PAIRGAIN TECHNOLOGIES HIGAIN™ LINE UNIT MODEL ELU-319 Issue 1

List 5, PairGain #150-1236-05 (75 Ohm)
List 6, PairGain #150-1236-06 (120 Ohm)

CONTENTS PAGE

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

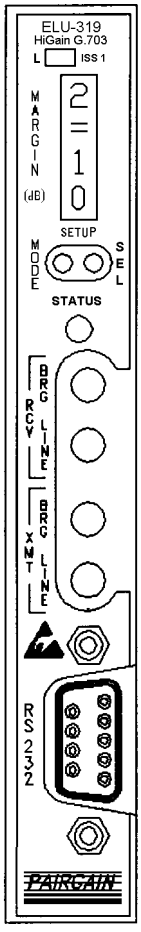

Figure 1. ELU-319 Front Panel. The PairGain ELU-319 is the local unit used in conjunction with the ERU-412 remote unit to provide a complete HiGain HDSL system.

A. PRODUCT OVERVIEW

1. DESCRIPTION AND FEATURES

1.01 PairGain's HiGain Line Units Model ELU-319, Lists 5 and 6 (Figure 1), are the Public Exchange side of a repeaterless G.703 transmission system. When used with an ERU-412 HiGain Remote Unit (ERU), the system provides 2.048 Mbps transmission on two unconditioned copper pairs. The HiGain system uses HDSL (High-bit-rate Digital Subscriber Line) transmission technology as recommended by Bellcore TA-TSY-001210. HiGain complies with TR-TSY-000063 (Network Equipment Building System (NEBS) Generic Equipment requirements) and TR-TSY-000499 (Transport System Generic Requirements–TSGR) common requirements.

1.02 Revision History of this practice.

Revision 01—July 6, 1995

a) Initial release.

b) This initial release is supported by software version 1.3.

1.03 The ELU-319 is compatible with the PairGain 22-slot HMS-318 shelf and the associated G.703 HiGain connector panel HCP-322.

1.04 ELU-319 Product Family:

- List 5: 75-ohm G.703 Impedance
- List 6: 120-ohm G.703 Impedance

1.05 ELU-319 Issue 1 features:

- -130V dc line power for ERU-412 or EDU-451
- Four-digit front panel display for HDSL signal/noise (S/N) margin configuration and alarms
- RS-232 maintenance port
- Non-volatile configuration memory
- Front panel splitting and bridging access to G.703 interface
- Lightning and power cross protection on HDSL interfaces
- 1040 kbps full-duplex two-bits one-quaternary (2B1Q) HDSL transmission on each of two pairs
- Front panel status-indicating light-emitting diode (LED) indicator
- On / Off front-panel display power cycling
- G.703 Loss of Signal (LOS) detector (125 consecutive zeros)
- Margin threshold alarm
- Single step default setting
- Circuit ID option
- Improved tolerance to cable noise
- Supports EDU-451 doubler

2. APPLICATIONS

2.01 The HiGain System provides a cost-effective, easy to deploy method for delivering G.703 High Capacity Digital Service (HCDS) over metallic pairs. The fiber-like quality service is deployed over two unconditioned, non-loaded copper pairs. Conventional span repeaters are not required. Cable pair conditioning, pair separation and bridged tap removal, are also not required.

2.02 The HiGain system operates with any number of other G.703, Plain Old Telephone System (POTS), digital or analog data service or other HiGain Systems sharing the same cable binder group. HiGain provides a means of quickly deploying service in advance of fiber-optic transmission systems. By using HiGain G.703, you can connect service within a few days or even a few hours. You can install fiber optic systems at a leisurely pace and cut-over from HiGain when the time allows. You can then easily remove the HiGain and utilize it elsewhere.

2.03 Table 1 provides a guide for the loss of various cable gauges at the HDSL line rate of 260 kHz and 135 ohms. The table applies to the HDSL cable pairs between the ELU and the EDU-451 as well as between the EDU-451 and a second EDU-451 or the ERU-412. Add 3 dB for each bridged tap and 1 dB for each cable gauge change.

TABLE 1. HDSL CABLE LOSS

Cable Gauge	Loss @ 260 kHz(db/km)	Ohms per km
26/0.4mm	13.94	272
24/0.51mm	10.47	171
22/0.61mm	8.14	105
19/0.91mm	5.74	52

2.04 The ELU to ERU operating ranges, on unimpaired cable pairs, are shown in Table 2 as a function of cable gauge and average margin.

TABLE 2. HIGAIN E1 RANGES (KM) ON UNIMPAIRED CABLES VS AVERAGE MARGIN(M) IN DB

Cable Gauge	M = 11	M = 7	M = 3
0.4 mm / #26 AWG	2.7km	3.0km	3.3km
0.51 mm / #24 AWG	3.6km	4.0km	4.4km
0.61 mm / #22 AWG	4.7km	5.2km	5.7km
0.81 mm / #19 AWG	6.6km	7.3km	8.0km

2.05 The ELU-319, List 5 and 6 line units can only support applications requiring an ERU (remote unit) or one ERU and one EDU (double unit). They can not support two doubler applications. For one doubler applications the ERU must be locally powered.

3. SPECIFICATIONS

HDSL Line Code

1040 kbps, 2B1Q

HDSL Output

+13.5 dBm ± 0.5 dB @ 135 ohms

HDSL Line Impedance

135 ohms

Maximum Provisioning Loss

35 dB @ 260 kHz, 135 ohms

Line Clock Rate

Internal Stratum 4 clock

HDSL Startup Time

30 seconds (typical), 60 seconds (maximum)

One-way G.703 Delay

Less than 220 microseconds

G.703 Line Impedance

List 5: 75 ohms

List 6: 120 ohms

G.703 Input Level

+1.5 to -7.5 dB

G.703 Line Rate

2.048 Mbps ± 200 bps

G.703 Line Format

HDB3

Power Consumption

14 watts (typical), 18 watts (maximum)

Heat Dissipation

6 watts (typical), 8 watts (maximum)

Fusing

Internal, 1.25 amps @ 125V; connected to FUSEALARM output on pin 10

Span Voltage

-136V dc ± 4V dc

Margin Indicator

Displays span SNR margin for both spans relative to 10^{-7} BER operation

Electrical Protection

Secondary surge protection on G.703 and HDSL ports

Power cross protection on HDSL ports

Operating Temperature and Humidity

-40° to 65° Celsius, 5 to 95% (non-condensing)

Mounting

STS, 28-slot, high-density shelf

Dimensions

Height: 4.75 in. (12.07 cm)
Width: 0.7 in. (1.78 cm)
Depth: 10.5 in. (26.67 cm)

4. CERTIFICATION

4.01 FCC compliance: The ELU-319 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.

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 installation. 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 voids 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.
(714) 832-9922
(800) 638-0031

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 or (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 2-Bits-1-Quaternary (2B1Q) HDSL transceiver systems to establish two full-duplex 1040 Kbps data channels between the ELU-319 and an ERU-412 HiGain Remote Unit. This provides a total capacity of 2.080 Mbps between the two units - 2.048 Mbps for the G.703 interface and 32 Kbps of overhead.

7.02 A block diagram of the ELU-319 is shown in Figure 2. The HiGain ELU-319 receives a 2.048-Mbps data stream from the G.703 digital cross-connect interface.

7.03 The ELU-319 contains a demultiplexer that generates two parallel 1040 kbps data streams. Each data stream consists of HDSL frames that are nominally 4704 bits (4.5 milliseconds) in length. Each frame contains a 14-bit Frame Sync Word (FSW), a 6-bit Cyclic Redundancy Check (CRC), a 21-bit operations channel and 16 of the 32 G.703 timeslots. The demultiplexer provides frame synchronization for each of the two HDSL channels. The multiplexer and HDSL transceivers work under control of the ELU-319 microprocessor and compensate for data inversions caused by tip-ring reversals and for channel swaps caused by pair reversals. The HiGain system allows for tip-ring (pair) reversals, but does not tolerate split pairs.

7.04 The two formatted HDSL channels pass to the HDSL transceivers, which convert them to 2B1Q format. The 2B1Q line code operates in full-duplex mode on unconditioned pairs. The transceiver's digital echo cancelers and adaptive equalizers receive the signal from the remote end in the presence of impairments and noise on the copper pairs. HDSL channel 1 contains G.703 timeslots 1 through 16. HDSL channel 2 contains G.703 timeslots 17 through 32.

7.05 The transceiver processes the HDSL channels it receives and passes them on to the ELU-319 multiplexer. The multiplexer removes data link messages from the HDSL channels and passes them to the microprocessor. This enables the ELU-319 and the ERU-412 Remote Unit to exchange operations messages and status. By synchronizing to the FSW of each channel, the multiplexer can reconstruct the original 2.048 Mbps G.703 stream from the payloads of the two HDSL channels. The CRC fields on the HDSL streams

enable the ELU-319 to determine if errors are present on the channel due to excessive impairments caused by impulse or crosstalk noise.

7.06 The reconstructed HDSL data channel is buffered in a first-in-first-out (FIFO) buffer within the multiplexer. A frequency synthesizer in conjunction with the buffer regulates the output bit rate and reconstructs the G.703 clock at the exact rate received from the remote end. The HiGain system operates at G.703 rates of 2.048 Mbps with up to ±50 ppm of offset.

7.07 A G.703 interface driver converts the G.703 channel to a High Density Bipolar 3 (HDB3) format.

7.08 The transmit and receive G.703 ports have splitting access and bridging "Bantam"-type jacks. Connecting one cable between the two BDG jacks and another between the two LINE jacks splits the XMT and RCV and creates metallic loopbacks towards both the customer equipment and the HDSL line.

7.09 The ELU-319 contains two separate power converters. The main power supply converts -48V local battery to logic power for the ELU-319 circuits. The line power supply converts the -48V battery to a -130V feed that provides simplex power feed on the HDSL loops. The line power can be turned on or off by the microprocessor and automatically shuts down in the presence of line short-circuits or microprocessor failure.

7.10 The three most important power demands of an ELU-319 on the shelf power supply are its maximum power consumption, its maximum power dissipation, and its maximum current drain. These three parameters for the ELU-319, on a per slot and per shelf basis, are as follows:

Maximum Power Dissipation
Per slot: 8.0W
Per shelf: 176W

Maximum Power Consumption
Per slot: 18W
Per shelf: 396W

Maximum Current Drain
Per slot: 0.423A
Per shelf: 9.3A

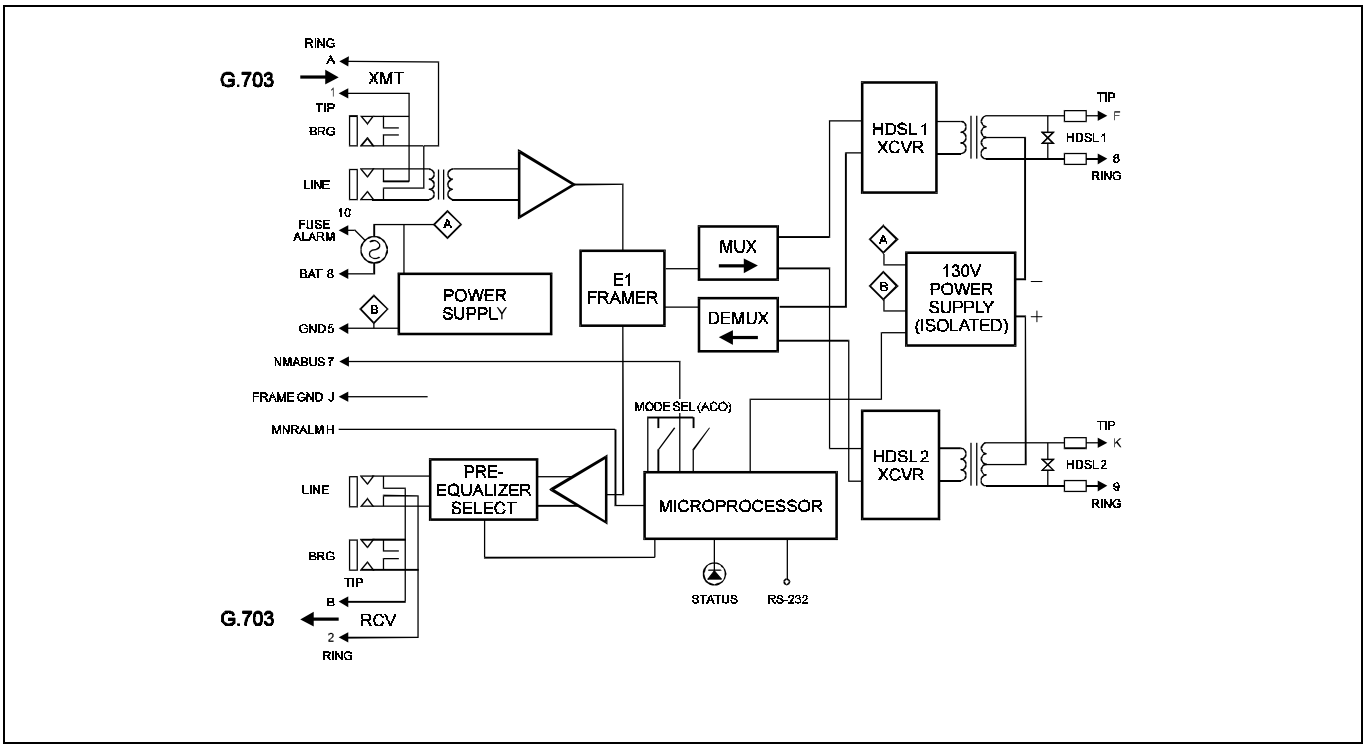

Figure 2. ELU-319 Block Diagram. PairGain's HDSL technology provides full-duplex services at 2.048 Mbps over copper wires between an ELU-319 and an ERU-412, which comprise one HiGain system.

7.11 Note that the worst case conditions under which these parameters were measured include a 2.51-km, 0.4-mm loop, a fully loaded 22-slot shelf, and a -42.5V shelf battery voltage. The front panel display is assumed to be in its normally OFF state (paragraph 11.01).

7.12 The Maximum Power Dissipation measures the power that is converted into heat build up 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/square meter (W/m^2).

7.13 The thermal loading limitations imposed when using the ELU-319 in controlled environmental vaults (CEVs) or other enclosures are determined by applying the ELU-319 power parameters to the manufacturer's requirements for each specific housing.

7.14 The Maximum Power Consumption is the total power the ELU-319 consumes or draws from its -48V shelf power source. This parameter is needed when the ELU-319 is located remote to its serving exchange. It determines the battery capacity required to maintain an 8-hour standby battery reserve for emergency situations. It thus limits the maximum number of plugs per remote enclosure. Use the above data to perform this analysis case by case.

7.15 The Maximum Current Drain is the maximum current drawn from the shelf power supply when it is at its minimum voltage (-42.5V). This determines the shelf fusing requirements. ELU-319 shelves have two separate 48V buses. Each bus is fused at 10A for a total of 20A per shelf. A fully loaded shelf with 22 ELU-319 units draws 9.3A in the worst case. This is well within the 20A fuse limit.

7.16 An RS-232 connector (DB-9) on the front panel provides access to HiGain maintenance, provisioning and performance monitoring interface. Basic functionality is available via a 'dumb terminal'. Refer to Section 9 for ‘dumb’ operation procedures.

7.17 Pin H of the ELU-319 is the minor alarm (MNRALM) output pin. This pin must never operate above 0V or below -60V. The ELU-319 forces pin H to ground (maximum of 10 mA) for any of the conditions listed below, with the accompanying front panel message in bold letters. More than one alarm condition can exist at any given time, but the unit can display only one message. For multiple alarms, only the highest priority alarm appears. The alarms are listed in their order of priority:

1) **ALRM LOSW**: Loss of synchronization in either HDSL loop.
2) **ALRM LLOS**: Loss of ELU-319 G.703 input signal.
3) **ALRM RLOS**: Loss of ERU-412 G.703 input signal.
4) **ALRM H1ES**: HDSL Loop 1 exceeded the 24-hour user-selected Errored-Seconds threshold (refer to Section 7).
5) **ALRM H2ES**: HDSL Loop 2 exceeded the 24-hour user-selected Errored-Seconds threshold (refer to Section 7).
6) **ALRM G.703**: The total number of bipolar violations (BPV) at the ELU and ERU G.703 inputs exceeded the 24-hour user-selected threshold refer to Section 7).
7) **ALRM MAL1** (**2**): The margin on HDSL Loop 1 (Loop 2) has dropped below the Margin Alarm Threshold value set from the Maintenance Port menu (refer to Section 7).

7.18 Pin H (Figure 5) (MNRALM) of the ELU-319 remains grounded for the duration of the alarm condition. The ELU-319 **STATUS** LED flashes red for the duration of a minor alarm condition. You can retire the MNALRM by pressing the front panel **SEL**(ect) button, thus executing the alarm cut-off (ACO) option. This turns the alarm off and replaces the ALRM message with ACO. The part of the message that defines the alarm remains until the alarm condition clears or another alarm occurs. Disabling the ALM also retires an ACO condition.

7.19 Setting the ALM option to DIS(able) only prevents the unit from activating the MNRALM output alarm bus on pin H on a minor alarm event. The **STATUS** LED still flashes red and the ALRM message still appears.

7.20 The ELU-319 drives pin 10 (FUSEALARM) to -48V whenever its on-board fuse opens. Its normally floating output must never operate above ground or below -80V. It can sink a current of 10 mA.

7.21 The ELU-319 Line Unit front panel tri-color **STATUS** LED has the following states:

- GREEN - Normal operation
- FLASHING GREEN - HDSL acquisition
- FLASHING RED - MNRALRM (For conditions see paragraph 6.17)
- RED - FUSEALRM
- YELLOW - Self-test in process or an ELU-319 loopback in effect (CREM or Network Local Loopback (NLOC))

8. SYSTEM PARAMETER SETTINGS

8.01 The operating mode of the ELU-319 depends on the settings of the following system operating parameters:

- PWRF—Power Feed (HDSL line power)
- ESAL—Errored Seconds Alarm Threshold
- LBTO—Loopback Timeout
- ALM—Minor Alarm
- MARG—Margin Alarm Threshold

8.02 Table 3 lists the ELU-319 system parameters and their optional settings. The ELU-319 stores the settings of the system parameters in non-volatile RAM to prevent their loss in the event that shelf power is lost or the ELU-319 is unplugged.

8.03 No DIP-switches or jumpers are required to set the ELU-319 configuration. You can set the ESAL, LBTO, and MAL system parameter options with the front panel pushbuttons (**MODE** and **SEL**); you can set all parameters from the maintenance terminal through the ELU-319 RS-232 interface as described in Section 8.

8.04 To initiate the Option Set mode from the ELU-319 front panel, press and hold the **MODE** button for one second. The front panel message alternates between the system parameter and its current setting. Press the **SEL** button to step through all possible values (in sequence) of the parameter being displayed. Press **MODE** when the desired setting is displayed. This selects the next configurable parameter. When you have selected the last parameter, the display displays “CONF/NO”. To return to original settings, press the **MODE** button. To accept the new settings, press the **SEL** button. This displays “CONF/YES”, installs the changes, and returns to normal display mode. If you do not press either button within 30 seconds, the parameters return to their original values, and the display returns to normal mode.

8.05 To set all parameters to their default values, press and hold the **SEL** button for six or more seconds. The message “DFLT/NO” appears when you release the button. Press **SEL** again to display “DFLT/YES” and accept the default values. Press **MODE** to cancel and return to the original values.

8.06 Press the **MODE** button for 3 or more seconds to scroll through the ELU-319 software version number, List #, and all parameter option settings.

TABLE 3. SYSTEM PARAMETER OPTION SETTINGS

Parameter	*Option*	*Description*
PWRF (Power Feed)	DIS	Disables powering to the ERU over the HDSL pairs.
	ENA*	Enables powering to the ERU over the HDSL pairs.
ESAL (Errored Seconds Alarm Threshold)	17	Activates MNRALM (on pin H) after 17 Errored Seconds (17 HDSL CRC errors on either HDSL loop or a total of 17 BPVs and FERR) occur within 24 hours.
	170	Activates MNRALM (on pin H) when 170 Errored Seconds occur within 24 hours.
	NONE*	Prevents generation of a minor alarm due to excessive Errored Seconds.
LBTO (Loopback Timeout)	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.
ALM (Minor Alarm)	DIS*	Retires an existing minor alarm on pin H by disabling its signal, and prevents another minor alarm from occurring.
	ENA	Enables pin H to be grounded when a minor alarm condition occurs.
CONF (Confirm)	YES	Confirms that all 4 operating modes are to be updated to their current choices.
	NO*	Prevents the most recently selected operating mode choices from being updated. They remain as they were prior to entry of system option settings procedure.
MARG (Margin Alarm Threshold)	0 to 15	Displays the Margin Alarm Threshold (in dB), set using the RS-232 Maintenance port. If the margin on either loop drops below this value, a minor alarm is reported (MAL1 or MAL2). The factory Default is 4.
	4*	

* Indicates the ELU-319 factory settings.

9. MAINTENANCE PORT OPERATION

9.01 To configure the ELU-319 from the Maintenance port, connect an ASCII display terminal to the RS-232 Maintenance port with a cable configured as shown in Figure 3. The maintenance port is configured as Data Communications Equipment (DCE) with 8 data bits, 1 stop bit and no parity. Striking the SPACE bar several times invokes the “autobaud” function over a range of 1200 to 9600 bps.

9.02 The menus and informational screens displayed by the terminal are shown in Figures 7 through 23. From the Main Menu (Figure 7), select C–SYSTEM SETTINGS. Entering the letter in parenthesis of the parameter you want to change scrolls the parameter through its options. When you have made the new settings, enter C to confirm.

9.03 Two user settings, Circuit ID, and Margin Alarm Threshold, must be set from the display terminal.

9.04 To set the Circuit ID, select H from the Main Menu to display “Enter circuit ID # (24 characters max)”. Enter the circuit ID, press ENTER, then press C to confirm the entry. If you enter more than 24 characters, the terminal beeps and accepts only the first 24 characters. The circuit ID appears in all screens, and you cannot reset it to a default as described in Paragraph 7.05.

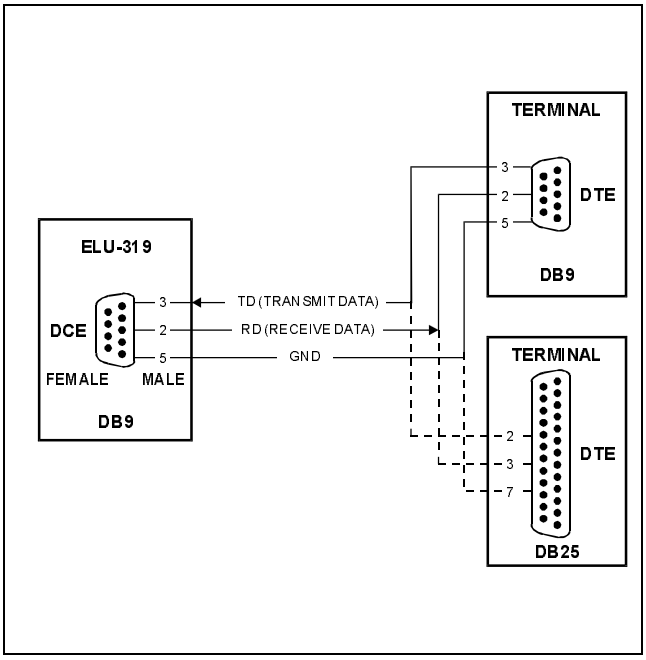

Figure 3. ELU-319 DB-9 Pin-Outs. A standard RS-232 (DB-9) connector on the front panel provides access to the menu interface feature via a dumb terminal.

9.05 To set the Margin Alarm Threshold, select G–SYSTEM SETTINGS and then select G–MAR(G)IN ALM THRES. Enter the minimum acceptable alarm threshold, from 0 to 15 dB. If the margin for HDSL Loop 1 or 2 drops ***below this value***, the ELU-319 triggers a minor alarm, and the front panel and status screen displays "MAL1" (Loop 1) or "MAL2" (Loop 2). Because a margin can never be less than zero, setting a threshold of zero turns this feature off.

9.06 To set the Clock, select B–SET CLOCK from the Main Menu. Enter the new date and time. Press U to update the ERU system time and date.

9.07 The Maintenance Port also provides several screens that display System Performance and Alarm Status information. Figures 13 through 24 illustrate these screens. Table 6 defines the terms used in the Alarm and System Setting screens. The illustrations of the System Setting and ELU Status screens show factory defaults with optional values or settings in parentheses.

10. LOOPBACK DESIGN DESCRIPTION

10.01 All HiGain ELU/ERU system loop-up codes must be initiated from either the front panel pushbuttons or from the maintenance terminal. The HiGain system does not respond to any ***in-band codes***.

10.02 Depressing both the **MODE** and **SEL** pushbuttons on the front panel for at least three seconds initiates a MANUAL loopback session. This session allows the user to **SEL** one of six HiGain loopbacks. The message "MAN LPBK" appears on the front panel display (see Figure 4.) followed by the message "NLO?". If the **SEL** button is now pressed, an NLOC loopback is executed and the message changes from "NLO?" to "NLOC". If the **MODE** button is pressed instead of **SEL** button, "NLO?" is replaced by "'ND1?. This now allows an NDU1 loopback to be executed (if it is a doubler application) with the **SEL** button. If it is not a doubler application, NRE? follows NLO?. If this same routine is followed, all six loopbacks (NLOC, NDU1, NREM, CLOC, CDU1, & CREM) are presented and can be initiated in the sequence listed. Note that NDU1 and CDU1 only can appear in doubler applications. Once a loopback is executed, it can be terminated and the next loopback option presented by pressing the **MODE** button. If neither button is pressed for 30 seconds and no loopback is in effect, this manual loopback session terminates and the normal margin displays reappear. If any loopback is in effect, this 30-second time-out is inhibited. The active loopback and the manual loopback session continue until the loopback times out in accordance with the user LBTO setting. Only one loopback may exist at any given time. Depressing both buttons, again for three seconds terminates any active loopback, ends the MANUAL loopback session, and returns the display to normal.

10.03 Note that these same six loopbacks can be initiated from the RS-232 maintenance port by choosing LOOPBACK MODE, option D, from the main menu. This displays the Loopback Menu, shown in Figures 22 and 23, from which you can initiate any of the six loopbacks.

10.04 The TLOS loopbacks (shown in Figure 4)is controlled by a user switch option in the ERU-412. When this option is enabled it forces the ERU-412 into a logic loopback state when its G.703 input signal is lost. When this TLOS option is disabled, it causes an AIS condition to occur at the G.703 output of the ELU-319 when the G.703 input to the ERU-412 is lost.

C. INSTALLATION AND TEST

11. INSTALLATION OPTIONS

11.01 Upon receipt of 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 Technologies.

11.02 The ELU-319 mounts in the PairGain HMS-318 shelf. The auxilary PairGain connector panel, HCP-322, connects to the HMS-318 shelf and provides G.703, 75 ohm, BNC connector access to each of the 22 slots. The ELU-319 slot pin-outs are shown in Figure 5.

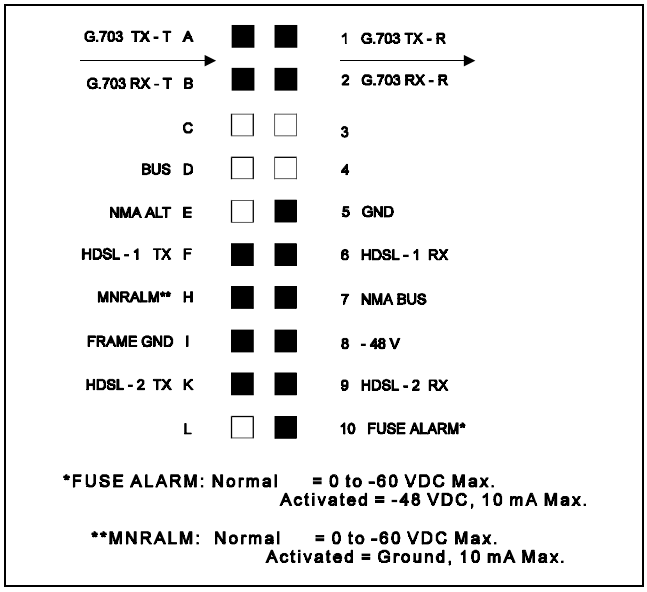

Figure 5. ELU-319 Pin-Outs. The active pins are highlighted in black in this illustration.

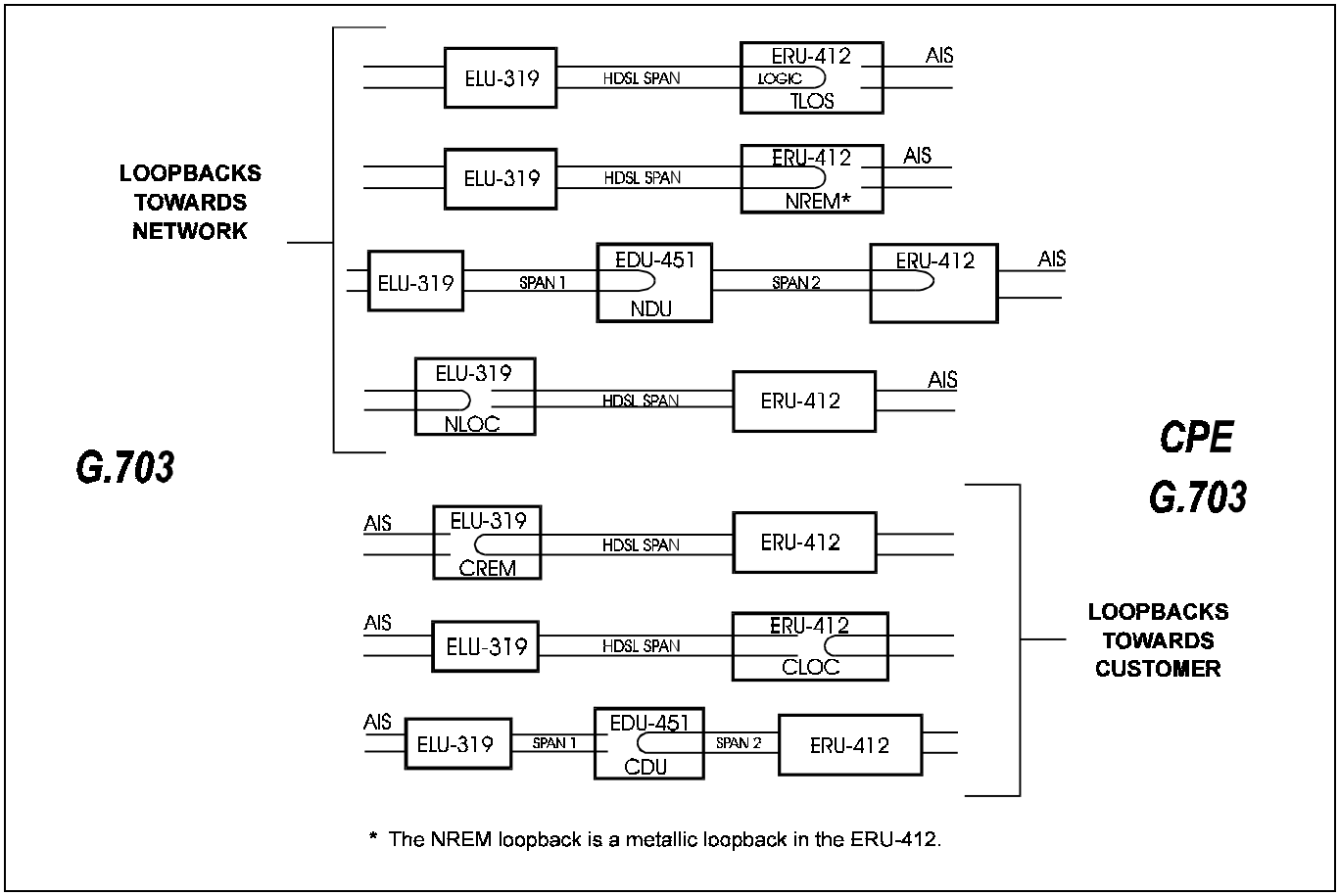

Figure 4. ELU-319 Loopback Configurations. All loopbacks are initiated from the front panel pushbuttons or from the maintenance terminal.

12. TESTING PROCEDURES

12.01 Table 4 lists the four-character front panel message displays of the ELU-319. This display energizes when power is initially applied to the ELU-319; it indicates system status and error conditions. In order to conserve power, the display de-energizes after five minutes if neither **MODE** or **SEL** are pressed. The use of either button restarts the 5-minute power-control timer.

12.02 If you encounter trouble with the G.703 interface, verify that the unit is making a positive connection with the mounting assembly's connector.

12.03 The transmit and receive G.703 ports have splitting access and bridging miniature 210-type jacks as shown in Figure 2. Connecting one cable between the two BRG jacks and another cable between the two SPAN jacks splits the XMT and RCV jacks and creates metallic loopbacks towards both the G.703 and the ELU-319.

TABLE 4. ELU-319 FOUR-CHARACTER FRONT PANEL MESSAGES

Message	*Full Name*	*Description*
CREM	Customer Remote Loopback	Signal from customer is looped back to customer at ELU-319.
NLOC	Network Local Loopback	G.703 signal is looped back to G.703 at ELU-319.
NDU	Network Doubler Loopback	Loopback at Doubler towards network.
CDU	Customer Doubler Loopback	Looback at Doubler towards CPE.
CLOC	Customer Local Loopback	Signal from Customer is looped back to customer at ERU-412.
NREM	Network Remote Loopback	G.703 signal is looped back to G.703 at the ERU-412.
TLOS	Transmit Loss Of Signal	ERU-412 is in a logic loopback state caused by a loss of its G.703 input from the NI, if enabled via the ERU-412 TLOS switch option set to **ON**.
LBPV	Local Bipolar Violation	A bipolar violation has been received at the G.703 input to the ELU-319.
SIG 1 or 2	Signal 1 or Signal 2	The ELU & ERU transceivers are trying to establish contact with each other on Loops 1 or 2 of Span 1.
S1L1 or 2	Signal 1 Loop 1 or Loop 2	The ELU and 1st doubler transceivers 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 1st Doubler and ERU transceivers 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 ELU & ERU multiplexers are trying to establish synchronization over each of Loops 1 or 2 of Span 1
A1L1 or 2	Acquisition 1 Loop 1 or Loop 2	The 1st Doubler and ERU multiplexers are trying to establish synchronization with each other on Loops 1 or 2 of Span 1.
A2L1 or 2	Acquisition 2 Loop 1 or Loop 2	The 1st Doubler and ERU multiplexers are trying to establish synchronization with each other on Loops 1 or 2 of Span 2.
H1ES		HDSL CRC error on Loop 1.
H2ES		HDSL CRC error on Loop 2.
ACO	Alarm CutOff	An MNRALM has occurred, and was retired to an ACO condition by pressing the **SEL** button on the ELU-319 front panel.

Table continued on next page

TABLE 4. ELU-319 FOUR-CHARACTER FRONT PANEL MESSAGES (CONTINUED)

Message	*Full Name*	*Description*
SELF TEST		The ELU-319 is in a self test mode. This occurs every power ON/OFF cycle. The self-test sequence includes the input G.703 transceiver chip when the HDSL loops are not in sync. This can cause the AIS pattern, normally transmitted from the ELU during this time, to exhibit bipolar violations (BPVs).
ALRM	Alarm Condition Exists	A minor alarm MNRALM condition is in effect.
1=xx or 2=yy	HDSL Loop Margins	Indicates the worst-case signal-to-noise ratio measured for each loop. A value of '06' or greater is adequate for reliable system operation.
PWR FEED SHRT	Power Feed Short	Indicates a short-circuit between the two HDSL pairs, or the ERU-412 cannot communicate with the ELU-319 over good cable.
PWR FEED OPEN	Power Feed Open	Indicates an open circuit in the Tip and Ring of either HDSL pair.
BAD RT?	No response from ERU	The ELU-319 does not receive any response from the ERU-412. Thus, the ERU's integrity is questionable.
VER	ELU Software Version #	This is displayed during the System Settings review mode. Press the Mode button for 3 seconds.
LIST 0xL	ELU's List #	Displayed during System Settings review mode defined above.
LOSW	Loss of Sync Word	Indicates that one of the HDSL loops has lost synchronization. Causes a minor alarm.
LLOS	Local Loss of Signal	Indicates that no signal is detected at the G.703 input to the ELU-319. Causes a minor alarm.
RLOS	Remote Loss of Signal	Indicates that no signal is detected at the G.703 input to the ERU-412. Causes a minor alarm.
G.703	G.703 BPV errors	Indicates that the number of BPVs at the ELU-319 and ERU-412 G.703 inputs that have exceeded the 24-hour ES threshold. Causes a minor alarm.
MAL1(2)	Margin Alarm Loop 1 or 2	The margin on HDSL loop 1 (2) has dropped below the threshold (1 to 15 dB) set by the user.

TABLE 5. ELU-319 STATUS MENU DEFINITIONS

Message	*Full Name*	*Description*
ALARMS		
NONE	No Alarms	
LLOS	Local Loss of Signal	No signal from local G.703 interface.
RLOS	Remote Loss of Signal	No signal from remote G.703 interface.
LOSW 1 (2)	Loss of (HDSL) Sync Word 1 or 2	HDSL LOOP 1 or 2 has lost frame sync.
H1ES	HDSL Loop 1 Errored Second	The number of Loop 1's Errored Seconds has exceeded the user-selected Errored Seconds threshold.
H2ES	HDSL Loop 2 Errored Second	The number of Loop 2's Errored Seconds has exceeded the user-selected Errored Seconds threshold.
G.703	G.703	G.703 input BPVs have exceeded the user selected ES threshold.
MAL1	Margin Alarm (HDSL Loop 1)	The margin on HDSL Loop 1 dropped below the Margin Alarm Threshold (1 to 15). Setting the threshold to 0 (zero) inhibits the alarm.
MAL2	Margin Alarm (HDSL Loop 2)	The margin on HDSL Loop 2 dropped below the user Margin Alarm Threshold (1 to 15). Setting the threshold to 0 (zero) inhibits the alarm.
ACO	Alarm Cut Off	Al Alarm cut-off is in effect.
LAIS	Local Alarm Indicating Signal	Indicates an AIS (all 1's) pattern is being transmitted from the local G.703 output port.
RAIS	Remote Alarm Indicating Signal	Indicates an AIS (all 1's) pattern is being transmitted from the remote G.703 output port.
LOOPBACKS		
NREM	Network Remote Loopback	Loopback at ERU-412 (remote) towards network initiated from ERU-412 front panel pushbutton, or maintenance terminal, or by pressing both the **MODE** & **SEL** ELU front panel pushbuttons. See Figure 4.
NLOC	Network Local Loopback	Loopback at ELU-319 (local) towards network by pressing both MODE and SEL pushbuttons on the ELU-319 front panel. See Figure 4.
NDU	Network Doubler Loopback	Loopback at Doubler towards network initiated from Loopback Mode menu screen or by pressing both the **MODE** & **SEL** ELU front panel pushbuttons. See Figure 4.
CLOC	Customer Local Loopback	Loopback at ERU-412 (local) towards customer interface (CI) initiated from the maintenance terminal or by pressing both MODE and SEL pushbuttons on the ELU-319 front panel. See Figure 4.

Table continued on next page

TABLE 5. ELU-319 STATUS MENU DEFINITIONS (CONTINUED)

Message	*Full Name*	*Description*
CHREV	Channels Reversed	Channel (loop) 1 & 2 HDSL pairs are reversed at the EDU or ERU line input ports.
CREM	Customer Remote Loopback	Loopback at ERU-412 (local) towards customer interface (CI) initiated from the maintenance terminal or by pressing both MODE and SEL pushbuttons on the ELU-319 front panel. See Figure 4.
CDU	Customer Doubler Loopback	Looback at Doubler towards CI initiated from Loopback Mode menu screen or by pressing both the **MODE** & **SEL** ELU front panel pushbuttons. See Figure 4.

TABLE 6. GLOSSARY OF HIGAIN TERMS

Term	*Definition*
MARGINS	Indicates the excess signal to noise ratio, at either the ELU-319 or ERU-412, relative to a 10^{-7} Bit Error Rate. 1st value is current margin, 2nd value is minimum margin since (C)leared last, 3rd value is maximum value since cleared, and NA means Not Available (loops are not synchronized). The normal range of a typical margin is from 6 to 22 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 loss at 260 kHz. The pulse attenuation is a more direct indication of the loop attenuation to the 2B1Q signal than the 260 kHz loss. The normal range of pulse attenuation is from 1 to 32 dB.
PPM	Indicates the relative offset (in parts per million) of the crystal oscillator in the ERU-412 from the ELU-319'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 1-second intervals that contained at least 1 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.
G.703 BPV Seconds (ES)	The number of seconds during which at least 1 bipolar violation was detected at the G.703 input.
G.703 UAS Count	The number of seconds during which the G.703 input signal was absent (125 or more consecutive zeroes).
ELU/Ver x.x-yyyy ERU/ver x.x-yyyy	"x.x" = the software version number of the ELU-319 or ERU-412. "yyyy" = the list number of the ELU-319 or ERU-412.

```
  HI-GAIN ELU-319 (G.703)   MAINTENANCE TERMINAL MAIN MENU   (ver V1.5L-0003)
                              CIRCUIT ID#: Slot #8

                          A. VIEW SPAN STATUS
                          B. SET CLOCK
                          C. SYSTEM SETTINGS
                          D. LOOPBACK MODE:  NONE
                          E. VIEW PERFORMANCE DATA
                          F. VIEW PERFORMANCE HISTORY
                          G. VIEW ALARM HISTORY
                          H. ENTER CIRCUIT ID #









 enter circuit ID # (24 characters max): Slot #8

 (C)onfirm
```

Figure 6. Main Menu.

```
                              SPAN STATUS
                    ( ELU/ver1.5-0003: ERU/ver0.0-0000)
 TIME: 13:32:42
 DATE: 05/18/95                        CIRCUIT ID#: Slot #8

 ALARMS:   LAIS LOSW1 LOSW2
 LOOPBACK: OFF
                           ELU                          ERU
                   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
 PPM OFFSET:        N/A          N/A          N/A          N/A   ppm
 24 HOUR ES:      00002        00002        00004        00004  seconds
 24 HOUR UAS:     00035        00035        00007        00000  seconds

                                  G.703 STATUS
                                ELU                  ERU
 24 HOUR BPV Seconds:         00007                00004
 24 HOUR UAS Count:           00000                00004

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

Figure 7. Span Status Display (no Doubler).

```
                          SPAN 1 STATUS
                  ( ELU/ver1.5-0003:EDU1/ver1.2-00FF)
TIME: 13:18:00
DATE: 05/18/95                      CIRCUIT ID#: Slot #8

ALARMS:   NONE
LOOPBACK: OFF
                        ELU                          EDU1
                  HDSL-1       HDSL-2       HDSL-1       HDSL-2
                cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:           17/17/19     18/15/19     21/00/22     21/00/22 dB
PULSE ATTN:         00           01           01           01    dB
PPM OFFSET:         00           00           -04          -04   ppm
24 HOUR ES:       00001        00001        00001        00001   seconds
24 HOUR UAS:      00016        00016        00005        00004   seconds

                                 G.703 STATUS
                               ELU                  ERU
24 HOUR BPV Seconds:         00006                00004
24 HOUR UAS Count:           00000                00004

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

Figure 8. Span 1 Status Display (in system with one Doubler).

```
                          SPAN 2 STATUS
                 (EDU1/ver1.2-00FF: ERU/ver1.2-0001)
TIME: 13:19:17
DATE: 05/18/95                      CIRCUIT ID#: Slot #8

ALARMS:   NONE
LOOPBACK: OFF
                        EDU1                         ERU
                  HDSL-1       HDSL-2       HDSL-1       HDSL-2
                cur/min/max  cur/min/max  cur/min/max  cur/min/max
MARGIN:           22/00/22     21/00/22     23/21/24     22/21/23 dB
PULSE ATTN:         00           00           01           01    dB
PPM OFFSET:         00           00           -30          -30   ppm
24 HOUR ES:       00001        00000        00003        00003   seconds
24 HOUR UAS:      00005        00004        00001        00000   seconds

                                 G.703 STATUS
                               ELU                  ERU
24 HOUR BPV Seconds:         00006                00004
24 HOUR UAS Count:           00000                00004

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

Figure 9. Span 2 Status Display (in system with one Doubler).

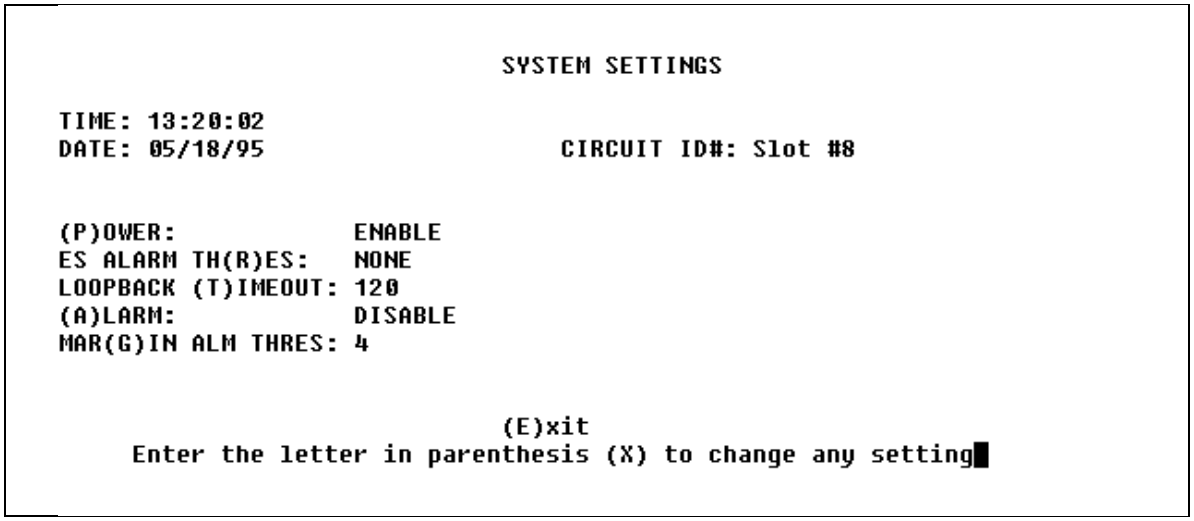

Figure 10. System Settings Menu.

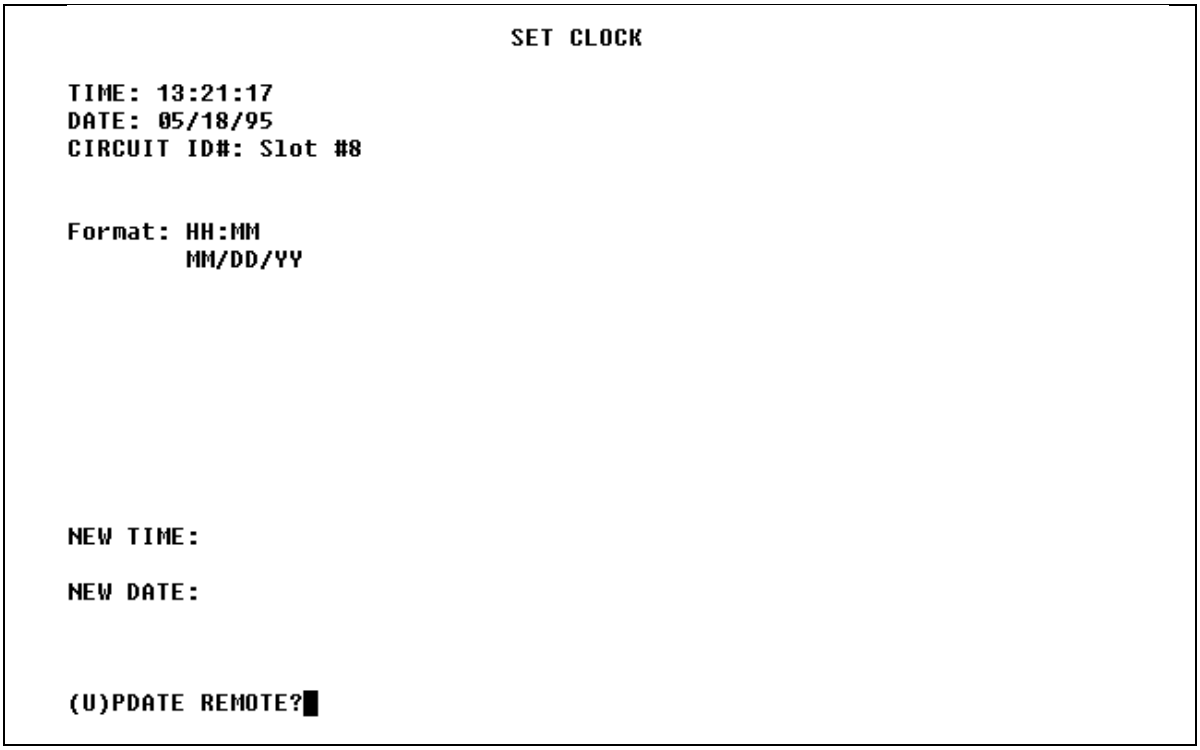

Figure 11. Set Clock Menu.

```
Date: 05/18/95              PERFORMANCE DATA
CIRCUIT ID#: Slot #8
                  ERRORED SECONDS/UNAVAILABLE SECONDS

               G.703              HDSL-1              HDSL-2
           ELU       ERU      ELU       ERU       ELU       ERU
09:45    000/000   000/000  000/000   000/000   000/000   000/000
10:00    000/000   000/000  000/000   000/000   000/000   000/000
10:15    000/000   000/000  000/000   000/000   000/000   000/000
10:30    000/000   000/000  000/000   000/000   000/000   000/000
10:45    000/000   000/000  000/000   000/000   000/000   000/000
11:00    000/000   000/000  000/000   000/000   000/000   000/000
11:15    000/000   000/000  000/000   000/000   000/000   000/000
11:30    000/000   000/000  000/000   000/000   000/000   000/000
11:45    000/000   000/000  000/000   000/000   000/000   000/000
12:00    000/000   000/000  000/000   000/000   000/000   000/000
12:15    006/000   004/004  001/016   003/001   001/016   003/000
12:30    000/000   000/000  000/000   000/000   000/000   000/000
12:45    000/000   000/000  000/000   000/000   000/000   000/000
13:00    000/000   000/000  000/000   000/000   000/000   000/000
13:15    000/000   000/000  000/000   000/000   000/000   000/000
13:30    000/000   000/000  000/000   000/000   000/000   000/000

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

Figure 12. Performance Data Display (no Doubler).

```
Date: 05/18/95          SPAN 1 PERFORMANCE DATA
CIRCUIT ID#: Slot #8
                  ERRORED SECONDS/UNAVAILABLE SECONDS

               G.703              HDSL-1              HDSL-2
           ELU       ERU      ELU       EDU1      ELU       EDU1
09:30    000/000   000/000  000/000   000/000   000/000   000/000
09:45    000/000   000/000  000/000   000/000   000/000   000/000
10:00    000/000   000/000  000/000   000/000   000/000   000/000
10:15    000/000   000/000  000/000   000/000   000/000   000/000
10:30    000/000   000/000  000/000   000/000   000/000   000/000
10:45    000/000   000/000  000/000   000/000   000/000   000/000
11:00    000/000   000/000  000/000   000/000   000/000   000/000
11:15    000/000   000/000  000/000   000/000   000/000   000/000
11:30    000/000   000/000  000/000   000/000   000/000   000/000
11:45    000/000   000/000  000/000   000/000   000/000   000/000
12:00    000/000   000/000  000/000   000/000   000/000   000/000
12:15    006/000   004/004  001/016   001/005   001/016   001/004
12:30    000/000   000/000  000/000   000/000   000/000   000/000
12:45    000/000   000/000  000/000   000/000   000/000   000/000
13:00    000/000   000/000  000/000   000/000   000/000   000/000
13:15    000/000   000/000  000/000   000/000   000/000   000/000

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

Figure 13. Span 1 Performance Data Display (in system with no Doubler).

```
Date: 05/18/95          SPAN 2 PERFORMANCE DATA
CIRCUIT ID#: Slot #8
                    ERRORED SECONDS/UNAVAILABLE SECONDS

                 G.703              HDSL-1              HDSL-2
              ELU       ERU      EDU1       ERU      EDU1       ERU
09:30     000/000   000/000   000/000   000/000   000/000   000/000
09:45     000/000   000/000   000/000   000/000   000/000   000/000
10:00     000/000   000/000   000/000   000/000   000/000   000/000
10:15     000/000   000/000   000/000   000/000   000/000   000/000
10:30     000/000   000/000   000/000   000/000   000/000   000/000
10:45     000/000   000/000   000/000   000/000   000/000   000/000
11:00     000/000   000/000   000/000   000/000   000/000   000/000
11:15     000/000   000/000   000/000   000/000   000/000   000/000
11:30     000/000   000/000   000/000   000/000   000/000   000/000
11:45     000/000   000/000   000/000   000/000   000/000   000/000
12:00     000/000   000/000   000/000   000/000   000/000   000/000
12:15     006/000   004/004   001/005   003/001   000/004   003/000
12:30     000/000   000/000   000/000   000/000   000/000   000/000
12:45     000/000   000/000   000/000   000/000   000/000   000/000
13:00     000/000   000/000   000/000   000/000   000/000   000/000
13:15     000/000   000/000   000/000   000/000   000/000   000/000

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

Figure 14. Span 2 Performance Data Display (in system with no Doubler).

```
Time: 13:36:17                    7 DAY HISTORY
CIRCUIT ID#: Slot #8


                        ERRORED SECONDS/UNAVAILABLE SECONDS

                 G.703                    HDSL-1                    HDSL-2
            ELU          ERU          ELU          ERU          ELU          ERU
05/11   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/12   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/13   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/14   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/15   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/16   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
05/17   00000/00000  00000/00000  00000/00000  00000/00000  00000/00000  00000/00000
current 00006/00000  00004/00004  00001/00016  00003/00001  00001/00016  00003/00000

                                  (E)xit
```

Figure 15. Performance Data History Display (no Doubler).

```
Time: 13:24:15                    7 DAY HISTORY
CIRCUIT ID#: Slot #8

                                  SPAN 1
                        ERRORED SECONDS/UNAVAILABLE SECONDS

              G.703                    HDSL-1                   HDSL-2
           ELU         ERU          ELU         EDU1         ELU         EDU1
05/11   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/12   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/13   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/14   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/15   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/16   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/17   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00006/00000 00004/00004 00001/00016 00001/00005 00001/00016 00001/00004

                                  (E)xit (S)pan
```

Figure 16. Span 1 Performance Data History Display (in system with one Doubler).

```
Time: 13:25:41                    7 DAY HISTORY
CIRCUIT ID#: Slot #8

                                  SPAN 2
                        ERRORED SECONDS/UNAVAILABLE SECONDS

              G.703                    HDSL-1                   HDSL-2
           ELU         ERU          EDU1        ERU          EDU1        ERU
05/11   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/12   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/13   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/14   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/15   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/16   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
05/17   00000/00000 00000/00000 00000/00000 00000/00000 00000/00000 00000/00000
current 00006/00000 00004/00004 00001/00005 00003/00001 00000/00004 00003/00000

                                  (E)xit (S)pan
```

Figure 17. Span 2 Performance Data History Display (in system with one Doubler).

```
                              ALARM HISTORY

TIME: 13:38:49
DATE: 05/18/95
CIRCUIT ID#: Slot #8

Type              First               Last                Current        Count
LOS, ELU                                                  OK             000
LOS, ERU                                                  OK             000
LOSW, HDSL1       04/08/95-00:00      05/18/95-13:32      ALARM          002
LOSW, HDSL2       04/08/95-00:00      05/18/95-13:32      ALARM          002
ES, HDSL1                                                 OK             000
ES, HDSL2                                                 OK             000
MARGIN L1         04/08/95-00:00      05/18/95-13:32      OK             002
MARGIN L2         04/08/95-00:00      04/08/95-00:00      OK             001

LAST CLEARED:  NONE



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

Figure 18. Alarm History (no Doubler).

```
                              ALARM HISTORY

TIME: 13:27:01
DATE: 05/18/95
CIRCUIT ID#: Slot #8

Type              First               Last                Current        Count
LOS, ELU                                                  OK             000
LOS, ERU                                                  OK             000
SPAN1 LOSW, HDSL1 04/08/95-00:00      04/08/95-00:00      OK             001
SPAN1 LOSW, HDSL2 04/08/95-00:00      04/08/95-00:00      OK             001
SPAN1 ES, HDSL1                                           OK             000
SPAN1 ES, HDSL2                                           OK             000
SPAN1 MARGIN L1   04/08/95-00:00      04/08/95-00:00      OK             001
SPAN1 MARGIN L2   04/08/95-00:00      04/08/95-00:00      OK             001

LAST CLEARED:  NONE



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

Figure 19. Span 1 Alarm History (in system with one Doubler).

```
                              ALARM HISTORY

TIME: 13:29:44
DATE: 05/18/95
CIRCUIT ID#: Slot #8

Type              First               Last                Current        Count
LOS, ELU                                                  OK             000
LOS, ERU                                                  OK             000
SPAN2 LOSW, HDSL1 04/08/95-00:00      04/08/95-00:00      OK             001
SPAN2 LOSW, HDSL2 04/08/95-00:00      04/08/95-00:00      OK             001
SPAN2 ES, HDSL1                                           OK             000
SPAN2 ES, HDSL2                                           OK             000
SPAN2 MARGIN L1   04/08/95-00:00      04/08/95-00:00      OK             001
SPAN2 MARGIN L2   04/08/95-00:00      04/08/95-00:00      OK             001

LAST CLEARED:  NONE



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

Figure 20. Span 2 Alarm History (in system with one Doubler).

```
                              LOOPBACK MENU

 TIME: 13:40:19
 DATE: 05/18/95
 CIRCUIT ID#: Slot #8


                          A. DISABLE LOOPBACKS
                          B. ELU LOOP TO NETWORK       (NLOC)
                          C. ERU LOOP TO NETWORK       (NREM)
                          G. ELU LOOP TO CUSTOMER      (CREM)
                          H. ERU LOOP TO CUSTOMER      (CLOC)









                                   (E)xit
```

Figure 21. Loopback Menu (no Doubler).

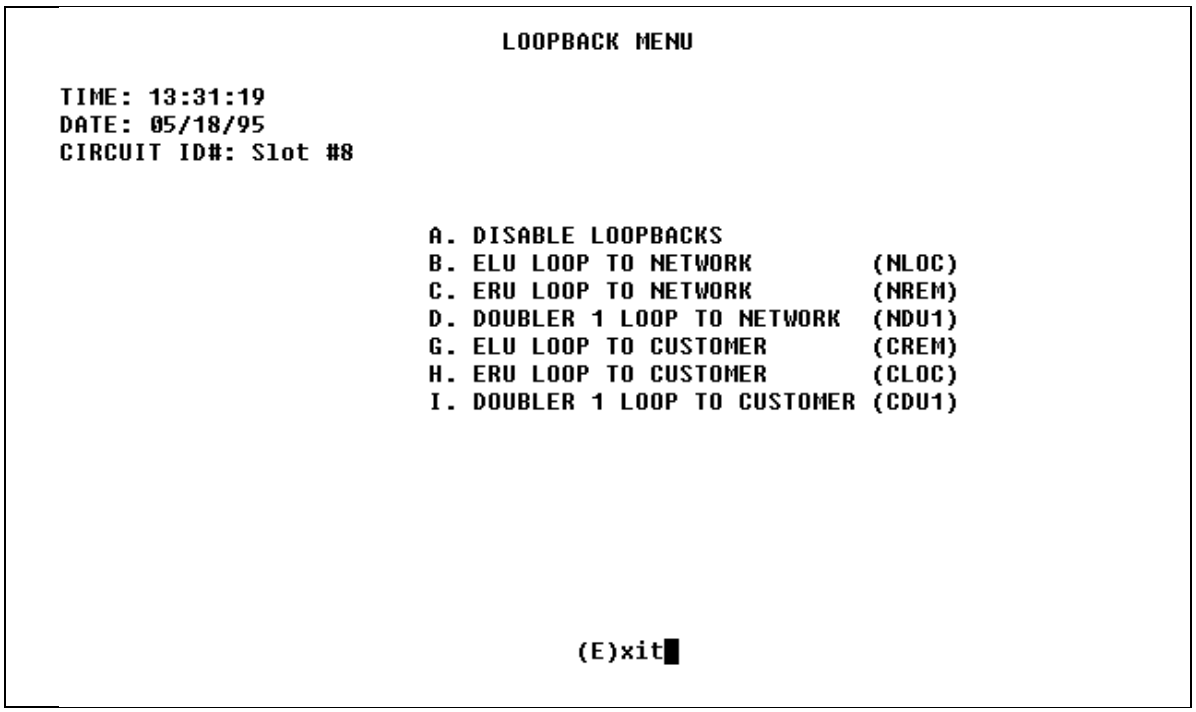

Figure 22. Loopback Menu (in system with one Doubler).