance data screens at both the HLU-388 and the HRU. The RS-232 terminal interface at the HRU does not allow the counters to be cleared.

The 7 Day History Screen: No Doubler

Press **F** (View Performance History) from the Maintenance Terminal Main Menu to open the 7 Day History screen for applications (Figure 17) without a doubler. The 7 Day History Span 1 screen shows the ES and UAS for the HDSL loop between the HLU-388 and the HRU.

```
Time: 00:16:55                    7 DAY HISTORY
CIRCUIT ID#:

                                     SPAN 1
                          ERRORED SECONDS/UNAVAILABLE SECONDS

                  DS1                    HDSL-1                  HDSL-2
            HLU          HRU          HLU          HRU          HLU          HRU
01/26   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/27   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/28   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/29   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/30   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
01/31   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
02/01   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00000/00015 00004/00001 00002/00016 00005/00002 00004/00013 00007/00001
                                     (Exit)
```

Figure 17. *7 Day History Screen for Span 1: No Doubler*

The 7 Day History Screen: With Doubler

The 7 Day History screen displays information by span. With no doubler, there is only one span (Figure 17). With multiple doublers (up to two), there can be as many as three span screens.

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

2 Press **S** from the 7 Day History screen to advance through the history screens for the various spans.

Figure 18 is an example of a 7 Day History screen that lists performance data for the first span (between the HLU-388 and the first doubler).

```
Time: 03:09:34                    7 DAY HISTORY
CIRCUIT ID#:

                                     SPAN 1
                          ERRORED SECONDS/UNAVAILABLE SECONDS

                  DS1                    HDSL-1                  HDSL-2
             HLU          HRU         HLU          HDU1        HLU         HDU1
04/09    00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/10    00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/11    00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/12    00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/13    00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/14    00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
04/15    00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current  00001/00000 01094/00798 00000/01101 00369/00004 00000/01101 00141/00006
                                 (E)xit       (S)pan
```

Figure 18. *7 Day History Screen Span 1: With Doubler*

VIEW ALARM HISTORY

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

- First and Last columns contain the time and date stamp of the first and last occurrence of each alarm.
- Current column shows the status of each alarm.
- Count column lists the number of times each alarm occurred.
- Maximum non-overflowing count is 999.

From each Alarm History screen you can do the following:

- Press **U** to update the screen.
- Press **S** to view another span.
- Press **C** to clear all data from the screen.
- Press **E** to exit from the Alarm History screen.

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

Table 11. *Alarm History Fields and Descriptions*

Field	Description
None	No alarms.
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.
Span 1 ES, HDSL 1	First and last instance of ES on HDSL1; Current condition, number of alarms.
Span 1 ES, HDSL 2	First and last instance of ES on HDSL 2; 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-SHRT	Power short condition; Current condition, number of alarms.
PWR-GND	Power ground condition; Current condition, number of alarms.
Last Cleared: None	Last time Alarm History cleared; Current condition, number of alarms.

Alarm History Screen: No Doubler

Press **G** from the Maintenance Terminal Main Menu to view the Alarm History screen for an application without a doubler (Figure 19).

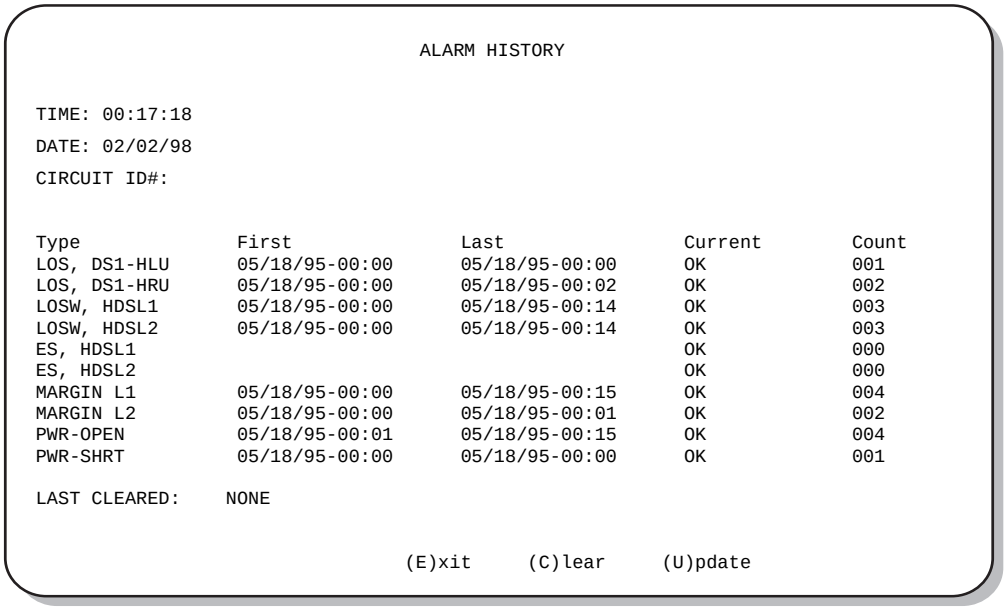


Figure 19. *Alarm History Screen for Span 1: No Doubler*

Alarm History Screen: With Doubler

The Alarm History screen displays information by span. With no doubler, there is only one span (Figure 19). With multiple doublers (up to two), there can be as many as three span screens.

1 Press **G** from the Maintenance Terminal Main Menu to view the Alarm History screen.

2 Press **S** from the Alarm History screen to advance through the alarm history screens for the various spans.

Figure 20 is an example of an Alarm History screen that lists history for the span one (between the HLU-388 and the first doubler).

```
                                ALARM HISTORY


TIME: 00:17:18
DATE: 02/02/98
CIRCUIT ID#:


Type              First               Last                Current       Count
LOS, DS1-HLU      05/18/95-00:00      05/18/95-00:00      OK            001
LOS, DS1-HRU      05/18/95-00:00      05/18/95-00:02      OK            002
SPAN1 LOSW, HDSL1 05/18/95-00:00      05/18/95-00:30      OK            004
SPAN1 LOSW, HDSL2 05/18/95-00:00      05/18/95-00:30      OK            004
SPAN1 ES, HDSL1                                           OK            000
SPAN1 ES, HDSL2                                           OK            000
SPAN1 MARGIN L1   05/18/95-00:00      05/18/95-00:31      OK            006
SPAN1 MARGIN L2   05/18/95-00:00      05/18/95-00:31      OK            003
PWR-OPEN          05/18/95-00:01      05/18/95-00:30      OK            005
PWR-SHRT          05/18/95-00:00      05/18/95-00:00      OK            001

LAST CLEARED:    NONE


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

Figure 20. *Alarm History Screen for Span 1: With Doubler*

CIRCUIT ID OPTION

To set the Circuit ID option:

1 From the Main Menu, press **H**.

The message `ENTER CIRCUIT ID#:` displays.

2 Type a Circuit ID (24 characters maximum), then press **ENTER**.

If you type more than 24 characters, a “Beep” sounds and only the first 24 characters are accepted as the Circuit ID.

3 Press **C** to confirm.

The ID appears in all HLU-388 screens. The ID does not appear on the HRU screens when you access them from the remote unit maintenance port.

Note that the Circuit ID can not be set to its factory setting (all blanks) using the DFLT setting option (see “Factory Default Values” on page 9).

SYSTEM ALARMS

Table 12 on page 35 lists possible HLU-388 alarm states. The accompanying front panel message is listed in the Alarm column. More than one alarm condition can exist at any given time, but only one message can be displayed. For multiple alarms, only the highest priority alarm displays.

Table 12. *HDSL System Alarms*

Front-Panel Message	Alarm	Description	To inhibit:
ALRM LOSW	Loss of Sync Word*	One of the HDSL loops has lost synchronization.	Cannot be inhibited.
ALRM LLOS	Local Loss of Signal	Loss of the DSX-1 input signal.	Cannot be inhibited.
ALRM RLOS	Remote Loss of Signal	Loss of the HRU DSX-1 input signal.	Disable the RDA (Remote DS1 Alarm) option. This prevents an LOS condition at the DS1 input to a HRU from activating Pin H. The front panel Status LED still flashes red and the ALRM RLOS message displays to alert you of the LOS state. LOS is sent towards the network from the HLU. This option prevents the common occurrences of a CPE LOS condition from generating recurring alarms and AIS payloads.
ALRM TLOS	Transmit Loss of Signal	The DS1 input is not present at the HRU. Places the HRU in loopback towards the network.	Set the TLOS switch at the HRU to disable.
ALRM H1ES	HDSL Loop 1 Errored Seconds	HDSL Loop 1 has exceeded the user-selected 24-hour Errored Seconds threshold. If both H1ES and H2ES occur simultaneously, only H1ES displays on the front panel.	Set ESAL system option to NONE. See "System Settings" on page 20 for more information.
ALRM H2ES	HDSL Loop 2 Errored Seconds	HDSL Loop 2 has exceeded the user-selected 24-hour Errored Seconds threshold. If both H1ES and H2ES occur simultaneously, only H1ES displays on the front panel.	Set ESAL system option to NONE. See "System Settings" on page 20 for more information.
ALRM DS1	Bipolar Violations	The total number of bipolar violations (BVP) at either the HLU-388 or the HRU DS1 inputs has exceeded the user-selected 24-hour threshold.	Set ESAL system option to NONE. See "System Settings" on page 20 for more information.
ALRM MAL1 or ALRM MAL2	Margin Alarm Loop1 or Margin Alarm Loop2	The margin on HDSL Loop 1 or Loop 2 has dropped below the minimum threshold value set by the terminal MARGIN ALARM THRES.	Set the Margin Alarm Threshold option to 0 (zero).

* When both HDSL loops lose sync word (LOSW), a system alarm condition exists. However, since the HLU-388 enters a self test cycling mode, the front panel LED lights yellow instead of red and the SELF TEST message displays instead of the ALRM message.

RETIRING SYSTEM ALARMS

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

SELF TEST

The Self Test mode that occurs when both HDSL loops are not in sync has been enhanced to include the input DS1 transceiver chip. The Self Test procedure can cause the AIS pattern, that is normally transmitted from the HLU-388 during these out of sync intervals, to exhibit occasional BPVs.

LOOPBACK OPERATION

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

GENERIC LOOPBACK CODE (GNLB)

The HiGain generic loopback code is GNLB. The GNLB allows in-band codes to loop-up either the HLU/NLOC (4 in 7) or HRU/NREM (3 in 7) towards the network. In addition, it allows in-band codes to loop-up the HLU/CREM (6 in 7) or HRU/CLOC (5 in 7) towards the customer. For doubler applications, it permits looping doubler 1 toward the network NDU1 (2 in 6) or toward the Customer CDU1 (4 in 6). Doubler #2 is looped toward the network with NDU2 (3 in 6) or toward the Customer with CDU2 (5 in 6). Either loop-up condition is terminated (looped-down) with the 3-in-5, loop-down code. Both in-band codes must be present for five seconds before the HiGain system responds. See “GNLB Loopback Test Procedures” on page 41 for the test procedures that apply when using the GNLB mode.

ADDRESSABLE REPEATER LOOPBACK FUNCTIONS

In addition to the SMJK loopback, a HiGain system can be configured for one of five special in-band loopback (SPLB) command sequences. These are selected from the SPLB user option shown in Table 9 on page 23 and Figure 21 on page 39 (non-doubler applications). Doubler loopback locations are shown in Figure 22 on page 40.

The A1LB loopback selection, Table 5, complies with that proposed for HDSL systems in the T1E1.4/92 recommendation with the following additions:

- Query loopback
- IOR (Intelligent Office Repeater) power-down
- Three loopback time-out choices
- Initiation from either end
- Repeating bit error signatures
- Alternate query loopback

These additions make A1LB identical to A2LB described below. It is given a separate identity to allow future T1E1 enhancements to be added without affecting A2LB.

A2LB through A5LB are four special, addressable, repeater loopback functions which are supported by the HLU-388. These loopbacks provide the HiGain system with sophisticated maintenance and trouble shooting tools. A2LB and A5LB are patterned after the Teltrend addressable T1 repeater loopbacks. A3LB and A4LB are patterned after the Wescom addressable T1 repeater loopbacks. All four SPLBs have been enhanced to handle the specific requirements of the following HiGain system customers:

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

A5LB differs from A2LB in that A5LB does not block the arming code from exiting the HLU-388 into the network. A2LB can be configured to either block this arming code after 2 seconds, and replace it with the AIS code, or to unblock it by executing the FAR-END ACTIVATE code. Since A5LB never blocks the arming code from exiting the Line Unit, it does not need this FAR-END ACTIVATE code. A3LB differs from A4LB in that A3LB supports the additional (1 in 6) SMJK loopback command.

When T1 loopback tests are performed on the HiGain system with metallic loopback connections at either end, the T1 code, which exists at the metallic loopback interface, may be different from the T1 code being received at the opposite end when the DS1 user code is set to Auto. This is caused by the fact that, in the Auto DS1 code mode, the HLU-319, List 2D and HRU-412 set their own codes independently of each other. Each end sets its transmit code to match its receive code. Thus, if one end is receiving AMI, and the other B8ZS, their codes are different. For example, if the HRU-412 has a metallic loopback, and the HLU-319, List 2D receive pattern code is changed from AMI to B8ZS, and next, the all “0” pattern is sent into the HLU-319, List 2D, then the HLU-319, List 2D changes to its B8ZS mode while the HRU-412 remains in its AMI mode, and thus loops all “0.” This causes the HRU-412 to indicate an LOS condition, which causes the HLU-319, List 2D to output the AIS pattern.

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

INITIATING MANUAL LOOPBACK SESSIONS

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

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

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

To initiate a manual loopback session:

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

`MAN LPBK`

followed by the message:

`NLO?`

2 Do one of the following:

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

  a Press the MODE button. The message changes from `NLO?` to `NRE?` in a non-doubler system (or ND1 in a doubler system).

  b Press the SEL button to execute the NREM loopback in a non-doubler system (or NDU1 in a doubler system).

In this manner all eight loopbacks can be initiated, in the following order: NLOC, NDU1, NDU2, NREM, CLOC, CDU2, CDU1, CREM.

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

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

These same loopbacks can be initiated from the RS-232 Craft port by choosing the Loopback Mode, option D, from the Main Menu. This displays the Loopback Menu (Figure 12 on page 26) from which any of the loopbacks can be initiated or terminated.

LOOPBACK TEST PROCEDURES

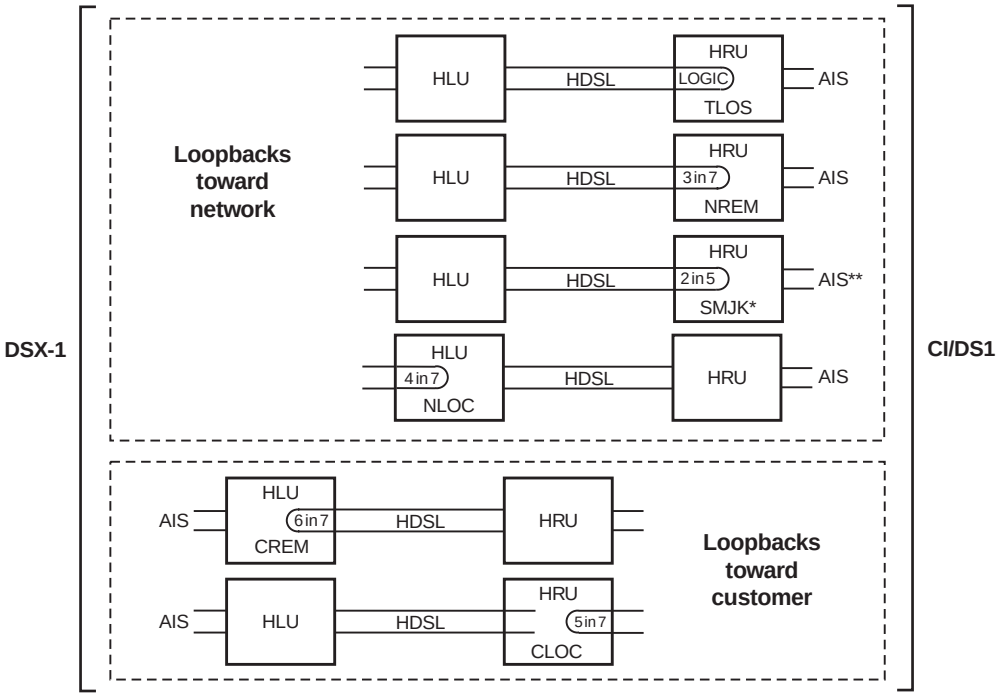
The following sections provide step-by-step test procedures for the HLU-388 as a function of the loopback option selected. These procedures allow verification of the integrity of the HDSL channels at every module location as well as the DS1 channels to the customer and the local DSX-1 interface.

If trouble is encountered on the HLU-388 DSX-1 interface, verify that the HLU is making a positive connection with its mounting assembly (shelf) connector. Also, verify that the HLU internal equalizer is set to the correct distance range per Table 9 on page 23. All equalizers should be set to the distance from the DSX-1 to the shelf.

The transmit and receive T1 DSX-1 ports have splitting access jacks and miniature, 210-series, bridging jacks as shown in Figure 1 on page 3. Connecting one cable between the two bridging jacks and another between the two SPAN jacks splits the XMT and RCV and creates metallic loopbacks towards both the DSX-1 and the HLU-388. If separate plugs are inserted into both SPAN jacks with the other end disconnected, the BRG jacks can be used to send and receive test patterns towards the DSX-1.

LOOPBACK OPERATION WITHOUT DOUBLERS

The complete family of loopbacks that a HiGain system without doublers can execute is shown in Figure 21. The loopbacks can be initiated from the HLU RS-232 Craft port, the HLU front-panel MODE and SEL buttons, or from a family of Special Loopback (SPLP) in-band loopback commands.



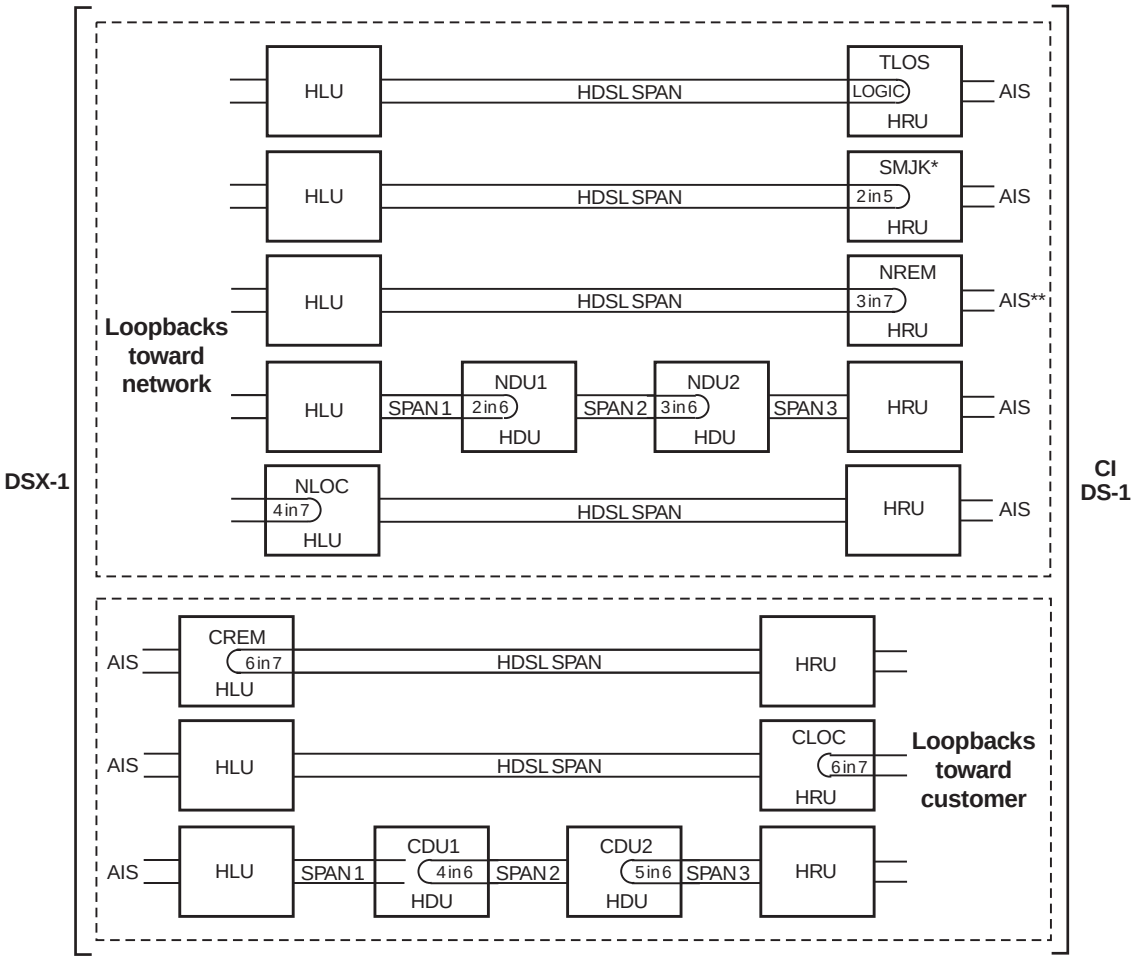
* The Smart-Jack loopback is a metallic loopback in the HRU Lists 6 and 7. It is a logic loopback in HRU Lists 1 through 5.

** Set the SAIS option to ENA to send the AIS pattern to the CI during Smart-Jack Loopback.

Figure 21. *HLU-388 Non-Doubler Loopback Configurations*

LOOPBACK OPERATION WITH DOUBLERS

The complete family of loopbacks that a HiGain system equipped with the HDU-409, HDU-417 or HDU-404 can execute is shown in Figure 22. The loopbacks can be initiated from the HLU RS-232 Craft port, the HLU front-panel MODE and SEL buttons, or from a family of Special Loopback (SPLP) in-band loopback commands.



Use the 3 in 5 code to loop down any of these loopbacks.

* The Smart-Jack loopback is a metallic loopback in the HRU's Lists 6 and 7. It is a logic loopback in all lower HRU list numbers.

** The SAIS option must be set to ENA to cause the AIS pattern to be sent to the CI during Smart-Jack Loopback.

Figure 22. *Doubler Loopback Configurations*

GNLB LOOPBACK TEST PROCEDURES

To perform the GNLB loopback test procedure:

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

2 Have the CO tester transmit a T1 test signal into the HLU-388 and verify that the returned (looped) signal is error-free.

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

4 Have the CO tester send the HLU-388 (4-in-7) in-band loopup for 5 seconds. You should be able to see that an NLOC HLU-388 loopback is in effect. (Loopback states are indicated by the green LOOP LED on the front panel and also display in the Span Status screen.)

5 Repeat Step 2. If the test passes, the problem is in the downstream direction. If it fails, the problem is in the upstream direction.

Notes on Non-doubler GNLB Loopback Test Procedures:

- The HLU-388 can be looped up from the remote location (CREM) by issuing the (6-in-7) command at the HRU DS1 input port.
- The HRU can be looped up from the remote location (CLOC) by issuing the (5-in-7) command at the HRU DS1 input port.

Notes on Doubler GNLB Loopback Test Procedures:

- Doubler #1 can engage loopback from the remote location (CDU1) by issuing the (4-in-6) loopback command at the HRU DS1 input port.
- Doubler #1 can engage loopback from the local location (NDU1) by issuing the (2-in-6) loopback command at the HLU-388 DS1 input port.
- Doubler #2 can engage loopback from the remote location (CDU2) by issuing the (5-in-6) loopback command at the HRU DS1 input port.
- Doubler #2 can engage loopback from the local location (NDU2) by issuing the (3-in-6) loopback command at the HLU-388 DS1 input port.

A1LB, A2LB, and A5LB Test Procedures

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

1 Send into the HLU-388 the in-band ARMING and NI LPBK code 11000 for at least five seconds.

2 Monitor the output of the HLU-388 for the return of the pattern. Return of the pattern indicates that:

- either the HRU has looped up (if the SMJK Loopback option is Enabled),
- or that an external NI has looped up (if the SMJK Loopback option is Disabled) and that the HLU-388 and HRU units have been ARMED.

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

4 Once armed, the HLU-388 can be looped back by sending Intelligent Office Repeater (IOR) LPBK activation code 1101 0011 1101 0011 (D3D3) for at least five seconds. The tester observes, the following activation response, in the order presented:

- two seconds of AIS (all ones)
- five seconds of returning data pattern
- 231 logic errors (including the frame bit) occurring in the returned pattern comprising:
  - 10 errors, if ILR-1 (Doubler 1) was sent
  - 200 errors, if ILR-20 (Doubler 2) was sent
  - 20 errors, if ILR-2 (HRU) was sent
  - normal looped data

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

The HLU is now in Logic Loopback. The Loopback Time-out option is user settable to:

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

These selections determine the duration of this loopback unless it is overridden by the Time-out Override command or a loop-down command is sent. If the Time-out Override code 1101 0101 1101 0110 (D5D6) is received, the activation sequence described in step 4, above, is repeated and the automatic timed expiration of the loopback is inhibited. If this Time-out Override is sent, then the only way to loop the HLU-388 down is to:

- Issue the IR (Intelligent Repeater) LPDN (loop-down) code 1001 0011 1001 0011 (9393) *or*
- Issue the NI LPDN and Disarm code 11100.

The automatic time-out timer is restored during subsequent loopback sessions.

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

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

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

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

Using the codes listed in Table 13 on page 44, a network tester can activate loopbacks NLOC or NREM or SMJK (if enabled). A customer tester can activate loopbacks CLOC or CREM. All loopbacks shown in Table 13 can also be initiated from the HLU-388 front panel MODE and SEL buttons (see "Setting Options Through SEL and MODE" on page 9).

Information specific to HiGain doublers is shown in bold in Table 13.

Table 13. *Addressable 1, 2, 5 (A1LB, A2LB, A5LB) Repeater Loopback Commands*

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

* The left most bit arrives first in all sequences. The detection algorithm functions reliably with a random 10^{-3} Bit Error Ratio (BER) on the facility. The IOR POWER DOWN code must remain present for the duration of the power down mode. When this code is removed, the HiGain system returns to its normal unlooped and unarmed state. Note that the entire arming and loopback sequence can be initiated at the remote HRU location.

† This is the HEX number for the 4-bit group.

A3LB and A4LB Test Procedures

The HLU-388 can be looped back by sending the Addressable Office Repeater (AOR) LPBK activation code 1111(F) 1111(F) 0001(1) 1110(E) for at least five seconds. This causes the HLU-388 to enter the NLOC state. The Loopback Time-out option can be set by the user to:

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

These selections determine the duration of this loopback, unless it is overridden by the reception of a second identical 16-bit loop-up command before the timer expires. When this time-out override state exists, the only way to loop the HLU-388 down is to issue one of the three loopdown commands listed in Step 2. The automatic time-out mode is restored during subsequent loopback sessions.

Table 14 summarizes the codes required to execute Addressable 3 and 4 (A3LB and A4LB) repeater loopback commands. All code sequences must be present for at least 5 seconds. The abbreviations used in Table 14 are as follows:

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

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

Table 14. *Addressable 3 and 4 (A3LB and A4LB) Repeater Loopback Commands*

Position	Name	Code*
HLU-388 LU FROM NI	NLOC	1111(F)† 1111(F)0001(1)1110(E)
HLU-388 LU from CI	CREM	0011(3)1111(F)0001(1)1110(E)
HDU DOUBLER 1 FROM NI	**NDU1**	**1111(F)1111(F)0000(0)1000(4)**
HDU DOUBLER 1 FROM CI	**CDU1**	**0011(3)1111(F)0000(0)0100(4)**
HDU DOUBLER 2 FROM NI	**NDU2**	**1111(F)1111(F)0000(0)0110(6)**
HDU DOUBLER 2 FROM CI	**CDU2**	**0011(3)1111(F)0000(0)0110(6)**
HRU LU FROM NI	NREM	1111(F)1111(F)0000(0)0010(2)
HRU LU FROM CI	CLOC	0011(3)1111(F)0000(0)0010(2)
HRU LU FROM NI	SMJK	11000 11000 11000 ...
HRU LU FROM NI	SMJK	100000 100000 100000 ...
HRU LU FROM NI (ESF-DL)	SMJK	1111(F)1111(F)0100(4)1000(8)
HLU and HRU LD FROM NI OR CI	Loopdown	11100 11100 11100 ...
HLU and HRU LD FROM NI OR CI	Loopdown	100 100 100 ...
HLU and HRU LD FROM NI OR CI (ESF-DL)	Loopdown	1111(F)1111(F)0010(2)0100(4)

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

† This is the HEX number for the 4-bit group.

APPENDIX A - TECHNICAL SPECIFICATIONS

HDSL Line Code	784 kbps 2B1Q
HDSL Output	+13.5 dBm ±0.5 dB at 135Ω
HDSL Line Impedance	135Ω
Maximum Provisioning Loss	35 dB at 196 kHz, 135Ω
Line Clock rate	Internal "Stratum 4" clock
HDSL Start-up Time	30 sec. (typical), 60 sec. (maximum) per span
One-way DS1 Delay	<200 µs per span without doublers.
DSX-1 Line Impedance	100Ω
DSX-1 Pulse Output	pre-equalized for 0 to 655 feet of ABAM cable ABAM cable shields must be grounded at both ends
DSX-1 Input Level	+1.5 to -7.5 dBDSX
DS1 Line Rate	1.544 Mbps ±200 bps
DS1 Line Format	AMI, B8ZS or ZBTSI
DS1 Frame Format	ESF, SF or UNFR
Maximum Heat Dissipation	6W (without doubler), 9W (with doubler) typical
Maximum Power Consumption	14W (without doubler), 25W (without doubler)
Fusing	Internal; connected to "FUSE ALARM" output on pin 10
HDSL Span Voltage	±130 to ± 200 Vdc
Margin Indicator	Displays HDSL span SNR margin for both HDSL spans relative to 10^{-7} BER operation
Electrical Protection	Secondary surge and power cross protection on HDSL ports. Secondary surge protection on DS1 ports.
Operating Temperature	-40° to +65° C (-40° to +149° F)
Operating Humidity	5% to 95% (non-condensing)
Mounting	DDM+ high-density shelf or equivalent
Dimensions	
Height:	3.5 in. (8.0 cm)
Width:	0.72 in. (1.8 cm)
Depth:	10.25 in. (26.0 cm)
Weight:	1 lb. (.45 kg)

APPENDIX B - ABBREVIATIONS

2B1Q	2 Binary, 1 Quaternary
AIS	Alarm Indicator Signal
AMI	Alternate Mark Inversion
B8ZS	Bipolar with 8-zero Substitution
BPV	Bipolar Violation
CI	Customer Installation
CO	Central Office
CLOC	Customer Local Loopback
CPE	Customer Premises Equipment
CRC	Cyclic Redundancy Check
CREM	Customer Remote Loopback
CSA	Carrier Servicing Area
DDM+	Double Dual Module Plus
DDS	Digital Data Service
DL	Data Link
DS1	Digital Signal Level 1
DSX-1	Digital System Cross-connect frame
ES	Errored Seconds
ESF	Extended Superframe
HCDS	High Capacity Digital Service
HDSL	High-bit-rate Digital Subscriber Line
HDU	HiGain Doubler Unit
HLU	HiGain Line Unit
HRU	HiGain Remote Unit
LOS	Loss of Signal
LOSW	Loss of Sync Word
NEBS	Network Equipment Building System

NI	Network Interface
NID	Network Interface Device
NLOC	Network Local Loopback
NREM	Network Remote Loopback
POTS	Plain Old Telephone Service
SAIS	SmartJack AIS
SF	SuperFrame
SNR	Signal to Noise Ratio
SPLB	Special Loopback
STS	Span Termination System
UAS	Unavailable Seconds
ZBTSI	Zero Byte Timeslot Interchange

APPENDIX C - FUNCTIONAL OPERATION

PairGain HDSL technology provides full-duplex services at standard T1 rates over copper wires between an HLU and an HRU, which comprise one HiGain system. HiGain systems use PairGain 2-Binary 1-Quartenary (2B1Q) HDSL transceiver systems to establish two, full-duplex, 784 kbps data channels between the HLU-388 and a remotely located HDU or HRU. This provides a total capacity of 1.568 Mbps between the two units.

A block diagram of the HLU-388 is shown in Figure 23. The HLU-388 receives a 1.544 Mbps DSX-1 data stream from the DSX-1 digital cross connect interface. The HLU-388 contains a DS1 frame synchronizer controlled by an 8-bit microprocessor that determines the type of framing on the DS1 stream and synchronizes to it. The HLU-388 recognizes Superframe (SF), including D4, or Extended Superframe (ESF) framing. When the data is unframed, the HLU-388 arbitrarily defines a frame bit.

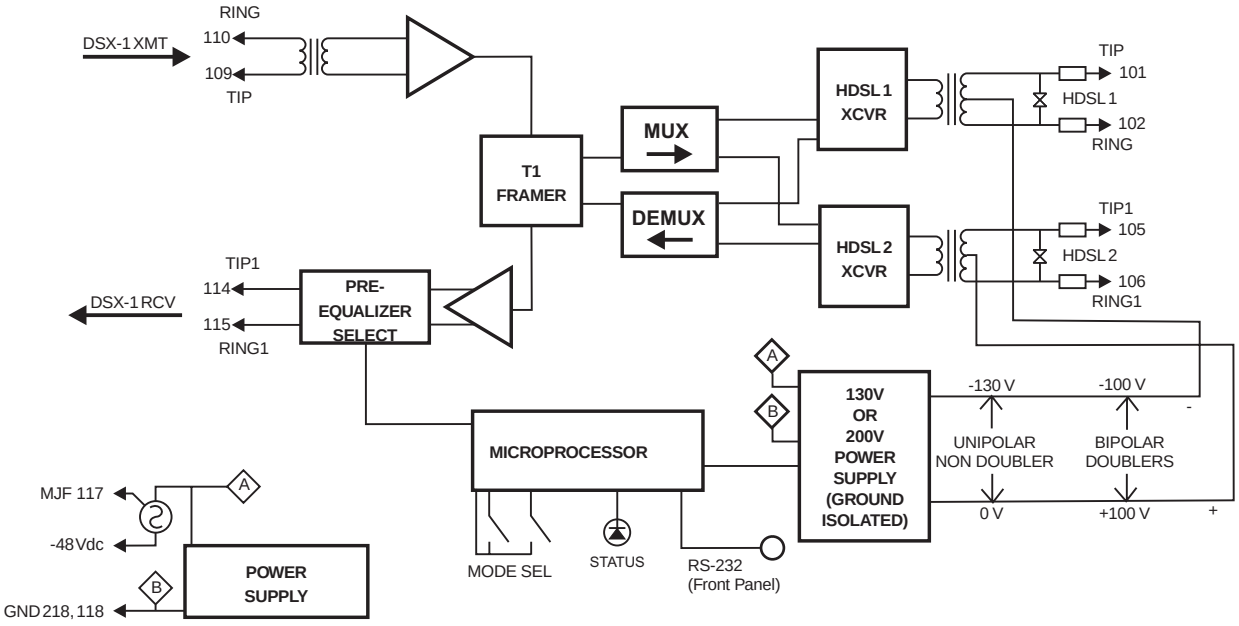


Figure 23. *HLU-388 Block Diagram*

The HLU-388 List 2E contains a multiplexer that generates two parallel 784 kbps data streams. The data streams contain HDSL frames that are nominally 4704 bits (6 milliseconds) in length. The HDSL frames contain a 14-bit Frame Sync Word (FSW), 6-bit Cyclic Redundancy Check (CRC), 21-bit operations channel and DSX-1 payload. The DSX-1 stream is separated into two parallel streams that comprise the payloads of the HDSl channels. The HLU-388 allocates the DS0 time slots according to the version of HRU to which it is connected. Older version HRUs require the odd DS0 time slots allocated to loop 1 and the even DS0 time slots to loop 2. Newer version HRUs require the allocation of DS0 time slots 1 through 12 to loop 1 and time slots 13 through 24 to loop 2. The 8 kbps frame bits of the DSX-1 stream are included on both HDSL channels. The two formatted HDSL channels are passed to the HDSL transceivers, which convert them to 2B1Q format on the HDSL lines. The 2B1Q line code is designated to operate in a full-duplex mode on unconditioned pairs. The transceiver echo canceler and adaptive equalizer receive the signal from the remote end in the presence of impairments and noise on the copper pairs.

The received HDSL channels are processed by the transceiver and then passed on to the HLU-388 demultiplexer module. The demultiplexer provides frame synchronization for each of the two HDSL loops. The demultiplexer and HDSL transceivers work under control of the HLU-388 microprocesser and compensate for data inversions caused by tip-ring reversals and loop swaps caused by pair reversals. The HiGain system allows for tip-ring or pair reversals, but does not tolerate split pairs. By synchronizing to the Frame Sync Word (FSW) of each loop, the demultiplexer can reconstruct the original 1.544 Mbps DS1 stream from the payloads of the two HDSL loops. The

CRC fields on the HDSL streams allow the HLU-388 to determine if errors are present on the channel due to excessive impairments on the HDSl pairs or excessive impulse or crosstalk noise.

The demultiplexer removes data link messages from the HDSL loops and passes them to the microprocessor. This mechanism allows operations messages and status to be exchanged between the HLU-388 and the HRU.

The reconstructed HDSL data is buffered in a first-in-first-out (FIFO) buffer within the demultiplexer. A frequency synthesizer, in conjunction with the FIFO, regulates the output bit rate and reconstructs the DSX-1 clock at the exact rate received from the remote end. The HiGain system operates at T1 rates of 1.544 Mbps with up to ±200 bps of offset.

A DSX-1 interface driver converts the input data to an Alternate Mark Inversion (AMI) or Binary Eight Zero Substitution (B8ZS) format. The DSX-1 equalizer is programmable to five different lengths, as determined by the distance between the HLU-388 and the DSX-1 interface. This provides CB-119 specification compliant pulses at the DSX-1 interface over a range of 0 to 655 feet of ABAM-specification cable. To comply with GR-1089 CORE, section 4.5.9, the shields of the ABAM cables must be grounded at both ends.

The new T1 transceiver chip allows the unit to process both B8ZS and AMI code inputs, regardless of the DS1 code setting (AMI or B8ZS). Earlier units caused input BPV, if B8ZS patterns were processed while in the AMI mode. When the newer units are in the AMI mode, they can receive B8ZS but can only transmit AMI. For this reason HiGain systems containing both the HLU-388 List 2E and older List HRUs will respond differently in each direction for B8ZS inputs when in AMI mode.

The HLU-388 List 2E contains two separate power converters. The main power supply converts -48 Vdc local battery to logic power for the HLU-388 circuits. The line power supply converts the -48 Vdc battery to either 130 Vdc (for non-doubler applications) or 200 Vdc for doubler applications), then provides simplex power feed on the two HDSL line interfaces. The 140 V output voltage used in non-doubler applications is always unipolar. The 200 V output voltage used in doubler unit applications is always bipolar. The line power supply can be turned on or off by the microprocessor and is automatically shot down in the presence of line short circuits or microprocessor failure.

HDSL Line Voltage

A unique feature of the HLU-388 List 2E is that its 200 V output voltage for doubler applications is always bipolar. This bipolar voltage is required to support the Ground Fault Detection (GFD) circuit, which is also unique to the HLU-388 List 2E. The 140 V output voltage used in non-doubler unit applications is always negative. This keeps the HDSL cable pair voltage at or below ground potential, thereby avoiding corrosion problems caused by cable voltages more positive than ground.

The specific bipolar voltage levels existing between ground and the two loops for doubler unit applications depend on the following factors:

- loop length
- number of doubler units
- type of doubler units (List)
- whether the HRU is line powered or locally powered

The line voltage power supply is ground referenced, but also ground isolated by 200 kohms. This ground isolation reduces problems due to induced noise currents and large surge voltages, which are ground referenced. It also reduces ground fault currents, which improves the product’s safety. The safety issue thus depends solely on the differential voltage across loop 1 and loop 2.

Ground Fault Detect

The HLU-388 has a Ground Fault Detect (GFD) circuit that is compliant with paragraph R7-1, Section 7.2.1 of GR-1089-CORE, Issue 1, Revision 1, December, 1996.

The GFD circuit immediately detects ground faults that occur at any point along any span on any conductor, and shuts down the HiGain circuit. The HLU-388 then applies power periodically to the first span to detect the ground fault condition. This power cycling and ground fault protection continues as long as the fault condition exists.

POWER CONSUMPTION

The three most important power parameters of an HLU are its maximum power consumption, its maximum power dissipation, and its maximum current drain.

The Maximum Power Consumption is the total power that the HLU-388 consumes or draws from its -48 V shelf power source. This parameter is needed when the HLU-388 is remotely located to its serving CO. It determines the battery capacity required to maintain an eight-hour standby battery reserve for emergency situations; thus limiting the maximum number of plugs per line unit's remote enclosure.

The Maximum Power Dissipation measures the power that is converted into heat buildup within the unit. It contributes to the total heat generated in the space around the unit. It is used to determine the maximum number of fully loaded shelves per bay that does not exceed the maximum allowable power dissipation density in Watts/sq. ft. In COs, the maximum power dissipation for open-faced, natural convection cooled mountings is limited to 134.7 Watts/sq. ft. per Section 4.2.3 of the NEBS GR-63-CORE. The footprint of a standard 28-slot 23-inch HLU-388 shelf is 7.024 sq. ft. Thus, the maximum bay dissipation is limited to 946 Watts. At 7 Watts per slot, this limits the number of occupied slots to 135 per bay. The thermal loading limitations, imposed when using the HLU-388 in a Controlled Environmental Vault (CEV) or other enclosures, are determined by applying the HLU-388 power parameters to the manufacturer's requirements for each specific housing.

The Maximum Current Drain is the maximum current drawn from the shelf power supply when it is at its minimum voltage (-42.5 V). It determines the shelf fusing requirements. All HLU-319 shelves are partitioned into two equal halves, each fused at 10 amps for a total of 20 amps per shelf. A fully loaded shelf draws 7.9 amps (no doublers) or 17 amps (with doublers) worst case. This is within the 20 amp fuse limit.

Heat baffles should be placed between every other shelf, in racks containing more than two shelves. This technique deflects the rack's heat outward and reduces thermo stress on the plugs.

Power Consumption: Without Doublers

Maximum Power Dissipation:

- Per Slot = 6 Watts
- Per Shelf = 168 Watts

Maximum Power Consumption:

- Per Slot = 15 Watts
- Per Shelf = 420 Watts

Maximum Current Drain:

- Per Slot = 0.28 Amps
- Per Shelf = 7.9 Amps

The worst case conditions, under which these parameters were measured, include a 9,000 ft., AWG 26 loop, 60 mA of Customer Provided Equipment (CPE) current, a fully loaded 28-slot shelf, and a -42.5 V shelf battery voltage with the HLU-319 4-character display "OFF." For the purpose of comparison, the HLU-319, List 1 unit dissipates 8.5 Watts and consumes 18 Watts per slot under similar worst case conditions.

Power Consumption: With Doublers

See Table 15 for CO current and other related power parameters for various doubler applications.

Table 15. *HLU-388 Power Parameters With HDU-451*

60 mA CPE Current	CO Voltage Volts	CO Current Amps	Power Consumption Watts	HLU Power Dissipation Watts	HDU Doubler Models
OFF	42.50	0.50	21.5	8	HDU-451, List 1-4, 4B HDU-439/437 List 1, 1B
OFF	48.00	0.44	21.5	8	HDU-451, List 1-4, 4B HDU-439/437 List 1, 1B
OFF	56.00	0.38	21.5	8	HDU-451, List 1-4, 4B HDU-439/437 List 1, 1B
ON	42.50	0.6	25.5	9	HDU-451, List 3, 4, 4B HDU-439/437 List 1, 1B
ON	48.00	0.53	25.5	9	HDU-451, List 3, 4, 4B HDU-439/437 List 1, 1B
ON	56.00	0.45	25.5	9	HDU-451, List 3, 4, 4B HDU-439/437 List 1, 1B

The worst case conditions, under which these parameters were measured, include a loop with one HDU-451 List 1 doubler, four 9000-foot #26 AWG spans, and an HRU-412 that is providing 60 mA of Customer Provided Equipment (CPE) current.

APPENDIX D - COMPATIBILITY

T1 REPEATER SHELVES AND RELATED EQUIPMENT

The HLU-388 List 5 is compatible with the following T1 repeater shelves and associated equipment:

- Shelf (23-inch)
  - Larus FT2 1188 (28-slot, connectorized)
  - AT&T DS1 Ext. (28-slot, connectorized)
- Shelf (19-inch)
  - Larus FT21187 (20-slot, connectorized)
- Cabinet Distant Terminal (23-inch)
  - Larus FT2 1190 (12 slots) for a 51A cabinet

DOUBLER DEPLOYMENT

For doubler applications, one or two doublers maybe used in the HDSL loops between the HLU-388 and the HRU. When using two doublers in an HDSL loop, the HRU must be locally powered. The HLU-388 can be used with low-power HDU-451 List 3 and List 4 doubler units and HDU-439/437 "mini" doublers over the entire CSA range in all three spans.

Use of the HLU-388 with the higher-powered HDU-451, List 1 or List 2 doubler is restricted per the following deployment rules:

- If Span 1's loop resistance is known, then the maximum loop resistance of Span 2 is the smaller of either 800 ohms or the following calculated value:

  Maximum Span 2 Loop Resistance = [2600 - 4 (Span 1 Loop Resistance)] ohms

  For example, if Span 1 Loop Resistance = 550 ohms, then Span 2 Loop Resistance must be no more than 400 ohms. If Span 1 Loop Resistance = 400 ohms, then Span 2 Loop Resistance must be no more than 800 ohms.
- If Span 2's loop resistance is known, then the maximum loop resistance of Span 1 is calculated as follows:

  Maximum Span 1 Loop Resistance = [650 - (Span 2 Loop Resistance/4)] ohms

  For example, if Span 2 Loop Resistance = 700 ohms, then Span 1 Loop Resistance must be no more than 475 ohms.

The Span Resistance formulas in Rules 1 and 2 above illustrate that Span 1's resistance has four times the effect on the total circuit's range than does Span 2's resistance. In other words, if Span 1 can be reduced by 50 ohms, Span 2 can be increased by 200 ohms. So, always minimize the length of Span 1

- Use only HRU-412 units with list numbers 6 or higher. Do not use Lists 1, 2, 3, 3A, 4, and 5.
- The HRU-412 CPE current option must be set to 0 mA. Its 60 mA CPE current switch must be set to 0 mA, or, its card edge pins must be strapped for 0 mA in the enclosure that provides these strapping options.
- In two-doubler applications, the first doubler (the one nearest the HLU) can be a List 1 or List 2. The second doubler, however, must be a List 3 unit.

APPENDIX E - PRODUCT SUPPORT

This section contains product support and warranty information.

TECHNICAL SUPPORT

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

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

Fax: (714) 832-9924

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

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

WARRANTY

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

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

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

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

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

FCC COMPLIANCE

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

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

- Cabling
- Correct connections
- Grounding

MODIFICATIONS

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

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

STANDARDS COMPLIANCE

The HLU-388 List 5 has been tested and verified to comply with the applicable sections of the following standards.

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

To comply with the intrabuilding wiring requirements of GR-1089-CORE, section 4.5.9, the shields of the ABAM-type cables that connect the HLU-388 DSX-1 output ports to the cross-connect panel must be grounded at both ends.

BAR CODE AND CONFIGURATION NUMBER INFORMATION

Figure 24 shows the location of the CLEI/ECI bar code label and the configuration number on the HLU-388. Table 16 gives a brief description of what each label contains.

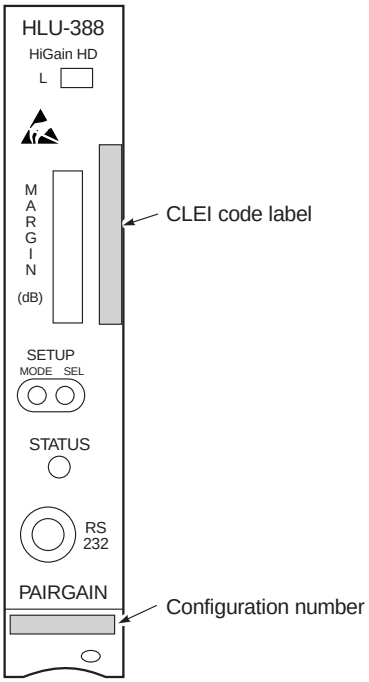


Figure 24. *Bar Code Label and Configuration Number*

Table 16. *Bar Code Label and Configuration Number Descriptions*

Number	Components
CLEI/ECI bar code label	Contains the serial number and part number of the unit, as indicated in both bar code and text format. Also contains the configuration number of the unit as indicated by "CFG:nn," where *nn* is the configuration number. For example, CFG:07 indicates a revision number 7.
Configuration number	The configuration number is a two or three-digit number that is either the last digits of a five or six-digit warranty control number or a standalone configuration number of two or three digits.

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