PAIRGAIN® TECHNOLOGIES HIGAIN® DOUBLER UNIT MODEL HDU-451 Issue 1

List 3B, PairGain #150-1143-32 CLEI Code: T1R5G54EAA

CONTENTS PAGE

CAUTION
This product incorporates static sensitive components. Proper electrostatic discharge procedures must be followed.

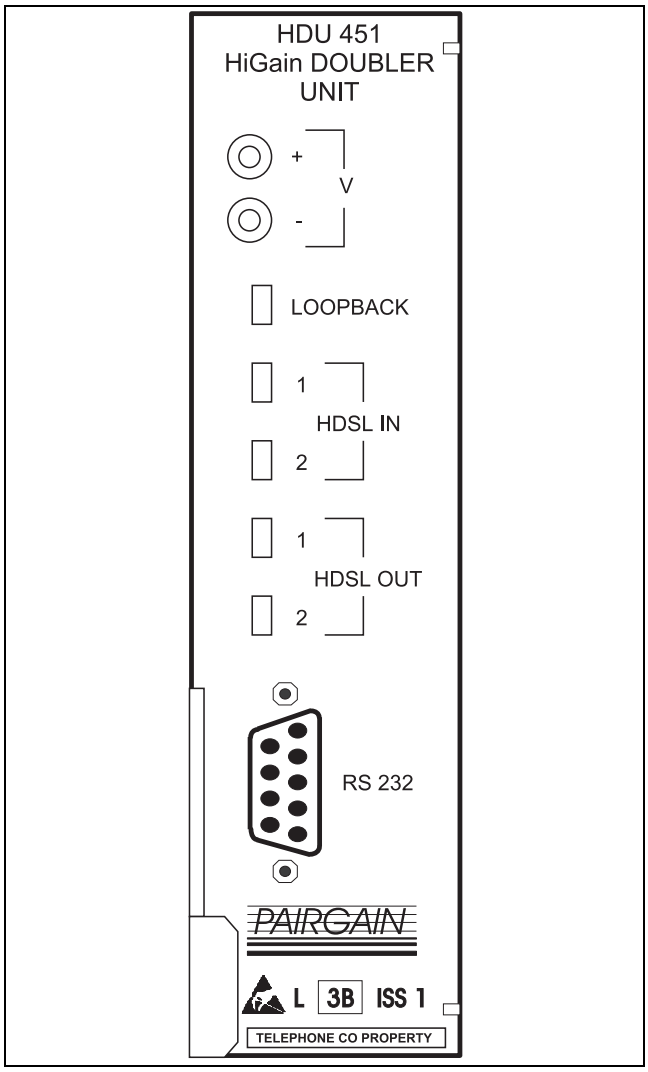

Figure 1. HDU-451 List 3B Front Panel. The PairGain HDU-451 extends the range of HiGain repeaterless T1 transmission systems.

A. PRODUCT OVERVIEW

1. DESCRIPTION AND FEATURES

1.01 PairGain's HiGain Model HDU-451 List 3B low-power Doubler Unit (Figure 1) extends the range of the HiGain repeaterless T1 transmission system. When installed between an HLU List 6D HiGain Line Unit and an HRU-412 HiGain Remote Unit, the HDU-451 enables 1.544 Mbps transmission over an extended Carrier Serving Area (CSA) range of approximately 24,000 feet of 24 AWG or 18,000 feet of 26 AWG wire. Customers can use two doublers in series to triple the normal CSA range (36,000 feet on 24 AWG).

1.02 The HDU-451 mounts in a single slot of any industry-standard 400 mechanics shelf or in equivalent enclosures manufactured by PairGain Technologies. All HiGain modules comply with the applicable requirements of TR-TSY-000063 (Network Equipment Building System (NEBS) Generic Equipment requirements) and TR-TSY-000499 (Transport System Generic Requirements - TSGR).

1.03 Revision History of this practice.

a) Revision 01 - October 3, 1997 (initial release).

b) Revision 02 - November 11, 1997.

1.04 HDU-451 List 3B, HiGain Doubler Unit features:

- Powered by all HLU doubler-compatible line units - no local power required
- Front Panel HDSL Status Display
- Front panel jacks for test access
- Lightning and power cross protection on the HDSL interfaces (both sides)
- Front Panel Doubler loopback LED indicator
- Low power dissipation

1.05 In line with PairGain's continuing efforts to provide equipment that fully complies with new industry standards, the List 3B doubler has been enhanced with a special ground fault-detecting circuit described in Paragraph R7-1, Section 7.2.1 of GR-1089-core, Issue 1, Revision 1, December, 1996.

When used with HiGain line units, ground faults occurring at any point along any span on any wire are immediately detected. This condition shuts the HiGain circuit down. The line unit will periodically try to apply power to the first span to determine whether the fault condition is still present. As long as the fault condition exists, the power cycling and ground fault protection will continue.

Circuits containing both the new List B and older doublers also support this new ground fault detecting feature, provided the doubler nearest the HLU is a List B unit. The presence of this new circuit causes the HDSL span-powering voltage levels to be shifted up to 100 volts more positive than what they are in non-List B doubler circuits. The actual shift depends on loop length, number of doublers, HRU powering option, and the setting of the HLU Bipolar/Unipolar Switch. The List B doublers are backward-compatible with all versions of HiGain line units.

The operation of the ground fault circuit requires that the doubler enclosure be connected to earth ground.

2. APPLICATIONS

2.01 The primary application of the HDU-451 HiGain Doubler is to extend the delivery of T1 High-Capacity Digital Service (HCDS) to customers over metallic cable pairs, up to 24,000 or 36,000 feet (24 AWG). A doubler application is shown in Figure 2. Customers can use a maximum of two HDU-451 units in tandem on a single service.

2.02 Table 1 provides a guide for the loss of various cable gauges at 196 kHz and 135 ohms. The table applies to the HDSL cable pairs between the HLU and the HDU-451 as well as between the HDU-451 and a second HDU-451 or the HRU-412. Add 3 dB for each bridged tap and 1 dB for each cable gauge change.

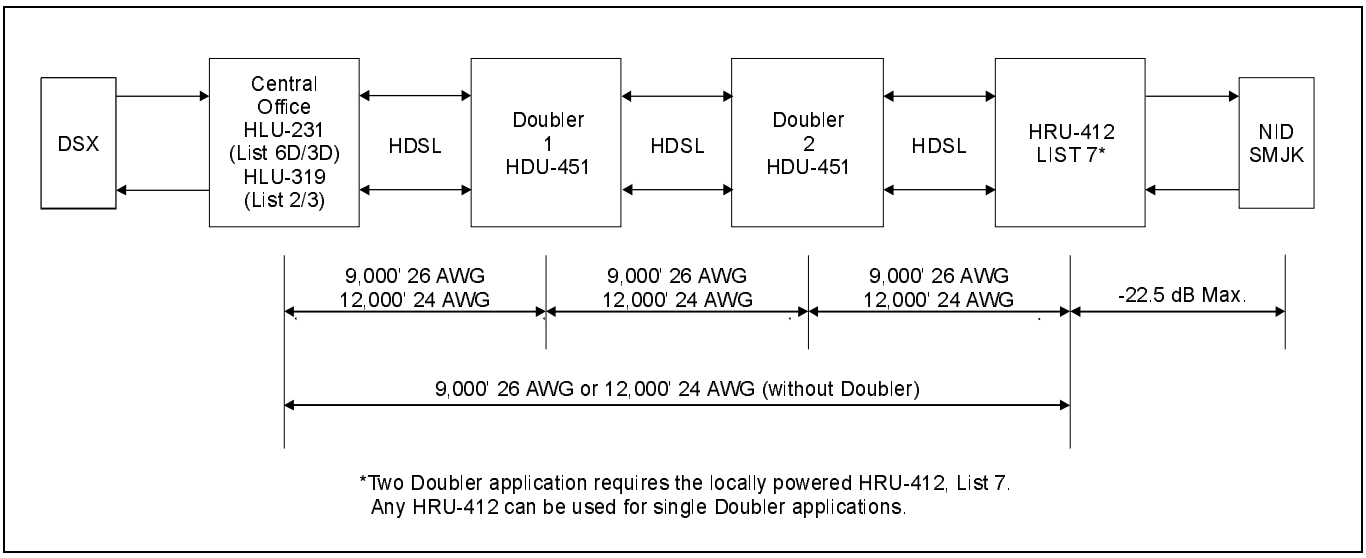

Figure 2. HiGain Installation with Two Doublers. The HDU-451 can extend the delivery of T1 High-Capacity Digital Service (HCDS) to customers over metallic cable pairs, up to 24,000 or 36,000 feet (24 AWG).

TABLE 1. HDSL LOSS OVER CABLES

Cable Gauge	Loss @ 196 kHz(dB/ft)	Ohms per ft
26/0.4mm	3.880	83.3
24/0.51mm	2.841	51.9
22/0.61mm	2.177	32.4
19/0.91mm	1.535	16.1

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

3. SPECIFICATIONS

HDSL Line Code

784 kbps, 2B1Q full duplex

HDSL Output

+13 dBm ±0.5 dB @ 135 ohms

HDSL Line Impedance

135 ohms

HDSL Line Input DC resistive signature

330 kilohms

HDSL Line Output DC resistive signature

25 ohms

Maximum Provisioning Loss

35 dB @ 196 kHz, 135 ohms

Line Clock Rate

Internal Stratum 4 clock

HDSL Startup Time

15 seconds (typical), 30 seconds (maximum)

Power Consumption

6 watts (maximum)

Electrical Protection

Secondary surge and power cross protection on all HDSL ports.

Operating Temperature and Humidity (non-condensing)

-40° to + 65° Celsius, 5 to 95%

Operating Temperature in Outside Enclosures

Complies with Section 10.2.1.3 of TA-NWT-001210. (See paragraph 8.01.)

Operating Elevation

200 feet below sea level to 13,000 feet above sea level.

Mounting

Single-width, 400-type mechanics.

Dimensions

Height: 5.6 " (14.22 cm)
Width: 1.4 " (3.5 cm)
Depth: 5.6 " (14.22 cm)

Weight

0.81 lb. (0.37 kg)

4. CERTIFICATION

4.01 FCC Compliance: The HDU-451 has been tested and found to comply with the limits for Class A digital devices pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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

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

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

5. WARRANTY

5.01 PairGain Technologies warrants this product to be free of defects and to be fully functional for a period of 36 months from the date of original shipment, given proper 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 improper use or installation.

5.02 This module should not be field repaired. 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 will void the warranty.

5.03 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.
14402 Franklin Avenue
Tustin, CA 92680
ATTN: Repair and Return Dept.
(800) 638-0031

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

6. TECHNICAL ASSISTANCE

6.01 PairGain Technical Assistance is available 24 hours a day, 7 days a week by contracting PairGain's Customer Service Engineering group at one of the following numbers:

Telephone:	**(800) 638-0031**
	(714) 832-9922
Fax:	**(714) 832-9924**

During normal business hours (8:00 AM to 5:00 PM, Pacific Time, Monday - Friday, excluding holidays), technical assistance calls are 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 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) 730-3299. Transmission speeds up to 28.8 kbps are supported with a character format of 8-N-1.

B. FUNCTIONAL DESCRIPTION

7. OPERATIONAL CAPABILITIES

7.01 HiGain utilizes PairGain's Two-Bits, One-Quaternary (2B1Q) HDSL transceiver systems to establish two full-duplex 784 kbps data channels (total of 1.568 Mbps) between the HLU and a remotely mounted HRU-412 HiGain Remote Unit. Each HDU-451 increases the total span of the

CSA by approximately 12,000 feet (24 AWG) or 9,000 feet (26 AWG).

7.02 A block diagram of the HDU-451 is shown in Figure 3. The HDU-451 power supply uses the 100 to 200V dc power feed voltage received on the simplex pairs to produce +5V and -5V dc required by the HDU-451 circuitry. The power feed is passed to the HDSL Output to power one other HiGain module, either a second HDU-451 ***or*** the remote HRU-412. If you use two doublers, the remote module must be a locally powered HRU-412 List 7 unit.

7.03 The maximum power dissipation of the HDU-451 is 6 watts.

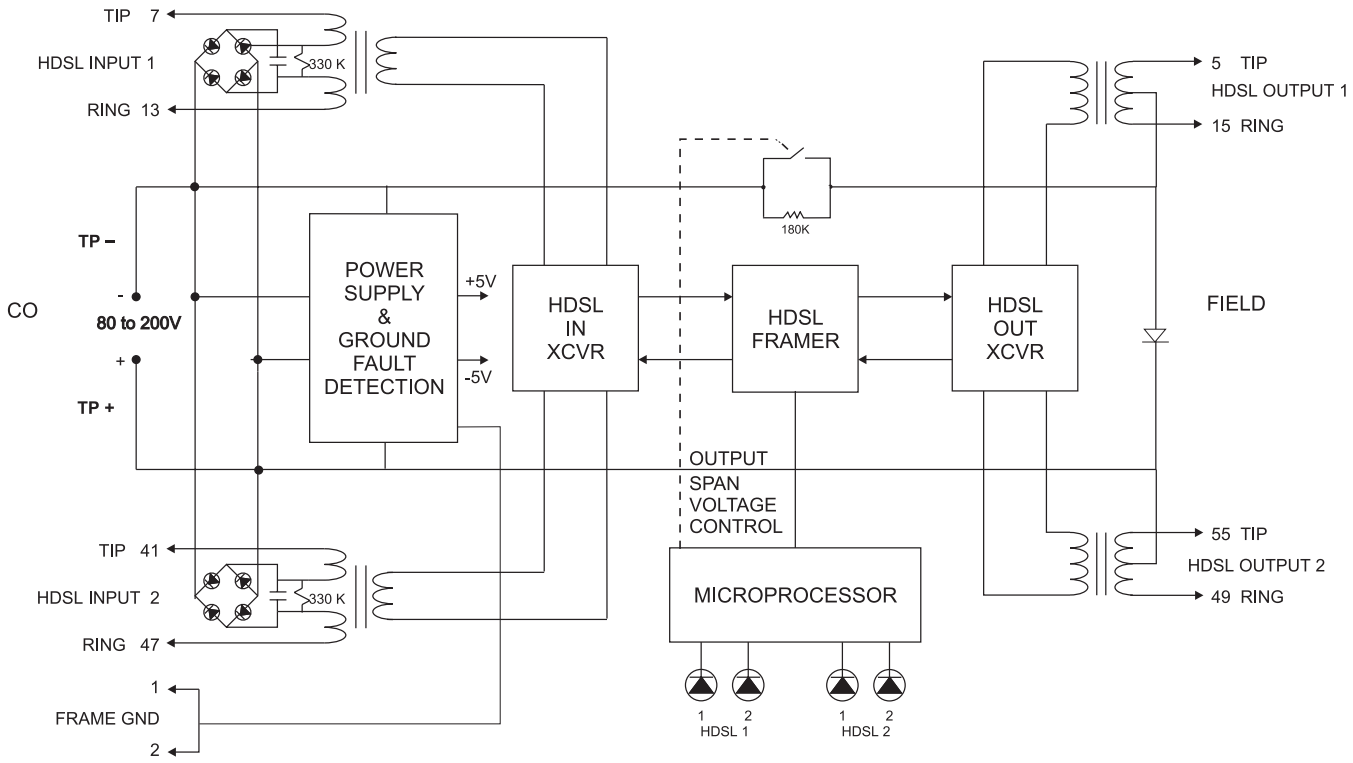

Figure 3. HDU-451 Block Diagram. Each HDU-451 increases the total span of the CSA by approximately 12,000 feet (24 AWG) or 9,000 feet (26 AWG).

8. OUTSIDE ENCLOSURE DEPLOYMENT RULES

8.01 Customers must take care when deploying the HDU-451 in sealed multislot outside enclosures, such as the PairGain HRE-423. These enclosures restrict the rate of heat transfer to the outside ambient. This effect can cause excessive heat build up if you do not follow the deployment rules shown in Table 1. Note that the allowable maximum outside ambient temperature is a function of the number of occupied slots. All of the applications in Table 1 exceed the temperature requirement of Section 10.2.1.3 of TA-NWT-001210. This section requires that HDSL equipment deployed in outside enclosures shall operate in a temperature, ambient outside the housing, of -40ºF with no solar load to +115ºF with maximum solar load and maximum power dissipation.

8.02 Customers may also enclose the doubler in the PairGain single-slot HRE-450 outdoor enclosure. Its thermal limits are also shown in Table 1.

TABLE 1. HDU-451 DEPLOYMENT RULES FOR HRE-423 AND HRE-450 ENCLOSURES

Ambient Temperature (maximum)	*Solar Loading*	*Number of Doublers*
HRE-423		
120ºF (49ºC) 135ºF (57ºC)	Full None	3 3
127ºF (52ºC) 142ºF (61ºC)	Full None	2 2
140ºF (60ºC) 149ºF (65ºC)*	Full None	1 1
HRE-450		
149ºF (65ºC)*	Full	1

Full Loading = Maximum sunlight exposure per Section 10.2.1.3 of TA-NWT-001210.

None = Indoor, underground or fully shaded location.

*Maximum operating temperature.

9. FRONT PANEL

9.01 The front panel of the HDU-451 contains the following connectors and indicators (see Figure 1):

- **+/- V Jacks**

  These two test jacks enable you to monitor the input voltage feed on the HDSL line. Typical values range from 130V to 200V, based on the distance from the HLU or first HDU-451.

- **LOOPBACK LED Indicator**

  Each HDU-451 supports two loopbacks as described in Section 10: NDU (1 or 2) and CDU (1 or 2). NDU1 (NDU2) loops back towards the Network through the HLU. CDU1 (CDU2) loops back toward the customer through the HRU-412. The **LOOPBACK** indicator has the following states:

  Green—indicates loopback NDU1 or NDU2 is active.

  Yellow—indicates loopback CDU1 or CDU2 is active.

  Flashing Yellow—indicates the doubler is in an armed state ready to accept a 16-bit intelligent loopback command issued at the HLU or HRU-412 DS1 inputs.

- **HDSL IN LED Indicators**

  Two LEDs indicate the status of the two HDSL input line pairs: **HDSL IN 1** and **HDSL IN 2**. These indicators have the following states:

  Flashing Green—indicates synchronization is being attempted with the HLU.

  Green—indicates HDSL frame synchronization between the HLU and HDSL input.

  Flashing Red—indicates an HDSL error

  Yellow—indicates a Margin alarm at this HDSL port.

- **HDSL OUT LED Indicators**

  Two LEDs indicate the status of the two HDSL output line pairs: **HDSL OUT 1** and **HDSL IN 2**. These indicators have the following states:

Flashing Green—indicates synchronization is being attempted with the HRU-412 or a second HDU-451.

Green—indicates HDSL frame synchronization between the HDSL output and the HRU-412 or a second HDU-451.

Flashing Red—indicates an HDSL Error

Yellow—indicates a Margin alarm at this HDSL port.

- **RS232 Connector**

The HDU-451 List 3B supports a full set of maintenance, test and status menus and displays on an ASCII terminal attached to the RS-232 front panel connector. (See Figure 4 for the RS-232 connector pinouts.) The array of displays are shown in Figures 7 through 24 at the end of this practice. The port is configured as DCE with 8 data bits, 1 stop bit, and no parity. Striking the Spacebar several times invokes the autobaud feature, which covers a 1200 to 9600 bps range.

The technique by which the various display information is obtained is called "remote log in". The doubler is actually logged onto the HLU unit and obtains all the display data from the HLU. This saves memory space because it eliminates the need to keep redundant information in three different locations. The consequence of this feature is that only one doubler can be on-line and logged in to the HLU at any given time. Thus, you must log in each doubler (press the Enter key) at the initial Log-On screen shown in Figure 7.

When you log in either doubler, no one can log in on the other doubler until you log off the on-line doubler by choosing the REMOTE LOG OFF selection from the Main Menu, shown in Figure 8. To prevent an operator from inadvertently failing to log off and thereby preventing another from logging on, an on-line logged-in doubler will automatically log itself off after five minutes of inactivity (no keyboard strikes).

10. LOOPBACK DESIGN DESCRIPTION

10.01 Figure 5 shows the complete family of loopbacks that a HiGain system can execute. Four of these loopbacks, NDU1, NDU2, CDU1, and CDU2, occur in the doubler. These loopbacks can be initiated from the HLU's maintenance port, the HLU's front panel pushbuttons, and from a family of Special Loopback (SPLP) in-band loopback commands. Figure 5 lists the Generic, SPLP, in-band loop-up command set for the four doubler loopbacks: 110000 (2 in 6) for NDU1, 111000 (3 in 6) for NDU2, 111100 (4 in 6) for CDU1 and 111110 (5 in 6) for CDU2. Refer to the appropriate HLU practices for more details regarding the other doubler loopback commands.

11. MAINTENANCE PORT DISPLAYS

11.01 Main Menu. Figure 8 is the main menu of the maintenance terminal. Its five submenus provide many useful provisioning, test, and monitoring tools.

11.02 Status. Figures 9 through 12 show the HDU-451 status displays. Span 1's display contains data on the two HDSL loops between the HLU and the first doubler. Span 2 refers to the loops between the first doubler and the HRU-412 for one-doubler circuits or between the first and second doublers for two-doubler circuits. Span 3 refers to the loops between the second doubler and the HRU-412 for two-doubler circuits. All status screen contain the same DS1 interface information.

11.03 System Settings. Figure 13 shows the System Settings menu. You can set these system options only at the HLU. The HDU-451 menu is a monitor only display.

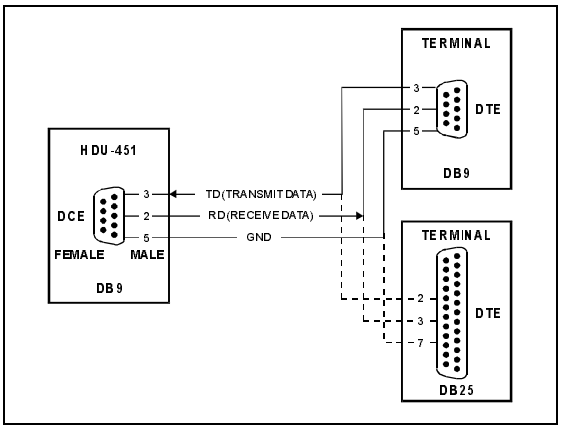

Figure 4. HDU-451 DB-9 Pin Outs. A standard RS-232 (DB-9) connector on the front panel provides access to the menu interface feature via a dumb terminal.

11.04 Performance Data. Figures 14 through 17 show the system Performance Data displays. Both the Errored and Unavailable Seconds for both HDSL loops and each T1 input are listed at 15-minute intervals over a 4-hour time duration. Span 1's display contains data on the two HDSL loops between the HLU and the first doubler HDU1. Span 2 refers to the loops between the first doubler HDU1 and the HRU-412 for one-doubler circuits or between the first and second doublers (HDU1 and HDU2) for two-doubler circuits. Span 3 refers to the loops between the second doubler and the HRU-412 for two-doubler circuits. All status screens contain the same DS1 interface errors. You can display earlier or later data, in four-hour increments, by entering "P" (previous) or "N" (next), respectively. You can display performance data from the different spans by entering "S" (span). You can set all of the counters to zero by selecting the (C)lear option from the **HLU** Status Screen only. Note that since the HLU is considered the master module, executing its Clear function clears **all** performance data screens at both the HLU, the HDUs, and the HRU-412.

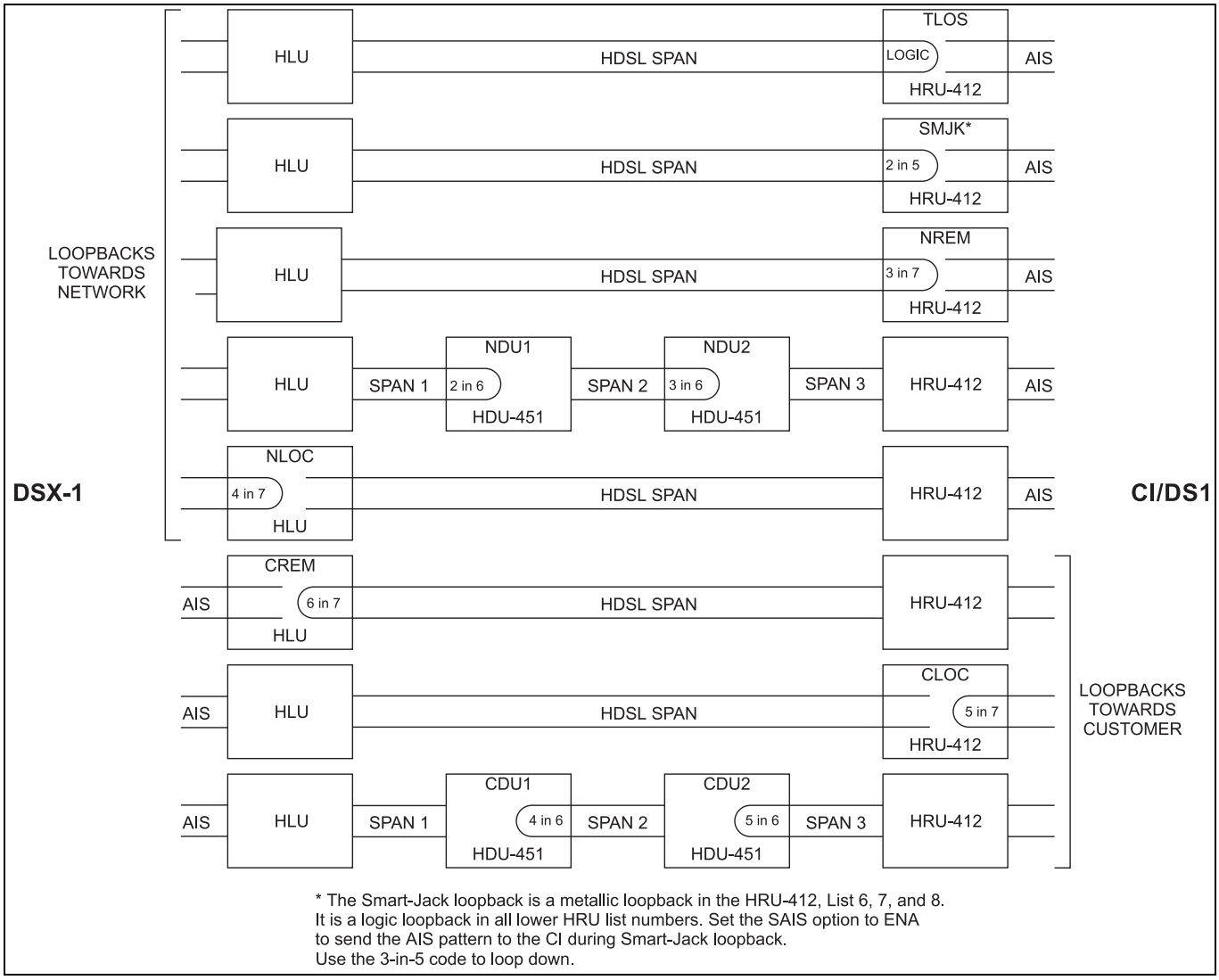

Figure 5. HiGain Loopbacks.

11.05 7-Day History. Figures 18 through 21 show the system 7-Day History Performance Data displays. The Errored and Unavailable Seconds for both HDSL loops and each of the two DS1 inputs are listed for the Current and the seven previous days. Span 1's display contains data on the two HDSL loops between the HLU and the first doubler HDU1. Span 2 refers to the loops between the first doubler HDU1 and the HRU-412 for one-doubler circuits or between the first and second doublers (HDU1 and HDU2) for two-doubler circuits. Span 3 refers to the loops between the second doubler and the HRU-412 for two-doubler circuits. All status screens contain the same DS1 interface errors. You can set all of the counters to zero by selecting the (C)lear option from the HLU Status Screen

11.06 Alarm History. Figures 22 through 24 show the system Alarm History screens. The alarms are defined in the HLU-231 List 6D Technical Practice, 150-231-164. The LOS and PWR system alarms are common to all spans. Only the LOSW, ES, and MARGIN are span-specific alarms. The PWR-OPEN and SHORT alarms indicate conditions on the HLU span as measured by the HLU. Neither PWR alarm is available on the other spans. The First and Last columns contain the time and date stamp of the first and last occurrence of each alarm. The Current column shows the status of each alarm. The Count column lists the number of times each alarm occurred. You can clear all the data with the (C)lear command. The maximum non-overflowing count is 999. Span 1's screen concerns alarms that occurred on the two HDSL loops between the HLU and the first doubler HDU1. Span 2 refers to the loops between the first doubler HDU1 and the HRU-412 for one-doubler circuits or between the first and second doublers (HDU1 and HDU2) for two-doubler circuits. Span 3 refers to the loops between the second doubler and the HRU-412 for two-doubler circuits.

C. INSTALLATION AND TEST

12. INSTALLATION

12.01 Upon receipt of the equipment, 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.

12.02 The HDU-451 mounts in the following PairGain Remote Enclosures:

- HRE-423 (three-slot, double-width, outdoor, above or below ground)
- HRE-450 (single-slot, outdoor, above ground)
- HRE-420 (single-slot, indoor)
- HRE-422 (two slot, single width, indoor)

12.03 The HDU-451 also mounts in any industry-standard 400-type multi-mount shelves. Pin-outs used by the HiGain Doubler Unit are shown in Figure 6.

12.04 The number of HDU-451 List 3B units that you can deploy in a doubler enclosure is determined by the ambient temperature and the solar loading. See Section 8 for further information.

12.05 Before installing the HDU-451, mount and cable the HiGain Remote Enclosure as described in the appropriate enclosure document.

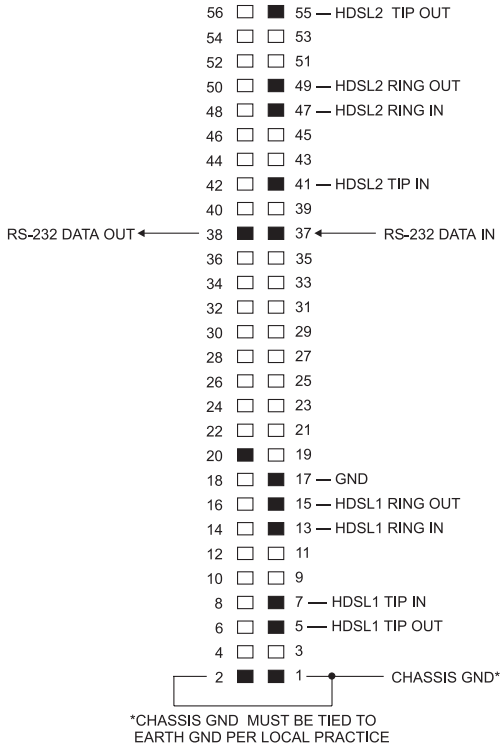

Figure 6. HDU-451 List 3B Pin-Outs. Active pins are highlighted in black.

12.06 Insert the HDU-451 into a slot in the Remote Enclosure.

12.07 If the HLU List xD in the CO is operational, the **HDSL IN** LED indicators will light within 30 seconds.

12.08 If the HRU-412 at the customer site is installed and operational, the **HDSL OUT** LED indicators will light and remain lit within one minute.

12.09 The front panel **HDSL IN** (loop) **1** and **HDSL IN** (loop) **2** LED indicators identify the cable pairs coming into the doubler from the upstream location. The pairs are identified by the polarity of the simplex voltage that is applied to them by the upstream unit, the HLU or the HDU-451. Loop 1 has the - simplex voltage. Loop 2 has the + simplex voltage. Thus, if the input pairs are swapped, as is often done during troubleshooting sessions to isolate the problem to either the upstream or down stream direction, the HDU-451 will continue to identify loop 1 as the - pair and loop 2 as the + pair. Therefore, if the problem remains with the same pair, as identified by the HDU, before and after the pairs are swapped, the problem is upstream or towards the pair. For example, assume the **HDSL IN 1** LED is flashing red, indicating errors on loop 1. If the pairs are swapped and the **HDSL IN 1** LED continues to flash the indicated problem is towards the upstream cable pair or attached equipment. If the **HDSL 2 IN** LED begins flashing, the problem lies toward the HDU-451 unit itself.

13. TROUBLESHOOTING

13.01 Table 3 provides step-by-step troubleshooting procedures for common problems. Refer to the functional block diagram in Figure 3 and the connector pin-outs in Figure 6.

TABLE 3. HDU-451 TROUBLESHOOTING PROCEDURES

Step	*Action*
	Case 1—LEDs do not light
1	Verify the HLU is installed and operational in the central office. Verify proper cabling between the Doubler Enclosure and the central office.
2	Measure 100 to 210V dc at the HDU-451 front panel jacks (**+/-V**). This voltage peaks every 15 seconds as the HLU powers up. If less than 130V dc is present, suspect cabling or the HLU. Only the line units listed in Paragraph 1.05 can be used to power doublers. Other HLU versions may sometimes "seem" to work but will not provide reliable operation and should not be used.
	Case 2—HDSL OUT LEDs do not light
1	Verify the HRU-412 at the customer site is installed and operational in the central office. The HRU-412 HDSL input has a signature resistance of 180 kOhms between the Tip and Ring on each loop.
2	Verify that the central office HLU complies with Paragraph 1.05.
	Case 3—HDSL LEDs flash green continuously
1	If the **OUT** LEDs are flashing, verify the HRU-412 is operational and the cables between the HDU-451 and HRU-412 are intact.
2	If the **IN** LEDs are flashing, verify the HLU is operational and the cables between the HLU and HDU-451 are intact.
	Case 4—HDSL IN LEDs light when HDSL OUT LEDs flash
1	No HRU-412 at the remote end. Measure the input resistance of the HRU's HDSL path at the HDU-451. The HRU-412 HDSL input has a signature resistance of 180 kOhms between the Tip and Ring on each loop.
2	Loop resistance or attenuation is out of specification (resistance should be less than or equal to 800 Ohms, attenuation should be less that or equal to 35 dB.

Table continued on next page

TABLE 3. HDU-451 TROUBLESHOOTING PROCEDURES (CONTINUED)

Case 5—HDU-451 loses power	
1	The HLU at the central is not present. Measure the resistance of the HDSL input loop. Resistance should be normal loop resistance plus the 25-Ohm signature of the HLU-231 List xD.

TABLE 4. HDU-451 STATUS MENU MESSAGES

Message	*Full Name*	*Description*
ALARMS		
NONE	No Alarms	
LLOS	Local Loss of Signal	No signal from local T1 interface.
RLOS	Remote Loss of Signal	No signal from remote T1 interface.
MNR	Minor Alarm	A Minor Alarm condition is in effect.
LOSW	Loss of Sync Word	One of the HDSL loops has lost synchronization.
H1ES	HDSL Loop 1 Errored Second	Loop 1's CRC has exceeded the user-selected Errored Seconds threshold.
H2ES	HDSL Loop 2 Errored Second	Loop 2's CRC has exceeded the user-selected Errored Seconds threshold.
DS1	Digital Service 1	DS1 input BPV's have exceeded the user-selected Errored Seconds threshold.
ACO	Alarm Cut Off	An Alarm Cut Off is in effect.
LAIS	Local Alarm Indicating Signal	Indicates an AIS (all 1s) pattern is being transmitted from the local T1 output port.
RAIS	Remote AIS	Indicates an AIS (all 1s) pattern is being transmitted from the local T1 output port.
HDSL-1(2)	HDSL Loop 1(2)	Defines HDSL loop 1(2) in any given span.
MAL 1(2)	Margin Alarm 1 (2)	The Margin on HDSL loop 1 (2) has dropped below the threshold (1 to 15) set by the user.
LOOPBACKS		
SMJK	Smartjack Loopback	Loopback at HRU-412 toward network initiated by 2 in 5 in-band loopback code or out-of-band ESF data link code. See Figure 5.
NREM	Network Remote Loopback	Loopback at HRU-412 (remote) toward network initiated from a family of special loopbacks (SPLP), HRU-412 front panel push-button, or maintenance terminal. See Figure 6.

Table continued on next page

TABLE 4. HDU-451 STATUS MENU MESSAGES (CONTINUED)

NLOC	Network Local Loopback	Loopback at HLU (local) toward network initiated from a family of special loopbacks (SPLP) or by depressing both the MODE and SEL HLU-231 front panel pushbuttons or mantenance terminal. See Figure 5.
NDU1	Network Doubler 1 Loopback	Loopback at Doubler 1 towards network initiated from CO (network) by a family of special loopbacks (SPLP) or from maintenance terminal or by depressing both the MODE and SEL HLU front panel pushbuttons. See Figure 5 and Section 10.
NDU2	Network Doubler 2 Loopback	Loopback at Doubler 2 towards network initiated from CO (network) by a family of special loopbacks (SPLP) or from maintenance terminal or by depressing both the MODE & SEL HLU front panel pushbuttons. See Figure 5 and Section 10.
CLOC	Customer Local Loopback	Loopback at HRU-412 (local) toward CI initiated from CPE (customer) by a family of special loopbacks (SPLP) or from maintenance terminal or by depressing both the MODE and SEL HLU front panel pushbuttons. See Figure 5.
CREM	Customer Remote Loopback	Loopback at HLU (remote) toward customer initiated from CPE (customer) by a family of special loopbacks (SPLP) or from maintenance terminal or by depressing both the MODE & SEL HLU front panel pushbuttons. See Figure 5.
CDU1	Customer Doubler 1 Loopback	Loopback a Doubler 1 toward CI initiated from CPE (customer) by a family of special loopbacks (SPLP) or from maintenance terminal or by depressing both the MODE and SEL HLU front panel pushbuttons. See Figure 5.
CDU2	Customer Doubler 1 Loopback	Loopback a Doubler 1 toward CI initiated from CPE (customer) by a family of special loopbacks (SPLP) or from maintenance terminal or by depressing both the MODE & SEL HLU front panel pushbuttons. See Figure 5.
ARM	Armed	HiGain has detected the intelligent repeater loopback (2 in 5) arming code.
TLOS	Transmit Loss Of Signal loopback	HRU-412 is in a logic loopback state caused by a loss of its T1 input from the NI, if enabled via the TLOS option switch in the HRU.

TABLE 5. GLOSSARY OF HIGAIN TERMS

Term	*Definition*
MARGINS	Indicates the excess signal-to-noise ratio, at either the HLU or HRU-412, relative to a 10^{-7} Bit Error Rate. First value is current margin, second value is minimum margin since (C)leared last, third value is maximum value since cleared, and NA means Not Available. The normal range of a typical margin is from 22 to 6 dB.
PULSE ATTENUATION	Indicates the attenuation of the 2B1Q pulse from the distant end. HiGain operates with pulse attenuations in excess of 30 dB. This value is related to the cable pair's 196 kHz loss. The pulse attenuation is a more direct indication of the loop attenuation to the 2B1Q signal than the 196 kHz loss. The normal range of pulse attenuation is from 1 to 32 dB
PPM	Indicates the relative offset of the crystal oscillator in the HRU-412 from the HLU's crystal oscillator. Any value between -64 and +64 is adequate. Values outside this range indicate out of tolerance components or excessive temperature drift of critical components.
HDSL 24 Hour ES (Errored Seconds)	The number of one-second intervals that contained at least one CRC error. This value is a running total of the last 24 Hours.
HDSL 24 Hour UAS (Unavailable Seconds)	The number of seconds the HDSL loop was out of synchronization.
DS1 BPV Seconds (ES)	The number of seconds in which at least one bipolar violation was detected on the DS1 input.
DS1 UAS Count	The number of seconds during which the DS1 input signal was absent (125 or more consecutive 0s)
Frame type	Type of DS1 framing used on the input stream (SF, ESF, Unframed or No Activity).
Code type	Type of DS1 line coding used (AMI, B8ZS, AMI : ZBTSI or B8ZS : ZBTSI). The latter two conditions indicate the code type that is being received when HiGain is set to its ZBTS mode. In either the AMI or B8ZS DS1 code mode, it displays the selected code. In the AUTO mode it displays the code being received.
HLU/ver x.x-yyyy HRU/ver x.x-yyyy HDU1/ver x.x-yyyy HDU2/ver x.x-yyyy	"x.x" = the software version number of the HLU, HRU-412, or HDU-451. "yyyy" = the list number of the HLU, HRU-412, or HDU-451.

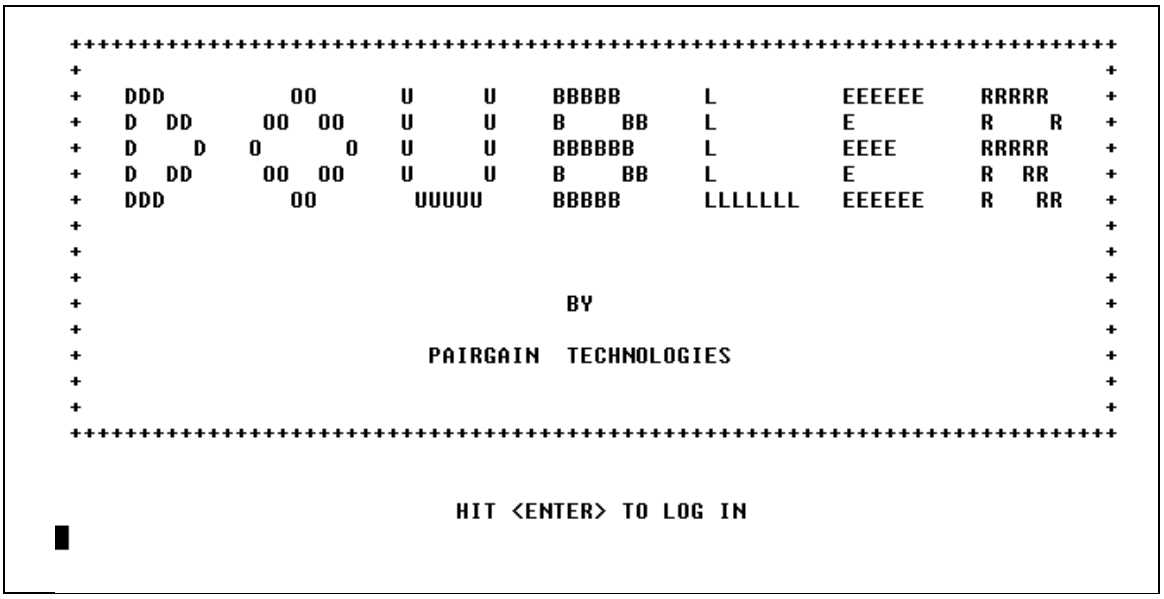

Figure 7. Doubler Log-In Screen

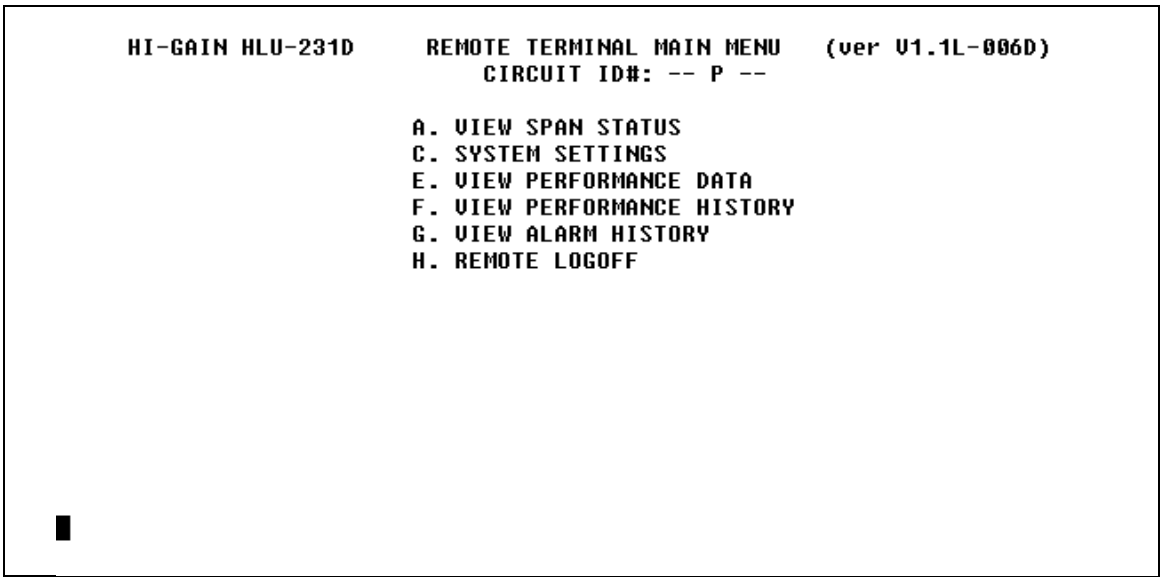

Figure 8. HDU-451 Main Menu.

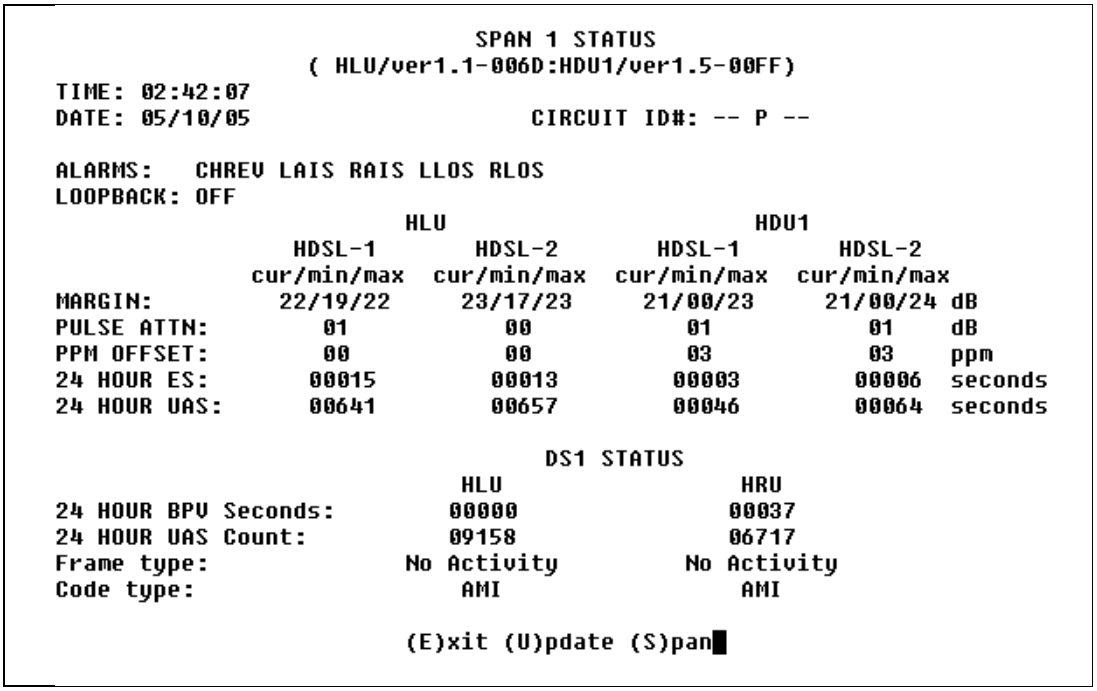

Figure 9. Status Display Span 1 (1 or 2 Doublers).

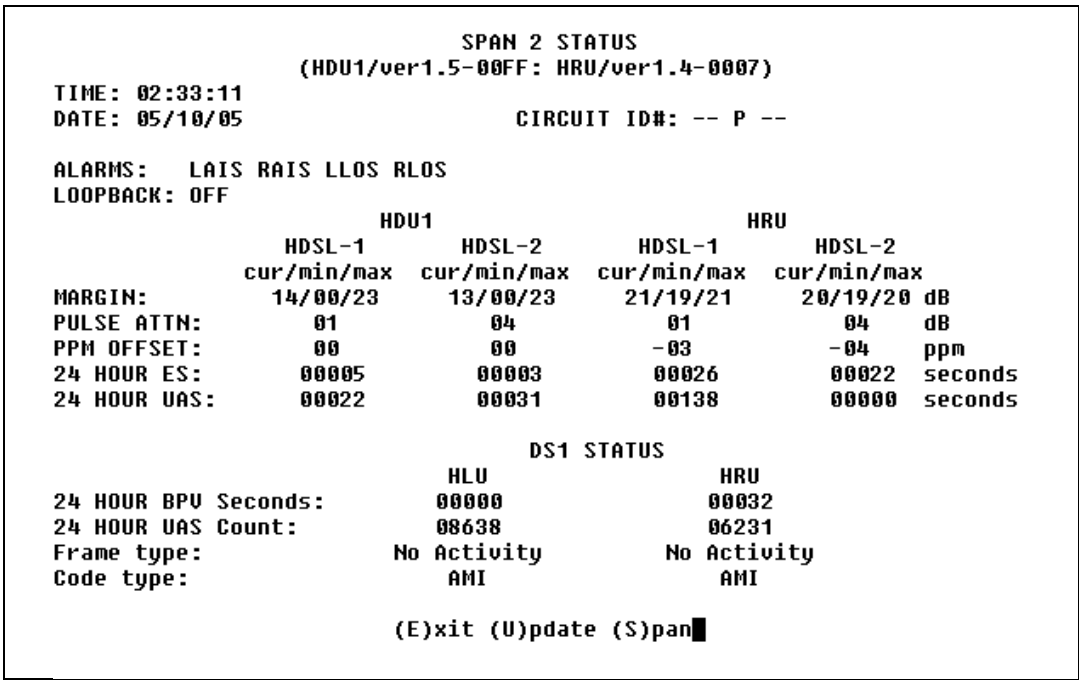

Figure 10. Status Display Span 2 (1 Doubler).

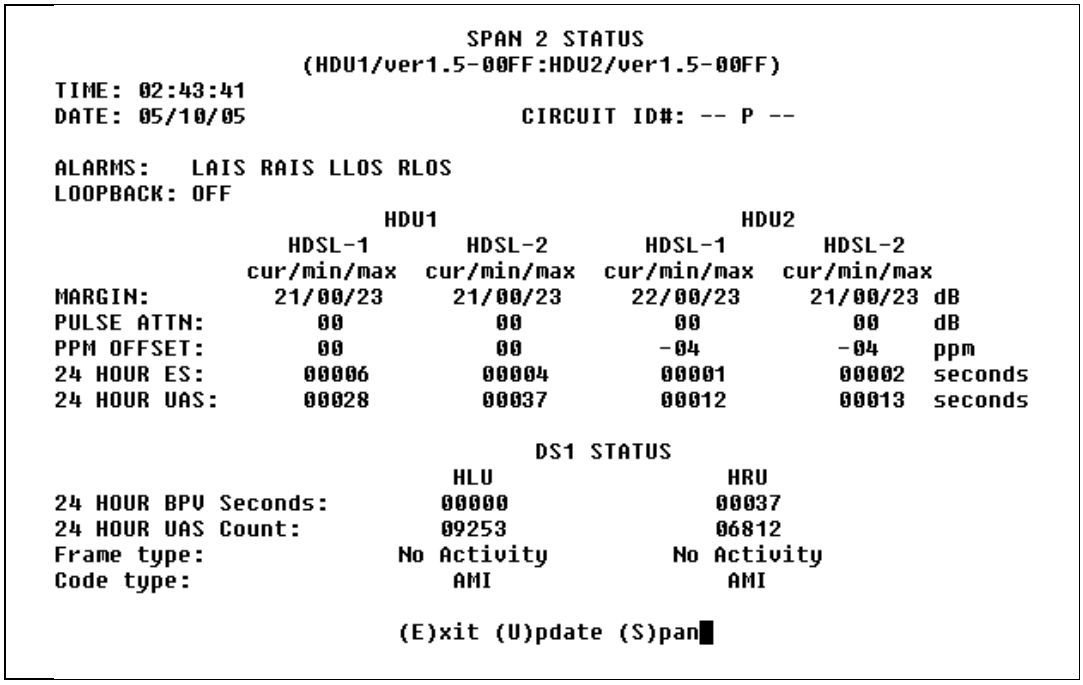

Figure 11. Status Display Span 2 (2 Doublers).

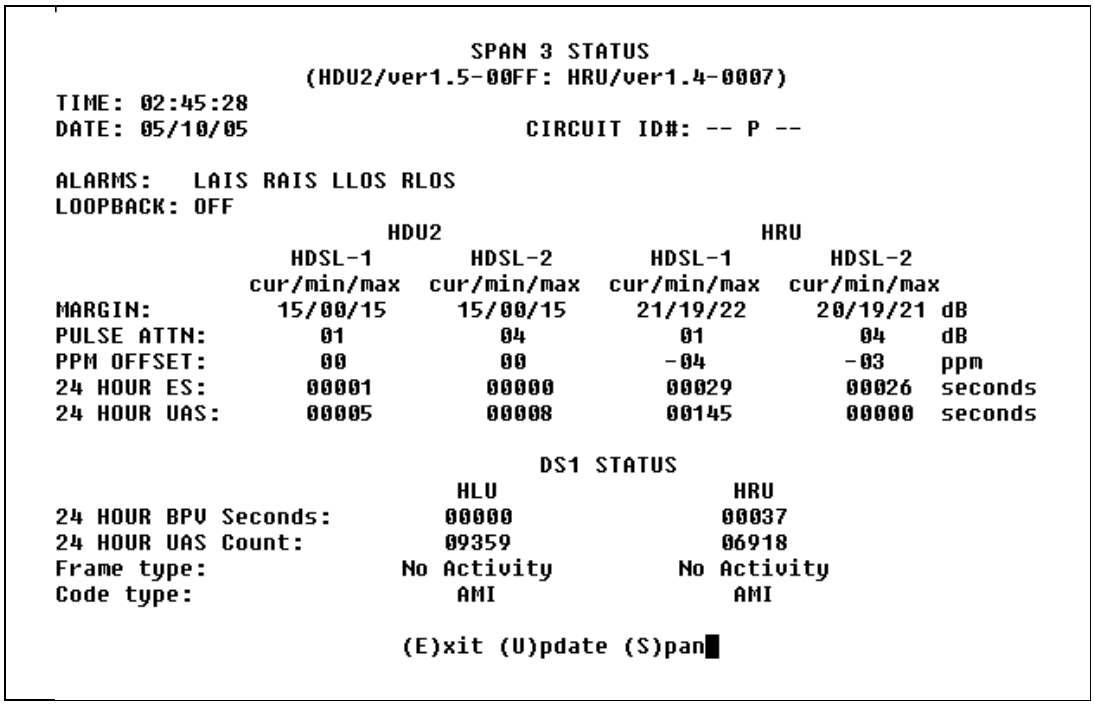

Figure 12. Status Display Span 3 (2 Doublers).

```
                              SYSTEM SETTINGS

TIME: 02:34:43
DATE: 05/10/05                      CIRCUIT ID#: -- P --

EQUALIZATION:      EXT
SMART-JACK LB:     ENABLE
SPECIAL LPBK:      GNLB
POWER:             ENABLE
ZBTSI:             OFF
ES ALARM THRES:    NONE
LOOPBACK TIMEOUT: 60
ALARM:             DISABLE
DS1 CODE:          AUTO
FRAMING:           AUTO
AIS ON HDSL LOSW: 2 LOOPS
AIS ON SMJK/NREM: ENABLE
MARGIN ALM THRES: 4
DSO BLOCKING: xx - Blocked Channels
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

                                 (E)xit
```

Figure 13. System Settings Menu

```
Date: 05/10/05          SPAN 1 PERFORMANCE DATA
CIRCUIT ID#: -- P --
                    ERRORED SECONDS/UNAVAILABLE SECONDS

                DS1              HDSL-1              HDSL-2
            HLU       HRU       HLU      HDU1       HLU      HDU1
23:00    000/000   000/000   000/000   000/000   000/000   000/000
23:15    000/000   000/000   000/000   000/000   000/000   000/000
23:30    000/000   000/000   000/000   000/000   000/000   000/000
23:45    000/000   000/000   000/000   000/000   000/000   000/000
00:00    000/000   000/000   000/000   000/000   000/000   000/000
00:15    000/688   008/562   004/222   001/013   003/241   002/031
00:30    000/900   000/900   000/000   000/000   000/000   000/000
00:45    000/900   000/900   000/000   000/000   000/000   000/000
01:00    000/900   000/900   000/000   000/000   000/000   000/000
01:15    000/883   004/861   001/025   000/004   002/025   001/004
01:30    000/900   000/900   000/000   000/000   000/000   000/000
01:45    000/852   012/631   004/075   002/012   004/074   002/013
02:00    000/900   000/000   000/000   000/000   000/000   000/000
02:15    000/900   000/000   000/000   000/000   000/000   000/000
02:30    000/673   004/439   002/220   000/005   001/221   000/007
02:45    000/820   009/782   004/099   000/012   003/096   001/009

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

Figure 14. Performance Data Span 1 (1 or 2 Doublers)

```
Date: 05/10/05        SPAN 2 PERFORMANCE DATA
CIRCUIT ID#: -- P --
                ERRORED SECONDS/UNAVAILABLE SECONDS

              DS1            HDSL-1           HDSL-2
          HLU      HRU     HDU1     HRU     HDU1     HRU
22:45  000/000  000/000  000/000  000/000  000/000  000/000
23:00  000/000  000/000  000/000  000/000  000/000  000/000
23:15  000/000  000/000  000/000  000/000  000/000  000/000
23:30  000/000  000/000  000/000  000/000  000/000  000/000
23:45  000/000  000/000  000/000  000/000  000/000  000/000
00:00  000/000  000/000  000/000  000/000  000/000  000/000
00:15  000/688  008/562  001/003  007/048  000/007  004/000
00:30  000/900  000/900  000/000  000/000  000/000  000/000
00:45  000/900  000/900  000/000  000/000  000/000  000/000
01:00  000/900  000/900  000/000  000/000  000/000  000/000
01:15  000/883  004/861  001/004  003/004  001/004  004/000
01:30  000/900  000/900  000/000  000/000  000/000  000/000
01:45  000/852  012/631  001/009  008/013  001/009  008/000
02:00  000/900  000/000  000/000  000/000  000/000  000/000
02:15  000/900  000/000  000/000  000/000  000/000  000/000
02:30  000/673  004/439  001/002  004/059  000/007  003/000

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

Figure 15. Performance Data Span 2 (1 Doubler)

```
Date: 05/10/05        SPAN 2 PERFORMANCE DATA
CIRCUIT ID#: -- P --
                ERRORED SECONDS/UNAVAILABLE SECONDS

              DS1            HDSL-1           HDSL-2
          HLU      HRU     HDU1     HDU2     HDU1     HDU2
23:00  000/000  000/000  000/000  000/000  000/000  000/000
23:15  000/000  000/000  000/000  000/000  000/000  000/000
23:30  000/000  000/000  000/000  000/000  000/000  000/000
23:45  000/000  000/000  000/000  000/000  000/000  000/000
00:00  000/000  000/000  000/000  000/000  000/000  000/000
00:15  000/688  008/562  001/003  000/000  000/007  000/000
00:30  000/900  000/900  000/000  000/000  000/000  000/000
00:45  000/900  000/900  000/000  000/000  000/000  000/000
01:00  000/900  000/900  000/000  000/000  000/000  000/000
01:15  000/883  004/861  001/004  000/000  001/004  000/000
01:30  000/900  000/900  000/000  000/000  000/000  000/000
01:45  000/852  012/631  001/009  001/008  001/009  002/008
02:00  000/900  000/000  000/000  000/000  000/000  000/000
02:15  000/900  000/000  000/000  000/000  000/000  000/000
02:30  000/673  004/439  001/002  000/000  000/007  000/000
02:45  000/820  009/782  002/010  000/004  002/010  000/005

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

Figure 16. Performance Data Span 2 (2 Doublers)

```
Date: 05/10/05          SPAN 3 PERFORMANCE DATA
CIRCUIT ID#: -- P --
                    ERRORED SECONDS/UNAVAILABLE SECONDS

                 DS1              HDSL-1            HDSL-2
              HLU      HRU      HDU2      HRU     HDU2      HRU
23:00     000/000  000/000  000/000  000/000  000/000  000/000
23:15     000/000  000/000  000/000  000/000  000/000  000/000
23:30     000/000  000/000  000/000  000/000  000/000  000/000
23:45     000/000  000/000  000/000  000/000  000/000  000/000
00:00     000/000  000/000  000/000  000/000  000/000  000/000
00:15     000/688  008/562  000/000  007/048  000/000  004/000
00:30     000/900  000/900  000/000  000/000  000/000  000/000
00:45     000/900  000/900  000/000  000/000  000/000  000/000
01:00     000/900  000/900  000/000  000/000  000/000  000/000
01:15     000/883  004/861  000/000  003/004  000/000  004/000
01:30     000/900  000/900  000/000  000/000  000/000  000/000
01:45     000/852  012/631  000/002  008/013  000/002  008/000
02:00     000/900  000/000  000/000  000/000  000/000  000/000
02:15     000/900  000/000  000/000  000/000  000/000  000/000
02:30     000/673  004/439  000/000  004/059  000/000  003/000
02:45     000/820  009/782  001/003  007/021  000/006  007/000

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

Figure 17. Performance Data Span 3 (2 Doublers)

```
Time: 02:51:24                    7 DAY HISTORY
CIRCUIT ID#: -- P --

                                  SPAN 1
                        ERRORED SECONDS/UNAVAILABLE SECONDS

                 DS1                    HDSL-1                  HDSL-2
              HLU          HRU          HLU          HDU1        HLU          HDU1
05/03    00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/04    00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/05    00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/06    00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/07    00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/08    00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/09    00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
current  00000/09316  00037/06875  00015/00641  00003/00046  00013/00657  00006/00064

                                  (E)xit (S)pan
```

Figure 18. Performance Data History Span 1 (1 or 2 Doublers)

```
Time: 02:38:16                    7 DAY HISTORY
CIRCUIT ID#: -- P --

                                  SPAN 1
                        ERRORED SECONDS/UNAVAILABLE SECONDS

                DS1                     HDSL-1                  HDSL-2
            HLU         HRU         HLU         HDU1        HLU         HDU1
05/03   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/04   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/05   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/06   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/07   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/08   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/09   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00000/08496 00028/06093 00011/00542 00003/00034 00010/00561 00005/00055

                                  (E)xit (S)pan
```

Figure 19. Performance Data History Span 1 (1 Doubler)

```
Time: 02:53:00                    7 DAY HISTORY
CIRCUIT ID#: -- P --

                                  SPAN 2
                        ERRORED SECONDS/UNAVAILABLE SECONDS

                DS1                     HDSL-1                  HDSL-2
            HLU         HRU         HDU1        HDU2        HDU1        HDU2
05/03   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/04   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/05   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/06   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/07   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/08   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/09   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00000/09316 00037/06875 00006/00028 00001/00012 00004/00037 00002/00013

                                  (E)xit (S)pan
```

Figure 20. Performance Data History Span 2 (2 Doublers)

```
Time: 02:54:22                    7 DAY HISTORY
CIRCUIT ID#: -- P --

                                  SPAN 3
                        ERRORED SECONDS/UNAVAILABLE SECONDS

                DS1                    HDSL-1                 HDSL-2
          HLU          HRU         HDU2         HRU         HDU2         HRU
05/03   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/04   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/05   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/06   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/07   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/08   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/09   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
current 00000/09316  00037/06875  00001/00005  00029/00145  00000/00008  00026/00000

                                  (E)xit (S)pan
```

Figure 21. Performance Data History Span 3 (2 Doublers)

```
                                ALARM HISTORY

TIME: 02:57:36
DATE: 05/10/05
CIRCUIT ID#: -- P --

Type              First              Last               Current        Count
LOS, DS1-HLU      05/10/05-00:00     05/10/05-00:00     ALARM          001
LOS, DS1-HRU      05/10/05-00:00     05/10/05-02:41     ALARM          011
SPAN1 LOSW, HDSL1 05/10/05-00:00     05/10/05-02:40     OK             010
SPAN1 LOSW, HDSL2 05/10/05-00:00     05/10/05-02:40     OK             010
SPAN1 ES, HDSL1                                         OK             000
SPAN1 ES, HDSL2                                         OK             000
SPAN1 MARGIN L1   05/10/05-00:00     05/10/05-02:41     OK             017
SPAN1 MARGIN L2   05/10/05-00:00     05/10/05-02:41     OK             021
PWR-OPEN          05/10/05-00:00     05/10/05-02:40     OK             036
PWR-SHRT          05/10/05-00:00     05/10/05-02:23     OK             004

LAST CLEARED:  NONE

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

Figure 22. HLU Alarm History Span 1 (1 or 2 Doublers)

```
                              ALARM HISTORY

TIME: 02:58:48
DATE: 05/10/05
CIRCUIT ID#: -- P --

Type              First               Last                Current        Count
LOS, DS1-HLU      05/10/05-00:00      05/10/05-00:00      ALARM          001
LOS, DS1-HRU      05/10/05-00:00      05/10/05-02:41      ALARM          011
SPAN2 LOSW, HDSL1 05/10/05-00:00      05/10/05-02:41      OK             008
SPAN2 LOSW, HDSL2 05/10/05-00:00      05/10/05-02:41      OK             008
SPAN2 ES, HDSL1                                           OK             000
SPAN2 ES, HDSL2                                           OK             000
SPAN2 MARGIN L1   05/10/05-00:08      05/10/05-02:41      OK             009
SPAN2 MARGIN L2   05/10/05-00:08      05/10/05-02:41      OK             009
PWR-OPEN          05/10/05-00:00      05/10/05-02:40      OK             036
PWR-SHRT          05/10/05-00:00      05/10/05-02:23      OK             004

LAST CLEARED:  NONE


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

Figure 23. HLU Alarm History Span 2 (1 or 2 Doublers)

```
                              ALARM HISTORY

TIME: 02:59:53
DATE: 05/10/05
CIRCUIT ID#: -- P --

Type              First               Last                Current        Count
LOS, DS1-HLU      05/10/05-00:00      05/10/05-00:00      ALARM          001
LOS, DS1-HRU      05/10/05-00:00      05/10/05-02:41      ALARM          011
SPAN3 LOSW, HDSL1 05/10/05-01:38      05/10/05-01:38      OK             001
SPAN3 LOSW, HDSL2 05/10/05-01:38      05/10/05-01:38      OK             001
SPAN3 ES, HDSL1                                           OK             000
SPAN3 ES, HDSL2                                           OK             000
SPAN3 MARGIN L1   05/10/05-02:41      05/10/05-02:41      OK             001
SPAN3 MARGIN L2   05/10/05-02:41      05/10/05-02:41      OK             001
PWR-OPEN          05/10/05-00:00      05/10/05-02:40      OK             036
PWR-SHRT          05/10/05-00:00      05/10/05-02:23      OK             004

LAST CLEARED:  NONE


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

Figure 24. HLU Alarm History Span 3 (2 Doublers)